Appendix C
Additional Monitoring Results for 2003

G. W. Patton and E. J. Antonio

This appendix contains additional information on 2003 monitoring results, supplementing the data summarized in the main body of the report. More detailed information is available in PNNL-14687, APP. 1.

Table C.1. Radionuclide Concentrations in Columbia River Water Samples Collected at Priest Rapids Dam, Washington, 2003 Compared to Previous 5 Years

Radionuclide[a]		2003 No. of Samples	2003 Concentration,[b] pCi/L Maximum	2003 Concentration,[b] pCi/L Average	1998-2002 No. of Samples	1998-2002 Concentration,[b] pCi/L Maximum	1998-2002 Concentration,[b] pCi/L Average	Ambient Surface Water Quality Standard, pCi/L
Composite System								
Tritium		12	80 ± 9.0	36 ± 35	58	200 ± 22	39 ± 49	20,000[c]
Alpha (gross)		12	0.94 ± 0.85[d]	0.48 ± 0.56	60	5.6 ± 3.1	0.57 ± 1.5	15[e,f]
Beta (gross)		12	2.5 ± 2.1[d]	0.66 ± 1.8	60	7.7 ± 2.2	0.94 ± 3.3	50[e,f]
Strontium-90		12	0.15 ± 0.047	0.088 ± 0.052	60	0.11 ± 0.038	0.072 ± 0.028	8[c,f]
Technetium-99		12	0.52 ± 0.53	0.094 ± 0.46	60	0.53 ± 0.55[d]	0.0075 ± 0.34	900[c]
Iodine-129		4	0.0000059 ± 0.0000016	0.0000046 ± 0.0000020	20	0.000022 ± 0.0000021	0.0000097 ± 0.000015	1[c]
Uranium-234		12	0.26 ± 0.058	0.22 ± 0.053	60	0.42 ± 0.087	0.23 ± 0.092	--[g]
Uranium-235		12	0.014 ± 0.014[d]	0.0036 ± 0.0094	60	0.025 ± 0.016	0.0062 ± 0.013	--
Uranium-238		12	0.23 ± 0.053	0.17 ± 0.049	60	0.38 ± 0.080	0.19 ± 0.089	--
Uranium (total)		12	0.50 ± 0.080	0.40 ± 0.097	60	0.81 ± 0.12	0.43 ± 0.17	--
Continuous System								
Cobalt-60	P	12	0.0018 ± 0.0012[d]	0.00040 ± 0.0013[d]	52	0.0013 ± 0.0016[d]	0.00026 ± 0.0010	100[c]
	D	12	0.0026 ± 0.0019[d]	0.00092 ± 0.0026[d]	52	0.0040 ± 0.0028[d]	0.00083 ± 0.0030	
Cesium-137	P	12	0.0014 ± 0.0011[d]	0.00033 ± 0.0011[d]	52	0.0032 ± 0.0013	0.00073 ± 0.0016	200[c]
	D	12	0.0027 ± 0.0022[d]	0.00084 ± 0.0026[d]	52	0.0034 ± 0.0021[d]	0.0010 ± 0.0021	
Europium-155	P	12	0.0030 ± 0.0026[d]	0.00043 ± 0.0028[d]	52	0.0032 ± 0.0044[d]	0.00026 ± 0.0021	600[c]
	D	12	0.0054 ± 0.0045[d]	0.0023 ± 0.0043[d]	52	0.012 ± 0.014[d]	0.0013 ± 0.0059	
Plutonium-239/240	P	4	0.000053 ± 0.000037	0.000036 ± 0.000051	20	0.00028 ± 0.00010	0.000046 ± 0.000013	--
	D	4	0.000025 ± 0.000036[d]	0.000021 ± 0.000013[d]	20	0.000055 ± 0.000072[d]	0.000023 ± 0.000039	

(a) Radionuclides measured using the continuous system show the particulate (P) and dissolved (D) fractions separately. Other radionuclides are based on unfiltered samples collected by the composite system (see Section 4.2).
(b) Maximum values are ± total propagated analytical uncertainty (2 sigma). Averages are ±2 standard deviations of the mean. To convert to the International System of Units, multiply pCi/L by 0.037 to obtain Bq/L.
(c) WAC 173-201A-50 and EPA-570/9-76-003.
(d) Less than the laboratory reported detection limit.
(e) WAC 246-290.
(f) 40 CFR 141.
(g) Dashes indicate no concentration guides available.

Table C.2. Radionuclide Concentrations in Columbia River Water Samples Collected at Richland, Washington, 2003 Compared to Previous 5 Years

Radionuclide[a]		2003 No. of Samples	2003 Concentration,[b] pCi/L Maximum	2003 Concentration,[b] pCi/L Average	1998-2002 No. of Samples	1998-2002 Concentration,[b] pCi/L Maximum	1998-2002 Concentration,[b] pCi/L Average	Ambient Surface Water Quality Standard, pCi/L
Composite System								
Tritium		12	140 ± 14	71 ± 64	58	150 ± 18	72 ± 49	20,000[c]
Alpha (gross)		12	1.6 ± 1.1	0.64 ± 0.93	60	1.8 ± 1.2	0.58 ± 0.76	15[e,f]
Beta (gross)		12	2.8 ± 2.1[d]	0.96 ± 1.8	60	6.6 ± 2.5	0.66 ± 2.8	50[e,f]
Strontium-90		12	0.14 ± 0.035	0.098 ± 0.049	60	0.10 ± 0.037	0.067 ± 0.037	8[e,f]
Technetium-99		12	1.2 ± 0.57	0.28 ± 0.79	60	0.53 ± 0.52	0.026 ± 0.34	900[c]
Iodine-129		4	0.00012 ± 0.0000096	0.000081 ± 0.000065	20	0.00019 ± 0.000022	0.000094 ± 0.000076	1[c]
Uranium-234		12	0.32 ± 0.073	0.28 ± 0.063	60	0.37 ± 0.070	0.26 ± 0.077	--[g]
Uranium-235		12	0.015 ± 0.012	0.0065 ± 0.0086	60	0.024 ± 0.015	0.0084 ± 0.012	--
Uranium-238		12	0.30 ± 0.066	0.22 ± 0.067	60	0.30 ± 0.066	0.21 ± 0.073	--
Uranium (total)		12	0.61 ± 0.093	0.51 ± 0.12	60	0.68 ± 0.093	0.49 ± 0.14	--
Continuous System								
Cobalt-60	P	12	0.0012 ± 0.001[d]	0.00029 ± 0.0010[d]	52	0.0016 ± 0.0011[d]	0.00022 ± 0.0011	100[f]
	D	12	0.0027 ± 0.0038[d]	0.00090 ± 0.0024[d]	52	0.0034 ± 0.0044[d]	0.00074 ± 0.0021	
Cesium-137	P	12	0.0014 ± 0.0012[d]	0.00061 ± 0.0093[d]	52	0.0037 ± 0.0015	0.00075 ± 0.0013	200[f]
	D	12	0.0023 ± 0.0023[d]	0.00084 ± 0.0019[d]	52	0.0031 ± 0.0035[d]	0.00086 ± 0.0020	
Europium-155	P	12	0.0023 ± 0.0028[d]	0.00014 ± 0.0020[d]	52	0.0023 ± 0.0020[d]	0.00029 ± 0.0023	600[f]
	D	12	0.0070 ± 0.0049[d]	0.0021 ± 0.0062[d]	52	0.0077 ± 0.013[d]	0.00086 ± 0.0061	
Plutonium-239/240	P	3	0.000089 ± 0.000046	0.000065 ± 0.000068	20	0.00017 ± 0.000087	0.000030 ± 0.000074	--
	D	4	0.000043 ± 0.000062[d]	0.000019 ± 0.000036[d]	20	0.00016 ± 0.000091	0.000034 ± 0.000094	

(a) Radionuclides measured using the continuous system show the particulate (P) and dissolved (D) fractions separately. Other radionuclides are based on unfiltered samples collected by the composite system (see Section 4.2).
(b) Maximum values are ± total propagated analytical uncertainty (2 sigma). Averages are ±2 standard deviations of the mean. To convert to the International System of Units, multiply pCi/L by 0.037 to obtain Bq/L.
(c) WAC 173-201A-50 and EPA-570/9-76-003.
(d) Less than the laboratory reported detection limit.
(e) WAC 246-290.
(f) 40 CFR 141.
(g) Dashes indicate no concentration guides available.

Table C.3. Radionuclide Concentrations Measured in Columbia River Water Samples Collected Along Transects of the Hanford Reach, 2003

Transect/Radionuclide	No. of Samples	Concentration,[a] pCi/L Maximum	Concentration,[a] pCi/L Minimum
Vernita Bridge (HRM 0.3)			
Tritium	16	130 ± 25	19 ± 3.9
Strontium-90	16	0.12 ± 0.028	0.062 ± 0.038
Uranium (total)	16	0.52 ± 0.081	0.34 ± 0.068
100-N Area (HRM 9.5)			
Tritium	7	150 ± 26	24 ± 5.5
Strontium-90	7	0.086 ± 0.035	0.058 ± 0.029
Uranium (total)	7	0.52 ± 0.086	0.36 ± 0.062
100-F Area (HRM 19)			
Tritium	6	35 ± 9.2	24 ± 6.8
Strontium-90	6	0.095 ± 0.029	0.075 ± 0.025
Uranium (total)	6	0.54 ± 0.081	0.41 ± 0.065
Hanford Town Site (HRM 28.7)			
Tritium	6	3,400 ± 560	26 ± 7.1
Strontium-90	6	0.090 ± 0.028	0.056 ± 0.020
Uranium (total)	6	0.56 ± 0.084	0.35 ± 0.061
300 Area (HRM 43.1)			
Tritium	6	120 ± 22	33 ± 7.4
Strontium-90	6	0.078 ± 0.026	0.050 ± 0.020
Uranium (total)	6	0.89 ± 0.12	0.42 ± 0.072
Richland (HRM 46.4)			
Tritium	26	140 ± 24	18 ± 3.8
Strontium-90	26	0.10 ± 0.027	0.050 ± 0.029
Uranium (total)	26	1.2 ± 0.16	0.34 ± 0.076

(a) Maximum and minimum values are ± total propagated analytical uncertainty (2-sigma). To convert to the International System of Units, multiply pCi/L by 0.037 to obtain Bq/L.

HRM = Hanford river mile.

Table C.4. Radionuclide Concentrations Measured in Columbia River Water Samples Collected at Near-Shore Locations in the Hanford Reach, 2003

Near-Shore/Radionuclide	No. of Samples	Concentration,[a] pCi/L Maximum	Concentration,[a] pCi/L Minimum
Vernita Bridge (HRM 0.3)			
Tritium	4	33 ± 6.7	22 ± 4.2
Strontium-90	4	0.12 ± 0.028	0.081 ± 0.036
Uranium (total)	4	0.49 ± 0.075	0.36 ± 0.068
100-N Area (HRM 8.4 to 9.8)			
Tritium	6	150 ± 26	29 ± 6.2
Strontium-90	6	0.43 ± 0.075	0.072 ± 0.026
Uranium (total)	6	0.47 ± 0.090	0.38 ± 0.072
100-F Area (HRM 18 to 23)			
Tritium	4	33 ± 8.2	25 ± 7.0
Strontium-90	4	0.094 ± 0.028	0.062 ± 0.024
Uranium (total)	4	0.43 ± 0.070	0.36 ± 0.062
Hanford Town Site (HRM 26 to 30)			
Tritium	5	19,000 ± 1,400	27 ± 7.3
Strontium-90	5	0.073 ± 0.022	0.052 ± 0.019
Uranium (total)	5	1.2 ± 0.16	0.34 ± 0.063
300 Area (HRM 41.5 to 43.1)			
Tritium	5	1,800 ± 210	120 ± 12
Strontium-90	5	0.089 ± 0.027	0.050 ± 0.020
Uranium (total)	5	13 ± 1.5	0.48 ± 0.074
Richland (HRM 43.5 to 46.4)			
Tritium	21	140 ± 25	20 ± 3.9
Strontium-90	21	0.10 ± 0.027	0.051 ± 0.032
Uranium (total)	21	0.80 ± 0.14	0.36 ± 0.075

(a) Maximum and minimum values are ± total propagated analytical uncertainty (2-sigma). To convert to the International System of Units, multiply pCi/L by 0.037 to obtain Bq/L.

HRM = Hanford river mile.

Table C.5. Concentrations (µg/L) of Dissolved Metals in Columbia River Transect and Near-Shore Water Samples Collected Near the Hanford Site, 2003

Location	Metal	No. of Samples	Maximum	Minimum	Average	±2SD[a]
Vernita Bridge	Antimony	16	0.25	0.16	0.19	0.050
	Arsenic	16	0.67	0.51	0.60	0.098
	Beryllium	16	0.066	0.0098	0.042	0.050
	Cadmium	16	0.031	0.014	0.022	0.0082
	Chromium	16	0.27	0.047[b]	0.11	0.15
	Copper	16	0.68	0.34	0.52	0.24
	Lead	16	0.066	0.0090	0.015	0.027
	Nickel	16	0.68	0.40	0.59	0.14
	Selenium	16	0.56	0.080	0.31	0.42
	Silver	16	0.0085	0.004	0.0063	0.0046
	Thallium	16	0.022	0.0090	0.014	0.0083
	Zinc	16	2.2	0.54	1.2	0.96
100-N Area	Antimony	10	0.23	0.18	0.20	0.032
	Arsenic	10	0.58	0.50	0.55	0.046
	Beryllium	10	0.066[b]	0.066[b]	0.066[b]	0
	Cadmium	10	0.028	0.023	0.024	0.0028
	Chromium	10	0.27	0.047	0.070	0.14
	Copper	10	0.73	0.48	0.54	0.14
	Lead	10	0.013	0.011	0.011	0.0017
	Nickel	10	0.61	0.47	0.54	0.093
	Selenium	10	0.50[b]	0.50[b]	0.50[b]	0
	Silver	10	0.0085[b]	0.0085[b]	0.0085[b]	0
	Thallium	10	0.020	0.0099	0.015	0.0065
	Zinc	10	0.99	0.63	0.72	0.22
100-F Area	Antimony	9	0.20	0.16	0.19	0.023
	Arsenic	9	0.62	0.50	0.56	0.075
	Beryllium	9	0.066[b]	0.066[b]	0.066[b]	0
	Cadmium	9	0.026	0.023	0.023	0.0019
	Chromium	9	0.047[b]	0.047[b]	0.047[b]	0
	Copper	9	0.56	0.45	0.51	0.064
	Lead	9	0.012	0.011	0.011	0.0010
	Nickel	9	0.64	0.44	0.51	0.15
	Selenium	9	0.50[b]	0.50[b]	0.50[b]	0
	Silver	9	0.0085[b]	0.0085[b]	0.0085[b]	0
	Thallium	9	0.017	0.0090	0.012	0.0060
	Zinc	9	1.7	0.64	1.0	0.80
Hanford Town Site	Antimony	10	0.21	0.16	0.18	0.037
	Arsenic	10	1.4	0.50	0.66	0.52
	Beryllium	10	0.066[b]	0.066[b]	0.066[b]	0
	Cadmium	10	0.023[b]	0.023[b]	0.023[b]	0
	Chromium	10	0.78	0.047[b]	0.13	0.46
	Copper	10	0.63	0.39	0.49	0.13
	Lead	10	0.011[b]	0.011[b]	0.011[b]	0
	Nickel	10	0.76	0.50	0.60	0.15
	Selenium	10	0.50[b]	0.50[b]	0.50[b]	0
	Silver	10	0.0085[b]	0.0085[b]	0.0085[b]	0
	Thallium	10	0.019	0.0090	0.010	0.0062
	Zinc	10	2.2	0.80	1.4	0.84

Table C.5. (contd)

Location	Metal	No. of Samples	Maximum	Minimum	Average	±2SD[a]
300 Area	Antimony	10	0.20	0.17	0.18	0.023
	Arsenic	10	0.94	0.55	0.67	0.27
	Beryllium	10	0.066[b]	0.066[b]	0.066[b]	0
	Cadmium	10	0.023[b]	0.023[b]	0.023[b]	0
	Chromium	10	0.25	0.047[b]	0.070	0.13
	Copper	10	0.59	0.47	0.51	0.066
	Lead	10	0.090	0.011	0.036	0.067
	Nickel	10	0.84	0.60	0.69	0.15
	Selenium	10	0.50[b]	0.50[b]	0.50[b]	0
	Silver	10	0.0085[b]	0.0085[b]	0.0085[b]	0
	Thallium	10	0.015	0.0090	0.0098	0.0041
	Zinc	10	2.0	1.1	1.5	0.51
Richland	Antimony	39	0.24	0.15	0.18	0.036
	Arsenic	39	1.1	0.37	0.62	0.26
	Beryllium	39	0.066	0.0098	0.042	0.049
	Cadmium	39	0.025	0.012	0.020	0.0070
	Chromium	39	0.40	0.020[b]	0.097	0.16
	Copper	39	1.7	0.38	0.57	0.48
	Lead	39	0.066	0.0062	0.021	0.033
	Nickel	39	0.68	0.49	0.61	0.10
	Selenium	39	0.50	0.068	0.30	0.40
	Silver	39	0.0085	0.004	0.0062	0.0045
	Thallium	39	0.019	0.0090	0.012	0.0064
	Zinc	39	2.0	0.48	1.3	0.90

(a) SD = Standard deviation.
(b) Below detection limit.

Table C.6. Selected U.S. Geological Survey Columbia River Water Quality Data for Vernita and Richland, Washington,[a] 2003

Analysis	Units	Vernita Bridge (upstream)				Richland (downstream)				Washington Ambient Surface Water Quality Standard[b]
		No. of Samples	Median	Maximum	Minimum	No. of Samples	Median	Maximum	Minimum	
Temperature	°C	2	13	19	7.8	2	13	19	7.9	20 (maximum)
Dissolved oxygen	mg/L	2	12.6	12.7	12.6	2	12.0	12.4	11.7	8 (minimum)
Turbidity	NTU[c]	2	2.9	4.0	1.7	2	3.0	3.1	2.9	5 + background
pH	pH units	2	8.0	8.0	8.0	2	8.0	8.2	7.9	6.5 - 8.5
Sulfate, dissolved	mg/L	2	9.0	9.3	8.8	2	9.3	9.4	9.2	--[d]
Dissolved solids, 180°C (356°F)	mg/L	2	84	86	83	2	84	86	81	--
Specific conductance	µS/cm	2	136	139	134	2	140	141	138	--
Total hardness, as $CaCO_3$	mg/L	2	65	66	64	2	64	66	62	--
Alkalinity	mg/L	2	56	59	54	2	58	60	55	
Phosphorus, total	mg/L	2	<0.04	<0.04	<0.03[e]	2	<0.04	<0.04	<0.03[e]	--
Chromium, dissolved	µg/L	2	<0.8	<0.8	<0.8	2	<0.8	<0.8	<0.8	--
Dissolved organic carbon	mg/L	2	1.3	1.4	1.2	2	1.4	1.5	1.3	--
Iron, dissolved	µg/L	2	<10	<10	<8	2	<10	<10	5[e]	--
Ammonia, dissolved, as N	mg/L	2	<0.04	<0.04	<0.04	2	<0.04	<0.04	<0.04	--
Nitrite + nitrate, dissolved, as N	mg/L	2	0.095	0.13	0.06	2	0.095	0.11	0.08	--

(a) Provisional data from U.S. Geological Survey National Stream Quality Accounting Network (NASQAN), subject to revision.
(b) From WAC 173-201A.
(c) NTU = Nephelometric turbidity units.
(d) Dashes indicate no standard available.
(e) Estimated value.

Table C.7. Radionuclide Concentrations in Sediment from the Columbia River Near the Hanford Site and from Columbia River Riverbank Springs Along the Hanford Site, 2003 Compared to Previous 5 Years

Location	Radionuclide	2003 No. of Samples	2003 Concentration, pCi/g[a] Median[b]	2003 Concentration, pCi/g[a] Maximum[c]	1998-2002 No. of Samples	1998-2002 Concentration, pCi/g[a] Median[b]	1998-2002 Concentration, pCi/g[a] Maximum[c]
River Sediment (2003 TOC Value)[d]							
Priest Rapids Dam (11,700 - 12,700 mg/kg)	Cobalt-60	2	0.0018[e]	0.0040 ± 0.011[e]	18	0.0051[e]	0.042 ± 0.041[e]
	Cesium-137	2	0.30	0.32 ± 0.048	18	0.40	0.65 ± 0.086
	Europium-155	2	0.046[e]	0.047 ± 0.034[e]	18	0.049[e]	0.082 ± 0.088[e]
	Plutonium-239/240	2	0.011	0.012 ± 0.0023	18	0.0096	0.015 ± 0.0028
	Strontium-90	2	0.070	0.074 ± 0.026	18	0.013	0.028 ± 0.028[e]
	Uranium-234	2	0.70	0.73 ± 0.12	18	0.52	0.83 ± 0.14
	Uranium-235	2	0.019	0.022 ± 0.0091	18	0.018	0.037 ± 0.014
	Uranium-238	2	0.62	0.66 ± 0.11	18	0.46	0.73 ± 0.12
White Bluffs Slough (11,800 mg/kg)	Cobalt-60	1		0.027 ± 0.018[e]	5	0.062	0.11 ± 0.024
	Cesium-137	1		0.53 ± 0.072	5	0.58	0.64 ± 0.089
	Europium-155	1		0.045 ± 0.044[e]	5	0.040[e]	0.10 ± 0.034
	Plutonium-239/240	1		0.0069 ± 0.0027	5	0.0050	0.0077 ± 0.0017
	Strontium-90	1		0.041 ± 0.023	5	0.0023	0.0082 ± 0.0049
	Uranium-234	1		0.31 ± 0.062	5	0.47	1.6 ± 0.30
	Uranium-235	1		0.015 ± 0.011	5	0.013	0.053 ± 0.016
	Uranium-238	1		0.28 ± 0.056	5	0.38	1.3 ± 0.24
100-F Slough (1,240 mg/kg)	Cobalt-60	1		0.0042 ± 0.013[e]	5	0.010[e]	0.023 ± 0.010[e]
	Cesium-137	1		0.39 ± 0.055	5	0.30	0.36 ± 0.042
	Europium-155	1		0.030 ± 0.031[e]	5	0.040[e]	0.069 ± 0.062[e]
	Plutonium-239/240	1		0.0020 ± 0.0012	5	0.0018	0.0023 ± 0.00054
	Strontium-90	1		0.058 ± 0.024	5	0.0017	0.0054 ± 0.013[e]
	Uranium-234	1		0.13 ± 0.031	5	0.16	0.31 ± 0.062
	Uranium-235	1		-0.00075 ± 0.0052[e]	5	0.0058	0.011 ± 0.0022
	Uranium-238	1		0.13 ± 0.031	5	0.15	0.29 ± 0.058
Hanford Slough (10,200 mg/kg)	Cobalt-60	1		0.055 ± 0.02	5	0.0099[e]	0.026 ± 0.026[e]
	Cesium-137	1		0.32 ± 0.046	5	0.027	0.16 ± 0.033
	Europium-155	1		0.054 ± 0.035[e]	5	0.058[e]	0.067 ± 0.036[e]
	Plutonium-239/240	1		0.0053 ± 0.0026	5	0.0014	0.0045 ± 0.00093
	Strontium-90	1		0.080 ± 0.025	5	0.0036	0.0059 ± 0.019[e]
	Uranium-234	1		0.36 ± 0.081	5	0.28	0.53 ± 0.10
	Uranium-235	1		0.021 ± 0.016	5	0.0090	0.017 ± 0.0077
	Uranium-238	1		0.32 ± 0.073	5	0.27	0.47 ± 0.092

Table C.7. (contd)

Location	Radionuclide	2003 No. of Samples	2003 Concentration, pCi/g[a] Median[b]	2003 Concentration, pCi/g[a] Maximum[c]	1998-2002 No. of Samples	1998-2002 Concentration, pCi/g[a] Median[b]	1998-2002 Concentration, pCi/g[a] Maximum[c]
Richland	Cobalt-60	1		0.0066 ± 0.013[e]	5	0.012[e]	0.032 ± 0.023[e]
(1,950 mg/kg)	Cesium-137	1		0.17 ± 0.030	5	0.23	0.24 ± 0.038
	Europium-155	1		0.098 ± 0.036	5	0.035[e]	0.047 ± 0.059[e]
	Plutonium-239/240	1		0.0016 ± 0.00091	5	0.0014	0.0021 ± 0.00056
	Strontium-90	1		0.054 ± 0.022	5	0.00065	0.0063 ± 0.0041
	Uranium-234	1		0.22 ± 0.044	5	0.18	0.25 ± 0.053
	Uranium-235	1		0.0062 ± 0.0051	5	0.0096	0.014 ± 0.0080
	Uranium-238	1		0.24 ± 0.047	5	0.19	0.24 ± 0.053
McNary Dam	Cobalt-60	4	0.044[e]	0.062 ± 0.028[e]	22	0.029	0.12 ± 0.042[e]
(8,150 - 10,800 mg/kg)	Cesium-137	4	0.34	0.42 ± 0.083	22	0.36	1.1 ± 0.15
	Europium-155	4	0.070[e]	0.11 ± 0.074[e]	22	0.056[e]	0.13 ± 0.066[e]
	Plutonium-239/240	4	0.0086	0.010 ± 0.0018	22	0.0082	0.032 ± 0.0048
	Strontium-90	5	0.081	0.10 ± 0.046	22	0.020	0.043 ± 0.028
	Uranium-234	4	0.81	1.0 ± 0.18	22	0.76	0.87 ± 0.17
	Uranium-235	4	0.024	0.026 ± 0.012	22	0.022	0.032 ± 0.012
	Uranium-238	4	0.64	0.76 ± 0.14	22	0.61	0.70 ± 0.13
Riverbank Spring Sediment							
100-B Spring	Cobalt-60	1		0.0076 ± 0.012[e]	5	0.0039[e]	0.022 ± 0.013[e]
	Cesium-137	1		0.068 ± 0.023	5	0.075	0.14 ± 0.026
	Europium-155	1		0.095 ± 0.037[e]	5	0.078[e]	0.11 ± 0.072[e]
	Strontium-90	1		0.0068 ± 0.016[e]	5	0.0020[e]	0.0041 ± 0.0083[e]
	Uranium-234	1		0.41 ± 0.077	5	0.26	0.49 ± 0.087
	Uranium-235	1		0.014 ± 0.0080	5	0.014	0.029 ± 0.016
	Uranium-238	1		0.35 ± 0.067	5	0.26	0.41 ± 0.085
100-K Spring	Cobalt-60	1		0.0044 ± 0.0099[e]	1		0.0053 ± 0.013[e]
	Cesium-137	1		0.11 ± 0.024	1		0.10 ± 0.023
	Europium-155	1		0.020 ± 0.029[e]	1		0.057 ± 0.041[e]
	Strontium-90	1		0.017 ± 0.019[e]	1		0.015 ± 0.024[e]
	Uranium-234	1		0.26 ± 0.052	1		0.30 ± 0.065
	Uranium-235	1		0.0091 ± 0.0064	1		0.0085 ± 0.0066
	Uranium-238	1		0.24 ± 0.048	1		0.28 ± 0.060

Table C.7. (contd)

Location	Radionuclide	2003 No. of Samples	2003 Concentration, pCi/g[a] Median[b]	2003 Concentration, pCi/g[a] Maximum[c]	1998-2002 No. of Samples	1998-2002 Concentration, pCi/g[a] Median[b]	1998-2002 Concentration, pCi/g[a] Maximum[c]
100-F Spring	Cobalt-60	1		0.0071 ± 0.012[e]	5	0.016[e]	0.021 ± 0.032[e]
	Cesium-137	1		0.26 ± 0.051	5	0.14	0.20 ± 0.035
	Europium-155	1		0.073 ± 0.033[e]	5	0.042	0.070 ± 0.031
	Strontium-90	1		-0.0016 ± 0.020[e]	5	0.018[e]	0.013 ± 0.032[e]
	Uranium-234	1		0.51 ± 0.095	6	0.51	0.70 ± 0.14
	Uranium-235	1		0.026 ± 0.011	6	0.023	0.060 ± 0.019
	Uranium-238	1		0.45 ± 0.085	6	0.42	0.68 ± 0.074
Hanford Spring	Cobalt-60	0			5	0.039	0.067 ± 0.026
	Cesium-137	0			5	0.20	0.23 ± 0.034
	Europium-155	0			5	0.069[e]	0.10 ± 0.035[e]
	Uranium-234	0			5	0.57	0.75 ± 0.13
	Uranium-235	0			5	0.017	0.024 ± 0.011
	Uranium-238	0			5	0.45	0.60 ± 0.10
300 Area Spring	Cobalt-60	2	0.0039[e]	0.014 ± 0.011[e]	7	0.011[e]	0.020 ± 0.010[e]
	Cesium-137	2	0.10	0.17 ± 0.029	7	0.057	0.27 ± 0.035
	Europium-155	2	0.074[e]	0.083 ± 0.032[e]	7	0.055[e]	0.086 ± 0.035[e]
	Uranium-234	2	1.5	1.5 ± 0.26	13	1.8	11 ± 2.0
	Uranium-235	2	0.059	0.067 ± 0.020	13	0.068	0.38 ± 0.075
	Uranium-238	2	1.4	1.5 ± 0.24	13	1.8	10 ± 1.8

(a) To convert to the International System of Units, multiply pCi/g by 0.037 to obtain Bq/g.
(b) Median values are not provided when only one sample analyzed.
(c) Values are ± total propagated analytical uncertainty (2-sigma).
(d) TOC = Total organic content.
(e) Below detection limit.

Table C.8. Median Metal Concentrations (mg/kg dry wt.) in Sediment Samples Collected from the Columbia River Near the Hanford Site, 2003

Metal	(n=2) Priest Rapids Dam	(n=4) Hanford Reach[a]	(n=2) McNary Dam	(n=6) Riverbank Springs[b]
Antimony	0.91	0.80	0.81	0.64
Arsenic	9.5	8.4	9.1	6.6
Beryllium	1.6	1.5	1.9	1.5
Cadmium	7.5	1.8	1.6	0.69
Chromium	90	72	72	65
Copper	48	26	32	18
Lead	52	39	26	24
Mercury	0.18	0.035	0.097	0.015
Nickel	44	22	31	21
Selenium[c]	0.48	0.48	0.48	0.48
Silver	0.46	0.32	0.41	0.058
Thallium	1.4	1.1	0.72	0.52
Zinc	543	360	260	160

(a) White Bluffs Slough, 100-F Slough, Hanford Slough, and Richland.
(b) 100-B Area, 100-K Area, 100-F Area, Hanford town site, and 300 Area.
(c) All values were below the detection limit of 0.48 mg/kg dry weight.

Table C.9. Radionuclide Concentrations Measured in Columbia River Water Samples Collected from Riverbank Springs Along the Hanford Site, 2003 Compared to Previous 5 Years

Location/Radionuclide	2003 No. of Samples	2003 Concentration,[a] pCi/L Maximum	2003 Concentration,[a] pCi/L Average	1998-2002 No. of Samples	1998-2002 Concentration,[a] pCi/L Maximum	1998-2002 Concentration,[a] pCi/L Average	Washington State Ambient Surface Water Quality Standard,[b] pCi/L
100-B Area							
Alpha (gross)	3	10 ± 4.2	4.4 ± 10	16	9.4 ± 3.8	2.5 ± 4.2	15
Beta (gross)	3	23 ± 4.8	14 ± 19	16	24 ± 4.5	9.4 ± 11	50
Strontium-90	3	4.0 ± 0.59	1.4 ± 4.5	16	5.7 ± 1.3	0.65 ± 3.5	8
Technetium-99	2	11 ± 0.89	7.3 ± 9.8	7	10 ± 1.4	4.9 ± 6.6	900[c]
Tritium	3	5,800 ± 500	4,700 ± 2,700	16	20,000 ± 870	8,600 ± 10,000	20,000
100-K Area							
Alpha (gross)	6	1.5 ± 1.2[d]	0.76 ± 1.2	19	4.1 ± 2.1	1.6 ± 2.6	15
Beta (gross)	6	10 ± 2.3	6.6 ± 5.2	19	46 ± 7.9	8.5 ± 20	50
Strontium-90	3	2.8 ± 0.41	1.0 ± 3.0	9	3.2 ± 0.72	0.83 ± 2.5	8
Technetium-99	1	0.66 ± 5.2[d]		6	2.3 ± 0.28	0.62 ± 1.9	900[c]
Tritium	6	1,600 ± 210	940 ± 1,400	19	12,000 ± 970	3,100 ± 6,400	20,000
100-N Area							
Alpha (gross)	1	4.9 ± 2.7		6	2.2 ± 1.4	1.6 ± 1.0	15
Beta (gross)	1	9.3 ± 2.4		6	5.9 ± 2.1	4.2 ± 2.9	50
Strontium-90	1	0.041 ± 0.063[d]		6	0.039 ± 0.044[d]	0.016 ± 0.034	8
Tritium	1	10,000 ± 800		6	24,000 ± 1,900	14,000 ± 14,000	20,000
100-D Area							
Alpha (gross)	7	3.8 ± 2.2	0.82 ± 2.7	25	32 ± 9.8	3.5 ± 14	15
Beta (gross)	7	3.8 ± 1.8	1.9 ± 2.0	25	41 ± 7.9	8.3 ± 22	50
Strontium-90	2	0.34 ± 0.061	0.21 ± 0.36	6	5.3 ± 1.3	1.4 ± 3.9	8
Tritium	7	2,600 ± 260	560 ± 1,900	25	9,800 ± 730	3,300 ± 6,900	20,000
100-H Area							
Alpha (gross)	5	20 ± 7.2	5.7 ± 16	32	10 ± 3.7	1.3 ± 3.6	15
Beta (gross)	5	28 ± 5.1	15 ± 22	32	72 ± 8.6	11 ± 29	50
Strontium-90	1	14 ± 2.0		10	14 ± 3.2	4.5 ± 11	8
Technetium-99	2	0.30 ± 0.36[d]	0.27 ± 0.079	10	77 ± 8.7	9.0 ± 48	900
Tritium	5	2,900 ± 290	850 ± 2,400	32	5,500 ± 470	850 ± 2,000	20,000
Uranium (total)	2	2.7 ± 0.32	1.7 ± 2.7	10	9.3 ± 0.70	2.1 ± 2.6	--

Table C.9. (contd)

Location/Radionuclide	2003 No. of Samples	2003 Concentration,[a] pCi/L Maximum	2003 Concentration,[a] pCi/L Average	1998-2002 No. of Samples	1998-2002 Concentration,[a] pCi/L Maximum	1998-2002 Concentration,[a] pCi/L Average	Washington State Ambient Surface Water Quality Standard,[b] pCi/L
100-F Area							
Alpha (gross)	2	4.7 ± 2.7	4.5 ± 0.71	14	6.3 ± 2.8	3.9 ± 3.2	15
Beta (gross)	2	25 ± 4.4	16 ± 26	14	16 ± 3.3	8.6 ± 7.1	50
Strontium-90	2	0.076 ± 0.26[d]	0.067 ± 0.025	14	1.5 ± 0.57	0.21 ± 0.92	8
Tritium	2	800 ± 150	520 ± 780	14	1,500 ± 320	980 ± 940	20,000
Uranium (total)	1	1.5 ± 0.19		6	5.2 ± 0.69	4.0 ± 2.1	--[e]
Hanford Town Site							
Alpha (gross)	2	1.3 ± 1.2[d]	0.98 ± 0.81	11	14 ± 5.9	4.1 ± 6.7	15
Beta (gross)	2	9.4 ± 2.3	8.8 ± 1.5	11	49 ± 7.9	29 ± 16	50
Iodine-129	2	0.14 ± 0.012	0.10 ± 0.12	11	0.41 ± 0.024	0.21 ± 0.18	1
Technetium-99	2	14 ± 1.1	11 ± 7.1	11	120 ± 8.0	83 ± 43	900[c]
Tritium	2	14,000 ± 1,100	14,000 ± 420	11	120,000 ± 8,800	82,000 ± 48,000	20,000
Uranium (total)	2	0.94 ± 0.13	0.88 ± 0.18	11	8.6 ± 1.0	3.7 ± 3.7	--
300 Area							
Alpha (gross)	2	140 ± 36	130 ± 21	11	230 ± 49	87 ± 110	15
Beta (gross)	2	55 ± 10	48 ± 19	11	49 ± 7.9	27 ± 18	50
Iodine-129	2	0.0068 ± 0.00084	0.0058 ± 0.0030	11	0.0067 ± 0.00066	0.0043 ± 0.0034	1
Technetium-99	0			5	16 ± 2.0	12 ± 4.3	900[c]
Tritium	2	10,000 ± 820	10,000 ± 1,000	13	12,000 ± 580	8,600 ± 3,700	20,000
Uranium (total)	2	140 ± 15	120 ± 38	15	210 ± 26	75 ± 98	--

(a) Maximum values are ± total propagated analytical uncertainty. Averages are ±2 standard deviations of the mean. To convert to the International System of Units, multiply pCi/L by 0.037 to obtain Bq/L.
(b) WAC 246-290, 40 CFR 141, and Appendix D, Table D.2.
(c) WAC 173-201A-50 and EPA-570/9-76-003.
(d) Value below the laboratory reported detection limit.
(e) Dashes indicate no concentration guides available.

Table C.10. Annual Average Dose Rates Measured On and Around the Hanford Site in Calendar Year 2003

Location	Location Number	Annual Average (mrem/yr)[a]
Onsite[b]		
100 B Reactor Museum	1	83 ± 10
100 K Area	2	72 ± 4
100 D Area	3	87 ± 7
100 F Met Tower	4	84 ± 4
N of 200 E	5	92 ± 8
B Pond	6	81 ± 6
E of 200 E	7	91 ± 3
200 ESE	8	86 ± 4
S of 200 E[c]	9	95 ± 4
200 Tel. Exchange	10	82 ± 5
SW of B/C Cribs	11	84 ± 4
200 W SE	12	82 ± 4
Army Loop Camp	13	87 ± 5
3705 Bldg. 300 Area	14	83 ± 5
313 Bldg.	15	96 ± 8
300 Water Intake	16	78 ± 3
300 Southwest Gate	17	79 ± 4
300 South Gate	18	83 ± 8
300 Trench	19	87 ± 6
300 NE	20	86 ± 4
400 E	21	83 ± 3
400 W	22	86 ± 6
400 S	23	82 ± 7
400 N	24	81 ± 3
US Ecology NE Corner	25	86 ± 2
US Ecology SE Corner	26	86 ± 7
US Ecology NW Corner	27	89 ± 5
US Ecology SW Corner	28	96 ± 5
Wye Barricade	29	85 ± 8
WPPSS 1; S of WNP 2	30	86 ± 9
Hanford Townsite	31	81 ± 8
West Lake[c]	32	90 ± 7
LIGO	33	78 ± 20
Perimeter[d]		
Ringold Met Tower	1	94 ± 7
W End of Fir Road	2	93 ± 2
Dogwood Met Tower	3	95 ± 6
Byers Landing	4	96 ± 3
Battelle Complex	5	80 ± 6
WPPSS 4; WPS Warehse	6	81 ± 3
Horn Rapids Substation	7	86 ± 6
Prosser Barricade	8	90 ± 6
Yakima Barricade	9	95 ± 5
Rattlesnake Springs	10	93 ± 7
Wahluke Slope	11	90 ± 3
Community[d]		
Mattawa	12	80 ± 5
Othello	13	74 ± 6
Basin City School[e]	14	77 ± 1
Edwin Markham School	15	77 ± 3
Pasco	16	88 ± 5
Kennewick - Ely Street	17	73 ± 14
Benton City	18	81 ± 11
Distant[d]		
Yakima	19	72 ± 4
Toppenish	20	72 ± 6
Columbia River Shoreline[f]		
Below 100N Outfall	1	99 ± 9
Above Tip 100N Berm	2	84 ± 4
100 N Trench Spring	3	99 ± 7
S End Vernita Bridge[e]	4	76 ± 8
Above 100 B Area	5	86 ± 12
Below 100B Retention Basin	6	98 ± 5
Above 1K Boat Ramp	7	83 ± 10
Below 100 D Area	8	71 ± 12
100-D Island[c]	9	79 ± 6
100 H Area	10	84 ± 9
Lower End Locke Island	11	87 ± 7
White Bluffs Ferry Landing	12	83 ± 11
White Bluffs Slough[c]	13	96 ± 16
Below 100 F	14	82 ± 7
100 F Flood Plain	15	84 ± 3
Hanford Slough	16	95 ± 10
Hanford Powerline Crossing	17	94 ± 6
Hanford Railroad Track	18	91 ± 15
Savage Island Slough	19	79 ± 10
Ringold Island	20	86 ± 15
Powerline Crossing	21	88 ± 14
S End Wooded Island	22	95 ± 8
Island Above 300 Area	23	93 ± 7
Island Near 300 Area	24	91 ± 3
Port of Benton-River[c]	25	85 ± 3
N. Richland[c]	26	75 ± 2
Island Downstream Bateman Island[c]	27	90 ± 7

(a) Average for four quarterly measurements ±2 standard deviations of the dose rate.
(b) All locations are shown on Figure 4.6.1.
(c) Measurements for three calendar quarters only.
(d) All locations are shown on Figure 4.6.2.
(e) Measurements for two calendar quarters only.
(f) All locations are shown on Figure 4.6.3.

References

40 CFR 141. U.S. Environmental Protection Agency. "National Primary Drinking Water Regulations; Radionuclides; Proposed Rule." *U.S. Code of Federal Regulations*.

EPA-570/9-76-003. 1976. *National Interim Primary Drinking Water Regulations*. Office of Water Supply, U.S. Environmental Protection Agency, Washington, D.C.

PNNL-14687, APP. 1. 2004. *Hanford Site Environmental Surveillance Data Report for Calendar Year 2003*. L.E. Bisping, Pacific Northwest National Laboratory, Richland, Washington.

WAC 173-201A. "Water Quality Standards for Surface Waters of the State of Washington." Washington Administrative Code, Olympia, Washington.

WAC 173-201A-50. "Radioactive Substances." Washington Administrative Code, Olympia, Washington.

WAC 246-290. "Group A Public Water Systems." Washington Administrative Code, Olympia, Washington.