

TABLE 1. ALBERTA TIER 1 SOIL REMEDIATION GUIDELINES

Soil Type	Fine					Coarse					Notes
	Natural Area	Agricultural	Residential/ Parkland	Commercial	Industrial	Natural Area	Agricultural	Residential/ Parkland	Commercial	Industrial	
Land Use	Natural Area	Agricultural	Residential/ Parkland	Commercial	Industrial	Natural Area	Agricultural	Residential/ Parkland	Commercial	Industrial	
Unit (unless otherwise indicated)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
General and Inorganic Parameters											
pH (in 0.01M CaCl ₂)	6.0-8.5	6.0-8.5	6.0-8.5	6.0-8.5	6.0-8.5	6.0-8.5	6.0-8.5	6.0-8.5	6-8.5	6.0-8.5	1
Cyanide (free)	0.90	0.90	0.90	8.0	8.0	0.90	0.90	0.90	8.0	8.0	2
Fluoride	200	200	200	2,000	2,000	200	200	200	2,000	2,000	1
Sulphur (elemental)	500	500	500	500	500	500	500	500	500	500	3
Metals											
Antimony	20	20	20	40	40	20	20	20	40	40	1
Arsenic (inorganic)	17	17	17	26	26	17	17	17	26	26	
Barium (non-barite)	750	750	500	2,000	2,000	750	750	500	2,000	2,000	2
Barite-barium	10,000	10,000	10,000	15,000	140,000	10,000	10,000	10,000	15,000	140,000	4
Beryllium	5.0	5.0	5.0	8.0	8.0	5.0	5.0	5.0	8.0	8.0	1
Boron (mg/L in saturated paste extract)	3.3	3.3	3.3	5.0	5.0	3.3	3.3	3.3	5.0	5.0	15
Cadmium	3.8	1.4	10	22	22	3.8	1.4	10	22	22	2
Chromium (hexavalent)	0.40	0.40	0.40	1.4	1.4	0.40	0.40	0.40	1.4	1.4	2
Chromium (total)	64	64	64	87	87	64	64	64	87	87	2
Cobalt	20	20	20	300	300	20	20	20	300	300	1
Copper	63	63	63	91	91	63	63	63	91	91	2
Lead	70	70	140	260	600	70	70	140	260	600	2
Mercury (inorganic)	12	6.6	6.6	24	50	12	6.6	6.6	24	50	2
Molybdenum	4.0	4.0	4.0	40	40	4.0	4.0	4.0	40	40	1
Nickel	45	45	45	89	89	45	45	45	89	89	2
Selenium	1.0	1.0	1.0	2.9	2.9	1.0	1.0	1.0	2.9	2.9	2
Silver	20	20	20	40	40	20	20	20	40	40	1
Thallium	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2
Tin	5.0	5.0	5.0	300	300	5.0	5.0	5.0	300	300	1
Uranium	33	23	23	33	300	33	23	23	33	300	
Vanadium	130	130	130	130	130	130	130	130	130	130	2
Zinc	250	250	250	410	410	250	250	250	410	410	2

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Unit (unless otherwise indicated)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
Hydrocarbons											
Benzene	0.046	0.046	0.046	0.046	0.046	0.078	0.015	0.015	0.078	0.078	5
Toluene	0.52	0.52	0.52	0.52	0.52	0.12	0.12	0.12	0.12	0.12	5
Ethylbenzene	0.073	0.073	0.073	0.073	0.073	0.14	0.14	0.14	0.14	0.14	5
Xylenes	0.99	0.99	0.99	0.99	0.99	1.9	1.9	1.9	1.9	1.9	5
Styrene	0.68	0.68	0.68	0.68	0.68	0.80	0.80	0.80	0.80	0.80	
F1	210	210	210	320	320	210	24	24	270	270	6
F2	150	150	150	260	260	150	130	130	260	260	6
F3	1,300	1,300	1,300	2,500	2,500	300	300	300	1,700	1,700	6
F4	5,600	5,600	5,600	6,600	6,600	2,800	2,800	2,800	3,300	3,300	6
Acenaphthene	0.33	0.33	0.33	0.33	0.33	0.38	0.38	0.38	0.38	0.38	
Anthracene	1.3	1.3	1.3	1.3	1.3	0.0056	0.0056	0.0056	0.0056	0.0056	
Fluoranthene	15.4	15.4	50	180	180	0.055	0.055	0.055	0.055	0.055	
Fluorene	0.40	0.40	0.40	0.40	0.40	0.34	0.34	0.34	0.34	0.34	
Naphthalene	0.014	0.014	0.014	0.014	0.014	0.017	0.017	0.017	0.017	0.017	
Phenanthrene	0.11	0.11	0.11	0.11	0.11	0.061	0.061	0.061	0.061	0.061	
Pyrene	7.7	7.7	2,100	3,200	30,000	0.15	0.15	0.15	0.15	0.15	
Carcinogenic PAHs	IACR<1.0	IACR<1.0 and TPE ≤ 5.6	IACR<1.0 and TPE ≤ 5.6	IACR<1.0 and TPE ≤ 8.5	IACR<1.0 and TPE ≤ 23	IACR<1.0	IACR<1.0 and TPE ≤ 5.6	IACR<1.0 and TPE ≤ 5.6	IACR<1.0 and TPE ≤ 8.5	IACR<1.0 and TPE ≤ 23	7, 17, 18
Benz[a]anthracene	6.2	6.2	-	-	-	6.2	6.2	-	-	-	8
Benzo[b+j]fluoranthene	6.2	6.2	-	-	-	6.2	6.2	-	-	-	8
Benzo[k]fluoranthene	6.2	6.2	-	-	-	6.2	6.2	-	-	-	8
Benzo[g,h,i]perylene	-	-	-	-	-	-	-	-	-	-	
Benzo[a]pyrene	0.60	0.60	20	72	72	0.60	0.60	20	72	72	8
Chrysene	6.2	6.2	-	-	-	6.2	6.2	-	-	-	8
Dibenz[a,h]anthracene	-	-	-	-	-	-	-	-	-	-	-
Indeno[1,2,3-c,d]pyrene	-	-	-	-	-	-	-	-	-	-	
Halogenated Aliphatics											
Vinyl chloride	0.014	0.0083	0.0083	0.014	0.014	0.020	0.00034	0.00034	0.0043	0.0043	
1,1-Dichloroethene	0.15	0.15	0.15	0.15	0.15	0.24	0.021	0.021	0.24	0.24	

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Land Use	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
Unit (unless otherwise indicated)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
Trichloroethene (Trichloroethylene, TCE)	0.054	0.0043	0.0043	0.030	0.030	0.081	0.00019	0.00019	0.0023	0.0023	5, 11
Tetrachloroethene (Tetrachloroethylene, Perchloroethylene, PCE)	0.26	0.26	0.26	0.26	0.26	0.46	0.018	0.018	0.22	0.22	
1,2-Dichloroethane	0.025	0.0062	0.025	0.025	0.025	0.041	0.0027	0.0027	0.033	0.033	
Dichloromethane (Methylene chloride)	0.10	0.052	0.10	0.10	0.10	0.095	0.048	0.095	0.095	0.095	
Trichloromethane (Chloroform)	0.16	0.16	0.16	0.16	0.16	0.030	0.030	0.030	0.030	0.030	
Tetrachloromethane (Carbon tetrachloride)	0.037	0.022	0.035	0.037	0.037	0.062	0.0015	0.0015	0.018	0.018	
Dibromochloromethane	0.91	0.12	0.91	0.91	0.91	1.5	0.12	0.27	1.5	1.5	
Chlorinated Aromatics											
Chlorobenzene	0.61	0.39	0.39	0.61	0.61	1.1	0.018	0.018	0.22	0.22	12
1,2-Dichlorobenzene	0.097	0.097	0.097	0.097	0.097	0.18	0.18	0.18	0.18	0.18	12
1,4-Dichlorobenzene	0.051	0.051	0.051	0.051	0.051	0.098	0.098	0.098	0.098	0.098	
1,2,3-Trichlorobenzene	0.26	0.26	0.26	0.26	0.26	0.31	0.26	0.26	0.31	0.31	
1,2,4-Trichlorobenzene	0.78	0.78	0.78	0.78	0.78	0.93	0.23	0.23	0.93	0.93	
1,3,5-Trichlorobenzene	1.9	1.9	1.9	1.9	1.9	3.6	0.13	0.13	1.3	1.3	
1,2,3,4-Tetrachlorobenzene	0.042	0.042	0.042	0.042	0.042	0.050	0.050	0.050	0.050	0.050	
1,2,3,5-Tetrachlorobenzene	0.37	0.37	0.37	0.37	0.37	0.70	0.10	0.10	0.70	0.70	
1,2,4,5-Tetrachlorobenzene	0.19	0.19	0.19	0.19	0.19	0.37	0.052	0.052	0.37	0.37	
Pentachlorobenzene	24	22	22	24	24	5.2	5.2	5.2	5.2	5.2	
Hexachlorobenzene	1.8	0.80	1.8	1.8	1.8	3.6	0.20	0.20	2.3	2.3	
2,4-Dichlorophenol	0.0029	0.0029	0.0029	0.0029	0.0029	0.0034	0.0034	0.0034	0.0034	0.0034	
2,4,6-Trichlorophenol	0.19	0.19	0.19	0.19	0.19	0.37	0.37	0.37	0.37	0.37	
2,3,4,6-Tetrachlorophenol	0.039	0.039	0.039	0.039	0.039	0.047	0.047	0.047	0.047	0.047	
Pentachlorophenol	0.025	0.025	0.025	0.025	0.025	0.029	0.029	0.029	0.029	0.029	5
Dioxins & Furans	0.00025	0.000004	0.000004	0.000004	0.000004	0.00025	0.000004	0.000004	0.000004	0.000004	9
PCBs	1.3	0.085	0.085	0.13	1.2	1.3	0.085	0.085	0.13	1.2	5
Pesticides											
Aldicarb	0.041	0.012	0.041	0.041	0.041	0.065	0.012	0.065	0.065	0.065	12
Aldrin	0.24	0.24	0.24	0.24	0.24	0.46	0.31	0.31	0.46	0.46	

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Land Use	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
Atrazine and metabolites	0.0088	0.0088	0.0088	0.0088	0.0088	0.010	0.010	0.010	0.010	0.010	
Azinphos-methyl (Guthion)	0.41	0.41	0.41	0.41	0.41	0.75	0.75	0.75	0.75	0.75	
Bromacil	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	13
Bromoxynil	0.044	0.044	0.044	0.044	0.044	0.052	0.052	0.052	0.052	0.052	13
Carbaryl	1.9	1.9	1.9	1.9	1.9	3.6	3.6	3.6	3.6	3.6	12
Carbofuran	0.68	0.082	0.68	0.68	0.68	1.2	0.089	1.2	1.2	1.2	12
Chlorothalonil	0.0085	0.0085	0.0085	0.0085	0.0085	0.010	0.010	0.010	0.010	0.010	
Chlorpyrifos	49	3.2	49	49	49	95	3.8	95	95	95	12
2,4-D	0.43	0.10	0.43	0.43	0.43	0.67	0.10	0.67	0.67	0.67	12
DDT	0.70	0.70	11	12	12	0.70	0.70	11	12	12	5
Diazinon	2.2	2.2	2.2	2.2	2.2	4.2	4.2	4.2	4.2	4.2	12
Dicamba	0.50	0.12	0.50	0.50	0.50	0.79	0.12	0.79	0.79	0.79	12,13
Diclofop-methyl	NGR	0.079	40	61	570	2.4	0.095	2.4	2.4	2.4	
Dieldrin	0.025	0.025	0.025	0.025	0.025	0.048	0.048	0.048	0.048	0.048	
Dimethoate	0.0058	0.0028	0.0058	0.0058	0.0058	0.0055	0.0027	0.0055	0.0055	0.0055	
Dinoseb	2.8	1.4	2.8	2.8	2.8	5.5	1.7	5.5	5.5	5.5	12
Diquat	11	11	11	11	11	21	21	21	21	21	
Diuron	1.9	1.9	1.9	1.9	1.9	3.5	3.5	3.5	3.5	3.5	
Endosulfan	0.80	0.80	0.80	0.80	0.80	0.0016	0.0016	0.0016	0.0016	0.0016	
Endrin	2.4	2.4	2.4	2.4	2.4	4.7	4.7	4.7	4.7	4.7	
Glyphosate	0.054	0.054	0.054	0.054	0.054	0.049	0.049	0.049	0.049	0.049	
Heptachlor epoxide	0.039	0.039	0.039	0.039	0.039	0.076	0.010	0.010	0.076	0.076	
Lindane	0.31	0.11	0.31	0.31	0.31	0.60	0.13	0.60	0.60	0.60	12
Linuron	0.051	0.051	0.051	0.051	0.051	0.059	0.059	0.059	0.059	0.059	13
Malathion	0.82	0.82	0.82	0.82	0.82	1.3	1.3	1.3	1.3	1.3	12
MCPA	0.42	0.026	0.42	0.42	0.42	0.66	0.025	0.66	0.66	0.66	12,13
Methoxychlor	NGR	110	110	170	800	0.32	0.32	0.32	0.32	0.32	
Metolachlor	0.048	0.048	0.048	0.048	0.048	0.055	0.055	0.055	0.055	0.055	
Metribuzin	0.024	0.012	0.024	0.024	0.024	0.028	0.014	0.028	0.028	0.028	
Paraquat (as dichloride)	1.1	1.1	1.1	1.1	1.1	2.2	2.2	2.2	2.2	2.2	
Phorate	0.075	0.075	0.075	0.075	0.075	0.14	0.14	0.14	0.14	0.14	

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Land Use	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
Unit (unless otherwise indicated)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
Picloram	0.024	0.024	0.024	0.024	0.024	0.022	0.022	0.022	0.022	0.022	
Simazine	0.033	0.033	0.033	0.033	0.033	0.038	0.038	0.038	0.038	0.038	13
Tebuthiuron	0.046	0.046	0.046	0.60	0.60	0.046	0.046	0.046	0.60	0.60	12,13
Terbufos	0.080	0.080	0.080	0.080	0.080	0.15	0.15	0.15	0.15	0.15	
Toxaphene	3.3	3.3	3.3	3.3	3.3	6.3	4.8	4.8	6.3	6.3	
Triallate	0.0077	0.0077	0.0077	0.0077	0.0077	0.0092	0.0092	0.0092	0.0092	0.0092	
Trifluralin	0.22	0.22	0.22	0.22	0.22	0.045	0.045	0.045	0.045	0.045	
Other Organics											
Aniline	0.36	0.36	0.36	0.36	0.36	0.60	0.60	0.60	0.60	0.60	12
Di- <i>n</i> -butyl phthalate	0.54	0.54	0.54	0.54	0.54	0.65	0.65	0.65	0.65	0.65	
Dichlorobenzidine	0.60	0.60	0.60	0.60	0.60	1.2	1.2	1.2	1.2	1.2	
Diethanolamine	2.0	2.0	2.0	2.0	2.0	3.5	3.5	3.5	3.5	3.5	14
Diethylene glycol	10	10	10	10	10	15	15	15	15	15	
Diisopropanolamine	14	14	14	14	14	17	17	17	17	17	5
Ethylene glycol	60	60	60	60	60	62	62	62	62	62	5
Hexachlorobutadiene	0.026	0.026	0.026	0.026	0.026	0.031	0.0067	0.0067	0.031	0.031	
Methanol	37	37	37	37	37	11	11	11	11	11	
Methylmethacrylate	36	36	36	36	36	49	1.4	1.4	17	17	
Monoethanolamine	20	20	20	20	20	10	10	10	10	10	14
MTBE	0.044	0.044	0.044	0.044	0.044	0.062	0.046	0.046	0.062	0.062	
Nonylphenol + ethoxylates	5.7	5.7	5.7	14	14	5.7	5.7	5.7	14	14	5
Perfluooctane sulfonate (PFOS)	0.010	0.010	0.070	0.070	0.070	0.010	0.010	0.14	0.14	0.14	
Phenol	0.0028	0.0014	0.0028	0.0028	0.0028	0.0024	0.0012	0.0024	0.0024	0.0024	5, 16
Sulfolane	0.18	0.18	0.18	0.18	0.18	0.21	0.21	0.21	0.21	0.21	5
Triethylene glycol	100	100	100	100	100	150	150	150	150	150	
Radionuclides											
Uranium-238 Series (all progeny)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	10
Uranium-238 (²³⁸ U, ²³⁴ Th, ²³⁴ mPa, ²³⁴ U)	10	10	10	10	10	10	10	10	10	10	10
Thorium-230	10	10	10	10	10	10	10	10	10	10	10

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Radium-226 (in equilibrium with its progeny)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	10
Lead-210 (in equilibrium with ²¹⁰ Bi and ²¹⁰ Po)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	10
Thorium-232 Series (all progeny)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	10
Thorium-232	10	10	10	10	10	10	10	10	10	10	10
Radium-228 (in equilibrium with ²²⁸ Ac)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	10
Thorium-228 (in equilibrium with its progeny)	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	10
Potassium-40	17	17	17	17	17	17	17	17	17	17	10

Notes:

Guideline values calculated for this document using latest available CCME protocols except where noted.

- Value adopted from AEP (1994) and/or CCME (1991)
- Value adopted from CCME (1999, as amended)
- For more information see Guidelines for Landfill Disposal of Sulphur Waste and Remediation of Sulphur Containing Soils (AENV, 2011)
- True total barium as measured by fusion-XRF or fusion-ICP. For more information see Soil Remediation Guidelines for Barite: Environmental Health and Human Health (AENV, 2009)
- Ecological direct contact values from CCME (1999, as amended), other values calculated in this document
- Ecological direct contact values from CCME (2007), other values calculated in this document
- Carcinogenic PAH concentrations must meet the Index of Additive Cancer Risk (IACR) <1 guideline. Individual PAH compounds must also meet guidelines for ecological receptors where specified in Table 1 with footnote 8. The IACR is calculated by dividing the soil concentration of each carcinogenic PAH by its Protection of Domestic Use Aquifer guideline value to calculate a hazard index for each PAH and subsequently summing the hazard indexes for the entire PAH mixture, as follows:

Fine Soil:

$$IACR = \frac{[Benz(a)anthracene]}{6.4} + \frac{[Benzo(b + j)fluoranthene]}{3.0} + \frac{[Benzo(k)fluoranthene]}{0.64} + \frac{[Benzo(g, h, i)perylene]}{130} + \frac{[Benzo(a)pyrene]}{7.0} + \frac{[Chrysene]}{40} + \frac{[Dibenz(a, h)anthracene]}{4.4} + \frac{[Indeno(1,2,3 - c, d)pyrene]}{51}$$

Coarse Soil:

$$IACR = \frac{[Benz(a)anthracene]}{12} + \frac{[Benzo(b + j)fluoranthene]}{5.8} + \frac{[Benzo(k)fluoranthene]}{1.2} + \frac{[Benzo(g, h, i)perylene]}{250} + \frac{[Benzo(a)pyrene]}{14} + \frac{[Chrysene]}{78} + \frac{[Dibenz(a, h)anthracene]}{8.5} + \frac{[Indeno(1,2,3 - c, d)pyrene]}{98}$$

- For ecological receptors only
- Expressed as toxic equivalents (TEQs) based on 2,3,7,8-TCDD (See CCME, 1999 and updates)

TABLE 1. ALBERTA TIER 1 SOIL REMEDIATION GUIDELINES

10. When two or more radionuclides are found, the following relationship should be satisfied:

$$\frac{[\text{Radionuclide}]_1}{\text{Guideline}_1} + \frac{[\text{Radionuclide}]_2}{\text{Guideline}_2} + \dots + \frac{[\text{Radionuclide}]_i}{\text{Guideline}_i} \leq 1$$

For more information see *Canadian Guidelines for the Management of Naturally Occurring Radioactive Materials (NORM)* (Health Canada, 2013)

- 11. If trichloroethene is found in soil, its degradation product vinyl chloride must also be measured and compared to guideline values
- 12. Guideline for protection of aquatic life is below detection limit and has not been included in the Tier 1 derivation. Groundwater monitoring is required for all land uses if the Tier 1 guideline is exceeded.
- 13. Guideline for protection of irrigation water is below detection limit and has not been included in the Tier 1 derivation. Groundwater monitoring is required for agricultural land use if the Tier 1 guideline is exceeded.
- 14. Analytical methodology specified in the Soil and Groundwater Remediation Guidelines for Monoethanolamine and Diethanolamine (AENV, 2010), or equivalent, must be used. See AENV (2010) for further details.
- 15. Boron must be measured in a saturated paste extract prepared in accordance with Method 15.2.1 (Carter and Gregorich, 2008).
- 16. Toxicity assumptions for protection of aquatic life and livestock watering are based on mono- and dihydric phenols. Toxicity assumptions for other pathways are based on phenol. Soil samples may be analysed for phenolic compounds as a screening procedure. If analytical results exceed the guideline value, then background concentrations should be evaluated to determine if the phenolic compounds are naturally occurring. Speciation to determine mono- and dihydric phenols may also be undertaken and the results compared to the Tier 1 guideline.
- 17. Human health direct soil contact guidelines for carcinogenic PAHs are based on B[a]P Total Potency Equivalents (TPE). TPEs are calculated by multiplying the soil concentration of individual carcinogenic PAHs by a the standardized Benzo[a]pyrene Potency Equivalence Factor (PEF) to produce a Benzo[a]pyrene relative potency concentration, and by subsequently summing the relative potency concentrations for entire PAH mixture. B[a]P PEFs are order of magnitude estimates of carcinogenic potential and are based on the World Health Organization (WHO/IPCS, 1998) scheme, as follows:

Carcinogenic PAH Compound	PEF
Benz[a]anthracene	0.1
Benzo(b+j)fluoranthene	0.1
Benzo[k]fluoranthene	0.1
Benzo[ghi]perylene	0.01
Benzo[a]pyrene	1
Chrysene	0.01
Dibenz[a,h]anthracene	1
Indeno[1,2,3-c,d]pyrene	0.1

- 18. The B[a]P Total Potency Equivalents (TPEs) calculated for specific soil samples using Potency Equivalency Factors (PEFs) should be multiplied by an Uncertainty Factor of 3 when evaluating PAH mixtures associated with creosote or coal tar-type environmental releases, prior to evaluating against the human health direct contact soil remediation guideline.

TABLE 2. ALBERTA TIER 1 GROUNDWATER REMEDIATION GUIDELINES

Soil Type	Fine				Coarse				Notes
	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	
Unit	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
General and Inorganic Parameters									
pH	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	6.5-8.5	
Ammonia	see note 1	see note 1	see note 1	see note 1	see note 1	see note 1	see note 1	see note 1	1
Bromate	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	
Chloride	120	100	120	120	120	100	120	120	
Cyanide (free)	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	
Electrical conductivity (dS/m)	-	1.0	-	-	-	1.0	-	-	
Fluoride	1.5	1.0	1.5	1.5	1.5	1.0	1.5	1.5	
Nitrate (as nitrogen)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Nitrate + nitrite (as nitrogen)	-	100	-	-	-	100	-	-	
Nitrite (as nitrogen)	see note 2	see note 2	see note 2	see note 2	see note 2	see note 2	see note 2	see note 2	2
Sodium	200	200	200	200	200	200	200	200	
Sodium adsorption ratio	-	5.0	-	-	-	5.0	-	-	
Sulphate	see note 2	see note 2	see note 2	see note 2	see note 2	see note 2	see note 2	see note 2	2
Sulphide – Total (as S)	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	0.0019	8
Total Dissolved Solids (TDS)	500	500	500	500	500	500	500	500	
Metals									
Aluminum	see note 1	see note 2	see note 1	see note 1	see note 1	see note 2	see note 1	see note 1	1,2
Antimony	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	0.0060	
Arsenic	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	
Barium	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	
Boron	1.50	1.0	1.50	1.50	1.50	1.0	1.50	1.50	
Cadmium	see note 2	see note 2	see note 2	see note 2	see note 2	see note 2	see note 2	see note 2	2
Chromium (trivalent)	0.0089	0.0049	0.0089	0.0089	0.0089	0.0049	0.0089	0.0089	
Chromium (hexavalent)	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	
Chromium (total)	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	9
Copper	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	0.0070	

TABLE 2. ALBERTA TIER 1 GROUNDWATER REMEDIATION GUIDELINES

Soil Type	Fine				Coarse				Notes
	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	
Land Use									
Unit	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
Iron	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	
Lead	see note 2	see note 2	see note 2	see note 2	see note 2	see note 2	see note 2	see note 2	2
Manganese	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	
Mercury (total)	0.0000050	0.0000050	0.0000050	0.0000050	0.0000050	0.0000050	0.0000050	0.0000050	9
Nickel	see note 1	see note 2	see note 1	see note 1	see note 1	see note 2	see note 1	see note 1	1,2
Selenium	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	
Silver	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	
Uranium	0.015	0.010	0.015	0.015	0.015	0.010	0.015	0.015	
Zinc	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	
Hydrocarbons									
Benzene	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	
Toluene	0.024	0.024	0.024	0.024	0.021	0.021	0.021	0.021	
Ethylbenzene	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	0.0016	
Xylenes	0.020	0.020	0.020	0.020	0.020	0.020	0.020	0.020	
Styrene	0.072	0.072	0.072	0.072	0.072	0.072	0.072	0.072	
F1	2.2	2.2	2.2	2.2	2.2	0.81	0.81	2.2	
F2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	
Acenaphthene	0.0060	0.0060	0.0060	0.0060	0.0058	0.0058	0.0058	0.0058	
Anthracene	0.0034	0.0034	0.0034	0.0034	0.000012	0.000012	0.000012	0.000012	
Fluoranthene	0.24	0.24	0.24	0.86	0.000057	0.000057	0.000057	0.000057	
Fluorene	0.0042	0.0042	0.0042	0.0042	0.0030	0.0030	0.0030	0.0030	
Naphthalene	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	
Phenanthrene	0.00086	0.00086	0.00086	0.00086	0.00040	0.00040	0.00040	0.00040	
Pyrene	0.71	0.71	0.71	0.71	0.000092	0.000092	0.000092	0.000092	
Carcinogenic PAHs (as B(a)P TPE)	0.000040	0.000040	0.000040	0.000040	0.000040	0.000040	0.000040	0.000040	3
Benz[a]anthracene									
Benzo[b+j]fluoranthene									
Benzo[k]fluoranthene									
Benzo[g,h,i]perylene									

TABLE 2. ALBERTA TIER 1 GROUNDWATER REMEDIATION GUIDELINES

Soil Type	Fine				Coarse				Notes
	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	
Land Use	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
Benzo[a]pyrene	0.0018	0.0018	0.0018	0.0066	0.0018	0.0018	0.0018	0.0066	4
Chrysene									
Dibenz[a,h]anthracene									
Indeno[1,2,3-c,d]pyrene									
Halogenated Aliphatics									
Vinyl chloride	0.0020	0.0020	0.0020	0.0020	0.0020	0.0011	0.0011	0.0020	
1,1-Dichloroethene	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	
Trichloroethene (Trichloroethylene, TCE)	0.0050	0.0050	0.0050	0.0050	0.0050	0.00032	0.00032	0.0038	5
Tetrachloroethene (Tetrachloroethylene, Perchloroethylene, PCE)	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	
1,2-Dichloroethane	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	0.0050	
Dichloromethane (Methylene chloride)	0.050	0.050	0.050	0.050	0.050	0.050	0.050	0.050	
Trichloromethane (Chloroform)	0.080	0.080	0.080	0.080	0.018	0.018	0.018	0.018	
Tetrachloromethane (Carbon tetrachloride)	0.0020	0.0020	0.0020	0.0020	0.0020	0.0015	0.0015	0.0020	
Dibromochloromethane	0.19	0.10	0.19	0.19	0.19	0.10	0.19	0.19	
Chlorinated Aromatics									
Chlorobenzene	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	
1,2-Dichlorobenzene	0.00070	0.00070	0.00070	0.00070	0.00070	0.00070	0.00070	0.00070	
1,4-Dichlorobenzene	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	
1,2,3-Trichlorobenzene	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	0.0080	
1,2,4-Trichlorobenzene	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	
1,3,5-Trichlorobenzene	0.014	0.014	0.014	0.014	0.014	0.014	0.014	0.014	
1,2,3,4-Tetrachlorobenzene	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	
1,2,3,5-Tetrachlorobenzene	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	0.0038	
1,2,4,5-Tetrachlorobenzene	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	
Pentachlorobenzene	0.0094	0.0094	0.0094	0.0094	0.0069	0.0069	0.0069	0.0069	
Hexachlorobenzene	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	0.00029	
2,4-Dichlorophenol	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	
2,4,6-Trichlorophenol	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	

TABLE 2. ALBERTA TIER 1 GROUNDWATER REMEDIATION GUIDELINES

Soil Type	Fine				Coarse				Notes
	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	
Land Use	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
2,3,4,6-Tetrachlorophenol	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	
Pentachlorophenol	0.00051	0.00051	0.00051	0.00051	0.00050	0.00050	0.00050	0.00050	
Dioxins & Furans	0.00000012	0.00000012	0.00000012	0.00000012	0.00000012	0.00000012	0.00000012	0.00000012	10
PCBs	0.000094	0.000094	0.000094	0.000094	0.000094	0.000094	0.000094	0.000094	
Pesticides									
Aldicarb	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	
Aldrin	0.000028	0.000028	0.000028	0.000028	0.000028	0.000028	0.000028	0.000028	
Atrazine and metabolites	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	
Azinphos-methyl (Guthion)	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	
Bromacil	0.0050	0.00020	0.0050	0.0050	0.0050	0.00020	0.0050	0.0050	
Bromoxynil	0.0050	0.00044	0.0050	0.0050	0.0050	0.00044	0.0050	0.0050	
Carbaryl	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	
Carbofuran	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	0.0018	
Chlorothalonil	0.00018	0.00018	0.00018	0.00018	0.00018	0.00018	0.00018	0.00018	
Chlorpyrifos	0.0000046	0.0000046	0.0000046	0.0000046	0.0000020	0.0000020	0.0000020	0.0000020	
2,4-D	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	0.0040	
DDT	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	0.0014	
Diazinon	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	0.00017	
Dicamba	0.010	0.0000080	0.010	0.010	0.010	0.0000080	0.010	0.010	
Diclofop-methyl	0.0090	0.00024	0.009	0.0090	0.0061	0.00024	0.0061	0.0061	
Dieldrin	0.000029	0.000029	0.000029	0.000029	0.000029	0.000029	0.000029	0.000029	
Dimethoate	0.0062	0.0030	0.0062	0.0062	0.0062	0.0030	0.0062	0.0062	
Dinoseb	0.000055	0.000055	0.000055	0.000055	0.000050	0.000050	0.000050	0.000050	
Diquat	0.070	0.070	0.070	0.070	0.070	0.070	0.070	0.070	
Diuron	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	
Endosulfan	0.0019	0.0019	0.0019	0.0019	0.0000031	0.0000031	0.0000031	0.0000031	
Endrin	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	0.0028	
Glyphosate	0.065	0.065	0.065	0.065	0.065	0.065	0.065	0.065	
Heptachlor epoxide	0.000052	0.000052	0.000052	0.000052	0.000052	0.000052	0.000052	0.000052	

TABLE 2. ALBERTA TIER 1 GROUNDWATER REMEDIATION GUIDELINES

Soil Type	Fine				Coarse				Notes
	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	
Land Use									
Unit	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
Lindane	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	0.000010	
Linuron	0.0070	0.00011	0.0070	0.0070	0.0070	0.00011	0.0070	0.0070	
Malathion	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	0.00010	
MCPA	0.0026	0.000040	0.0026	0.0026	0.0026	0.000040	0.0026	0.0026	
Methoxychlor	0.90	0.90	0.90	0.90	0.00017	0.00017	0.00017	0.00017	
Metolachlor	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	0.0078	
Metribuzin	0.0010	0.00050	0.0010	0.0010	0.0010	0.00050	0.0010	0.0010	
Paraquat (as dichloride)	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	
Phorate	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	0.0020	
Picloram	0.029	0.029	0.029	0.029	0.029	0.029	0.029	0.029	
Simazine	0.010	0.00050	0.010	0.010	0.010	0.00050	0.010	0.010	
Tebuthiuron	0.0016	0.00043	0.0016	0.0016	0.0016	0.00043	0.0016	0.0016	
Terbufos	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	
Toxaphene	0.00043	0.00043	0.00043	0.00043	0.00043	0.00043	0.00043	0.00043	
Triallate	0.00024	0.00024	0.00024	0.00024	0.00024	0.00024	0.00024	0.00024	
Trifluralin	0.0012	0.0012	0.0012	0.0012	0.00020	0.00020	0.00020	0.00020	
Other Organics									
Aniline	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	0.0022	
Di- <i>n</i> -butyl phthalate	0.019	0.019	0.019	0.019	0.019	0.019	0.019	0.019	
Dichlorobenzidine	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	
Diethanolamine	0.060	0.060	0.060	0.060	0.060	0.060	0.060	0.060	
Diethylene glycol	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	
Diisopropanolamine	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	
Ethylene glycol	31	31	31	31	31	31	31	31	
Hexachlorobutadiene	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	0.0013	
Methanol	19	19	19	19	19	19	19	19	
Methylmethacrylate	13	13	13	13	13	11	11	13	
Monoethanolamine	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
MTBE	0.015	0.015	0.015	0.015	0.015	0.015	0.015	0.015	

TABLE 2. ALBERTA TIER 1 GROUNDWATER REMEDIATION GUIDELINES

Soil Type	Fine				Coarse				Notes
	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	
Unit	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
Nitritotriacetic acid	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	
Nonylphenol + ethoxylates	0.0081	0.0081	0.0081	0.020	0.0081	0.0081	0.0081	0.020	
Perfluorooctane sulfonate (PFOS)	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	0.00060	11
Perfluorooctanoic acid (PFOA)	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	0.00020	11
Phenol	0.0040	0.0020	0.0040	0.0040	0.0040	0.0020	0.0040	0.0040	6
Sulfolane	0.090	0.090	0.090	0.090	0.090	0.090	0.090	0.090	
Triethylene glycol	60	60	60	60	60	60	60	60	
Trihalomethanes - total (THMs)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	
Naturally Occurring Radionuclides									
Beryllium-7	4,000	4,000	4,000	4,000	4,000	4,000	4,000	4,000	7
Bismuth-210	70	70	70	70	70	70	70	70	7
Lead-210	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	7
Polonium-210	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	7
Radium -224	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	7
Radium-226	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	7
Radium-228	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	7
Thorium-228	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	7
Thorium-230	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	7
Thorium-232	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	7
Thorium-234	20	20	20	20	20	20	20	20	7
Uranium-234	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	7
Uranium-235	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	7
Uranium-238	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	7
Other Radionuclides									
Americium-241	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	7
Antimony-122	50	50	50	50	50	50	50	50	7
Antimony-124	40	40	40	40	40	40	40	40	7
Antimony-125	100	100	100	100	100	100	100	100	7
Barium-140	40	40	40	40	40	40	40	40	7

TABLE 2. ALBERTA TIER 1 GROUNDWATER REMEDIATION GUIDELINES

Soil Type	Fine				Coarse				Notes
	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	
Unit	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
Bromine-82	300	300	300	300	300	300	300	300	7
Calcium-45	200	200	200	200	200	200	200	200	7
Calcium-47	60	60	60	60	60	60	60	60	7
Carbon-14a	200	200	200	200	200	200	200	200	7
Cerium-141	100	100	100	100	100	100	100	100	7
Cerium-144	20	20	20	20	20	20	20	20	7
Cesium-131	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	7
Cesium-136	50	50	50	50	50	50	50	50	7
Cesium-137	10	10	10	10	10	10	10	10	7
Chromium-51	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	7
Cobalt-57	40	40	40	40	40	40	40	40	7
Cobalt-58	20	20	20	20	20	20	20	20	7
Cobalt-60	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	7
Gallium-67	500	500	500	500	500	500	500	500	7
Gold-198	90	90	90	90	90	90	90	90	7
Indium-111	400	400	400	400	400	400	400	400	7
Iodine-129	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	7
Iodine-131	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	7
Iron-55	300	300	300	300	300	300	300	300	7
Iron-59	40	40	40	40	40	40	40	40	7
Manganese-54	200	200	200	200	200	200	200	200	7
Mercury-197	400	400	400	400	400	400	400	400	7
Mercury-203	80	80	80	80	80	80	80	80	7
Neptunium-239	100	100	100	100	100	100	100	100	7
Niobium-95	200	200	200	200	200	200	200	200	7
Phosphorus-32	50	50	50	50	50	50	50	50	7
Plutonium-238	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	7
Plutonium-239	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	7
Plutonium-240	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	7
Plutonium-241	10	10	10	10	10	10	10	10	7
Rhodium-105	300	300	300	300	300	300	300	300	7

TABLE 2. ALBERTA TIER 1 GROUNDWATER REMEDIATION GUIDELINES

Soil Type	Fine				Coarse				Notes
	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	Natural Area	Agricultural	Residential/ Parkland	Commercial/ Industrial	
Unit	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	(mg/L)	
Rubidium-81	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	7
Rubidium-86	50	50	50	50	50	50	50	50	7
Ruthenium-103	100	100	100	100	100	100	100	100	7
Ruthenium-106	10	10	10	10	10	10	10	10	7
Selenium-75	70	70	70	70	70	70	70	70	7
Silver-108m	70	70	70	70	70	70	70	70	7
Silver-110m	50	50	50	50	50	50	50	50	7
Silver-111	70	70	70	70	70	70	70	70	7
Sodium-22	50	50	50	50	50	50	50	50	7
Strontium-85	300	300	300	300	300	300	300	300	7
Strontium-89	40	40	40	40	40	40	40	40	7
Strontium-90	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	7
Sulphur-35	500	500	500	500	500	500	500	500	7
Technetium-99	200	200	200	200	200	200	200	200	7
Technetium-99m	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7
Tellurium-129m	40	40	40	40	40	40	40	40	7
Tellurium-131m	40	40	40	40	40	40	40	40	7
Tellurium-132	40	40	40	40	40	40	40	40	7
Thallium-201	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	7
Tritium	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7
Ytterbium-169	100	100	100	100	100	100	100	100	7
Yttrium-90	30	30	30	30	30	30	30	30	7
Yttrium-91	30	30	30	30	30	30	30	30	7
Zinc-65	40	40	40	40	40	40	40	40	7
Zirconium-95	100	100	100	100	100	100	100	100	7

Notes:

1. See Environmental Quality Guidelines for Alberta Surface Waters (ESRD, 2014) for further guidance on aquatic life pathway.
2. Tier 1 guideline = lowest of aquatic life guideline and all other guidelines (See Appendix B).
3. B[a]P TPE (Total Potency Equivalents) are calculated by multiplying the groundwater concentration of individual carcinogenic PAHs by a standardized Benzo[a]pyrene Potency Equivalence Factor (PEF) to produce a Benzo[a]pyrene relative potency concentration, and by subsequently summing the relative potency concentrations for the entire PAH mixture. B[a]P PEFs are order of magnitude estimates of carcinogenic potential and are based on the estimates of carcinogenic potential and are based on the World Health Organization (1999) scheme, as follows:

TABLE 2. ALBERTA TIER 1 GROUNDWATER REMEDIATION GUIDELINES

Carcinogenic PAH Compound	PEF
Benz[a]anthracene	0.1
Benzo(b+j)fluoranthene	0.1
Benzo[k]fluoranthene	0.1
Benzo[ghi]perylene	0.01
Benzo[a]pyrene	1
Chrysene	0.01
Dibenz[a,h]anthracene	1
Indeno[1,2,3-c,d]pyrene	0.1

4. For ecological receptors only
5. If trichloroethene is found in groundwater, its degradation product vinyl chloride must also be measured and compared to guideline values
6. Toxicity assumptions for protection of aquatic life and livestock watering are based on mono- and dihydric phenols. Toxicity assumptions for other pathways are based on phenol. Groundwater samples may be analysed for phenolic compounds as a screening procedure. If analytical results exceed the guideline value, then background concentrations should be evaluated to determine if the phenolic compounds are naturally occurring. Speciation to determine mono- and dihydric phenols may also be undertaken and the results compared to the Tier 1 guideline.
7. When two or more radionuclides are found, the following relationship should be satisfied:

$$\frac{[\text{Radionuclide}]_1}{\text{Guideline}_1} + \frac{[\text{Radionuclide}]_2}{\text{Guideline}_2} + \dots + \frac{[\text{Radionuclide}]_i}{\text{Guideline}_i} \leq 1$$

8. As S, but can be applied to undissociated H₂S if concerns arise.
 9. Total means all chemical species.
 10. Expressed as toxic equivalents (TEQs) based on 2,3,7,8-TCDD (See CCME, 1999 and updates)
 11. As the toxicological effects of PFOA and perfluorooctanoyl sulfonate (PFOS) are considered to be additive, the sum of the ratios of the detected concentrations to the corresponding MACs for PFOS and PFOA should not exceed 1.
- NGR = no guideline required - values for all exposure pathways that could be calculated are above compound solubility

TABLE 3. ALBERTA TIER 1 SUBSOIL REMEDIATION GUIDELINES (BTEX AND PHCS ONLY)

Soil Type	Fine					Coarse					Notes
	Natural Area	Agricultural	Residential/ Parkland	Commercial	Industrial	Natural Area	Agricultural	Residential/ Parkland	Commercial	Industrial	
Unit	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	
Benzene	0.046	0.046	0.046	0.046	0.046	0.078	0.021	0.021	0.078	0.078	2
Toluene	0.52	0.52	0.52	0.52	0.52	0.12	0.12	0.12	0.12	0.12	2
Ethylbenzene	0.073	0.073	0.073	0.073	0.073	0.14	0.14	0.14	0.14	0.14	2
Xylenes	0.99	0.99	0.99	0.99	0.99	1.9	1.9	1.9	1.9	1.9	2
F1	420	420	420	640	640	420	30	30	440	440	1, 3
F2	300	300	300	520	520	300	160	160	520	520	1, 3
F3	2,600	2,600	2,600	4,300	4,300	600	600	600	3,400	3,400	1, 3
F4	10,000	10,000	10,000	10,000	10,000	5,600	5,600	5,600	6,600	6,600	1, 3

Notes:

Guideline values calculated for this document using latest available CCME protocols except where noted.

1. Ecological direct contact pathway may be eliminated below 3 metres in depth for F1 to F4 only; the next lowest guideline value applies.
2. Ecological direct contact values from CCME (1999), other values calculated in this document.
3. All values calculated in this document.

TABLE 4. ALBERTA TIER 1 SALT REMEDIATION GUIDELINES

Rating Categories	Good	Fair	Poor	Unsuitable	Commercial/ Industrial
Topsoil^e					
EC ^a (dS/m)	<2.0 ^c	2.0 to 4.0	4.0 to 8.0	>8.0	4.0
SAR ^b	<4.0	4.0 to 8.0	8.0 to 12	>12 ^d	12
Subsoil^e					
EC ^a (dS/m)	<3.	3.0 to 5.0	5.0 to 10	>10	4.0
SAR ^b	<4.0	4.0 to 8	8.0 to 12	>12 ^d	12

Notes:

- a. Electrical conductivity, measured in a saturated paste extract prepared in accordance with Method 15.2.1 (Carter and Gregoritch, 2008).
- b. Sodium Adsorption Ratio, measured in a saturated paste extract prepared in accordance with Method 15.2.1 (Carter and Gregoritch, 2008).
- d. Material characterized by SAR of 12 to 20 may be rated as poor if texture is sandy loam or coarser and saturation % is less than 100.
- e. Topsoil: surface A, L, F, H, and O horizons on the control area, or the equivalent surface soil where these horizons are not present.
Subsoil: B and C horizons and the upper portion of the parent material.