GW - ___1___

River Terrace Voluntary Corrective Measures Bioventing System Annual Report (2 of 3)

2017

Chemical	CAS. NO.	MW (g/mole)	Ref.	Kp (cm/hr)	Ref.	FA (unitless)	Ref.	τ_{event} (hr/event)	B (unitless)	b	c	t* (hr)	DA_event carc	DA_event noncarc	DA_event mutagen
Fluoride	7782-41-4	19	P	1.00E-03	E	1	E	1.34E-01	1.68E-03	3.04E-01	3.34E-01	3.22E-01		1.42E-01	
Furan	110-00-9	68.08	EPI	5.05E-03	EPI	1	E	2.53E-01	1.60E-02	3.13E-01	3.44E-01	6.06E-01		2.37E-03	
Heptachlor	76-44-8	373.32	EPI	5.44E-02	EPI	0.8	E	1.29E+01	4.04E-01	6.14E-01	6.42E-01	3.10E+01	2.09E-05	1.19E-03	
Hexachlorobenzene	118-74-1	284.78	EPI	2.54E-01	EPI	0.9	E	4.13E+00	1.65E+00	2.69E+00	1.77E+00	1.65E+01	5.87E-05	1.90E-03	
Hexachloro-1,3-butadiene	87-68-3	260.76	EPI	8.10E-02	EPI	0.9	E	3.03E+00	5.03E-01	7.13E-01	7.25E-01	7.27E+00	1.20E-03	2.37E-03	
Hexachlorocyclopentadiene	77-47-4	272.77	EPI	1.03E-01	EPI	1	E	3.54E+00	6.54E-01	8.86E-01	8.56E-01	1.39E+01		1.42E-02	
Hexachloroethane	67-72-1	236.74	EPI	4.15E-02	EPI	1	E	2.22E+00	2.46E-01	4.75E-01	5.13E-01	5.34E+00	2.35E-03	1.66E-03	
n-Hexane	110-54-3	86.18	EPI	2.01E-01	EPI	1	E	3.19E-01	7.18E-01	9.67E-01	9.12E-01	1.24E+00		1.42E-01	
HMX	2691-41-0	296.16	EPI	4.36E-05	EPI	1	E	4.78E+00	2.89E-04	3.03E-01	3.34E-01	1.15E+01		1.19E-01	
Hydrazine anhydride	302-01-2	32.05	EPI	4.36E-05	EPI	1	E	1.59E-01	9.49E-05	3.03E-01	3.33E-01	3.81E-01	3.13E-05		
Hydrogen cyanide	74-90-8	27.03	EPI	7.54E-04	EPI	1	E	1.49E-01	1.51E-03	3.04E-01	3.34E-01	3.57E-01		1.42E-03	
Indeno(1,2,3-c,d)pyrene	193-39-5	276.34	EPI	1.24E+00	EPI	0.6	E	3.70E+00	7.93E+00	4.28E+01	7.97E+00	1.66E+01	1.29E-04		4.16E-05
Iron	7439-89-6	55.85	P	1.00E-03	E	1	E	2.16E-01	2.87E-03	3.05E-01	3.35E-01	5.18E-01		1.66E+00	
Isobutanol (Isobutyl alcohol)	78-83-1	74.12	EPI	1.92E-03	EPI	1	E	2.73E-01	6.36E-03	3.07E-01	3.38E-01	6.55E-01		7.11E-01	
Isophorone	78-59-1	138.21	EPI	3.54E-03	EPI	1	E	6.24E-01	1.60E-02	3.13E-01	3.44E-01	1.50E+00	9.88E-02	4.74E-01	
Lead	7439-92-1	207.2	P	1.00E-03	E	1	E	1.52E+00	5.54E-03	3.07E-01	3.37E-01	3.65E+00			
Lead (tetraethyl-)	78-00-2	323.45	EPI	1.37E-02	EPI	1	E	6.80E+00	9.48E-02	3.64E-01	3.99E-01	1.63E+01		2.37E-07	
Maleic hydrazide	123-33-1	112.09	EPI	1.02E-04	EPI	1	E	4.46E-01	4.15E-04	3.04E-01	3.34E-01	1.07E+00		1.19E+00	
Manganese	7439-96-5	54.94	P	1.00E-03	E	1	E	2.13E-01	2.85E-03	3.05E-01	3.35E-01	5.12E-01		1.33E-02	
Mercury (elemental)	7439-97-6	200.59	EPI	1.00E-03	E	1	E	1.39E+00	5.45E-03	3.07E-01	3.37E-01	3.35E+00			
Mercury (methyl)	22967-92-6	215.63	EPI	1.00E-03	E	1	E	1.69E+00	5.65E-03	3.07E-01	3.37E-01	4.06E+00		2.37E-04	
Mercury Chloride (Mercury Salts)	7487-94-7	271.5	EPI	1.00E-03	E	1	E	3.48E+00	6.34E-03	3.07E-01	3.38E-01	8.35E+00		4.98E-05	
Methacrylonitrile	126-98-7	67.09	EPI	1.86E-03	EPI	1	E	2.49E-01	5.86E-03	3.07E-01	3.37E-01	5.99E-01		2.37E-04	
Methomyl	16752-77-5	162.21	EPI	4.82E-04	EPI	1	E	8.50E-01	2.36E-03	3.05E-01	3.35E-01	2.04E+00		5.93E-02	
Methyl acetate	79-20-9	74.08	EPI	7.92E-04	EPI	1	E	2.73E-01	2.62E-03	3.05E-01	3.35E-01	6.55E-01		2.37E+00	
Methyl acrylate	96-33-3	86.09	EPI	1.75E-03	EPI	1	E	3.19E-01	6.25E-03	3.07E-01	3.38E-01	7.65E-01		7.11E-02	
Methyl isobutyl ketone	108-10-1	100.16	EPI	3.19E-03	EPI	1	E	3.82E-01	1.23E-02	3.11E-01	3.42E-01	9.17E-01		1.90E-01	
Methyl methacrylate	80-62-6	100.12	EPI	3.55E-03	EPI	1	E	3.82E-01	1.37E-02	3.12E-01	3.43E-01	9.16E-01		3.32E+00	
Methyl styrene (alpha)	98-83-9	118.18	EPI	6.99E-02	EPI	1	E	4.82E-01	2.92E-01	5.13E-01	5.50E-01	1.16E+00		1.66E-01	
Methyl styrene (mixture)	25013-15-4	118.18	EPI	6.60E-02	EPI	1	E	4.82E-01	2.76E-01	4.99E-01	5.37E-01	1.16E+00		1.42E-02	
Methylcyclohexane	108-87-2	98.19	EPI	1.10E-01	EPI	1	E	3.72E-01	4.19E-01	6.28E-01	6.54E-01	8.94E-01			
Methylene bromide (Dibromomethane)	74-95-3	173.84	EPI	2.23E-03	EPI	1	E	9.88E-01	1.13E-02	3.10E-01	3.41E-01	2.37E+00		2.37E-02	
Methylene chloride	75-09-2	84.93	EPI	3.54E-03	EPI	1	E	3.14E-01	1.25E-02	3.11E-01	3.42E-01	7.53E-01	4.69E-02	1.42E-02	1.52E-02
Molybdenum	7439-98-7	95.96	P	1.00E-03	E	1	E	3.62E-01	3.77E-03	3.06E-01	3.36E-01	8.69E-01		1.19E-02	
Naphthalene	91-20-3	128.18	EPI	4.66E-02	EPI	1	E	5.48E-01	2.03E-01	4.41E-01	4.80E-01	1.32E+00		4.74E-02	
Nickel	7440-02-0	58.69	EPI	2.00E-04	E	1	E	2.24E-01	5.89E-04	3.04E-01	3.34E-01	5.37E-01		1.90E-03	

Chemical	CAS. NO.	MW (g/mole)	Ref.	Kp (cm/hr)	Ref.	FA (unitless)	Ref.	τ_{event} (hr/event)	B (unitless)	b	c	t* (hr)	DA_event carc	DA_event noncarc	DA_event mutagen
Nitrate	14797-55-8	62	EPI	1.00E-03	E	1	E	2.34E-01	3.03E-03	3.05E-01	3.35E-01	5.61E-01		3.79E+00	
Nitrite	14797-65-0	47.01	EPI	1.00E-03	E	1	E	1.93E-01	2.64E-03	3.05E-01	3.35E-01	4.62E-01		2.37E-01	
Nitrobenzene	98-95-3	123.11	EPI	5.41E-03	EPI	1	E	5.14E-01	2.31E-02	3.17E-01	3.49E-01	1.23E+00		4.74E-03	
Nitroglycerin	55-63-0	227.09	EPI	9.94E-04	EPI	1	E	1.96E+00	5.76E-03	3.07E-01	3.37E-01	4.71E+00	5.52E-03	2.37E-04	
N-Nitrosodiethylamine	55-18-5	102.14	EPI	8.72E-04	EPI	1	E	3.92E-01	3.39E-03	3.05E-01	3.36E-01	9.41E-01	6.26E-07		2.02E-07
N-Nitrosodimethylamine	62-75-9	74.08	EPI	2.51E-04	EPI	1	E	2.73E-01	8.31E-04	3.04E-01	3.34E-01	6.55E-01	1.84E-06	1.90E-05	5.95E-07
N-Nitrosodi-n-butylamine	924-16-3	158.25	EPI	1.13E-02	EPI	1	E	8.08E-01	5.47E-02	3.37E-01	3.71E-01	1.94E+00	1.74E-05		
N-Nitrosodiphenylamine	86-30-6	198.23	EPI	1.45E-02	EPI	1	E	1.35E+00	7.85E-02	3.53E-01	3.88E-01	3.25E+00	1.92E-02		
N-Nitrosopyrrolidine	930-55-2	100.12	EPI	3.21E-04	EPI	1	E	3.82E-01	1.24E-03	3.04E-01	3.34E-01	9.16E-01	4.47E-05		
m-Nitrotoluene	99-08-1	137.14	EPI	1.13E-02	EPI	1	E	6.15E-01	5.09E-02	3.35E-01	3.68E-01	1.48E+00		2.37E-04	
o-Nitrotoluene	88-72-2	137.14	EPI	8.99E-03	EPI	1	E	6.15E-01	4.05E-02	3.28E-01	3.61E-01	1.48E+00	4.27E-04	2.13E-03	
p-Nitrotoluene	99-99-0	137.14	EPI	1.00E-02	EPI	1	E	6.15E-01	4.50E-02	3.31E-01	3.64E-01	1.48E+00	5.87E-03	9.48E-03	
Pentachlorobenzene	608-93-5	250.34	EPI	1.68E-01	EPI	0.9	E	2.65E+00	1.02E+00	1.42E+00	1.19E+00	1.02E+01		1.90E-03	
Pentachlorophenol	87-86-5	266.34	EPI	1.27E-01	EPI	0.9	E	3.26E+00	7.97E-01	1.07E+00	9.83E-01	1.25E+01	2.35E-04	1.19E-02	
Perchlorate	14797-73-0	99.45	EPI	1.00E-03	E	1	E	3.79E-01	3.84E-03	3.06E-01	3.36E-01	9.08E-01		1.66E-03	
Phenanthrene	85-01-8	178.24	EPI	1.44E-01	EPI	1	E	1.05E+00	7.39E-01	9.95E-01	9.31E-01	4.04E+00		7.11E-02	
Phenol	108-95-2	94.11	EPI	4.34E-03	EPI	1	E	3.53E-01	1.62E-02	3.13E-01	3.44E-01	8.48E-01		7.11E-01	
Polychlorinatedbiphenyls															
Aroclor 1016	12674-11-2	257.55	EPI	3.05E-01	EPI	0.6	E	2.91E+00	1.88E+00	3.29E+00	2.00E+00	1.18E+01	1.34E-03	1.66E-04	
Aroclor 1221	11104-28-2	188.66	EPI	1.68E-01	EPI	0.6	E	1.20E+00	8.88E-01	1.20E+00	1.06E+00	4.60E+00	4.69E-05		
Aroclor 1232	11141-16-5	188.66	EPI	1.68E-01	EPI	0.6	E	1.20E+00	8.88E-01	1.20E+00	1.06E+00	4.60E+00	4.69E-05		
Aroclor 1242	53469-21-9	291.99	EPI	5.45E-01	EPI	0.6	E	4.53E+00	3.58E+00	9.71E+00	3.65E+00	1.94E+01	4.69E-05		
Aroclor 1248	12672-29-6	291.99	EPI	4.75E-01	EPI	0.6	E	4.53E+00	3.12E+00	7.61E+00	3.20E+00	1.92E+01	4.69E-05		
Aroclor 1254	11097-69-1	326.44	EPI	7.51E-01	EPI	0.6	E	7.07E+00	5.22E+00	1.93E+01	5.27E+00	3.10E+01	4.69E-05	4.74E-05	
Aroclor 1260	11096-82-5	395.33	EPI	9.86E-01	EPI	0.6	E	1.72E+01	7.54E+00	3.89E+01	7.58E+00	7.69E+01	4.69E-05		
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)	35065-30-6	395.33	EPI	2.96E+00	EPI	0.6	E	1.72E+01	2.26E+01	3.33E+02	2.27E+01	7.95E+01	7.22E-06	1.66E-05	
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)	35065-29-3	395.33	EPI	2.96E+00	EPI	0.6	E	1.72E+01	2.26E+01	3.33E+02	2.27E+01	7.95E+01	7.22E-05	1.66E-04	
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)	39635-31-9	395.33	EPI	2.96E+00	EPI	0.6	E	1.72E+01	2.26E+01	3.33E+02	2.27E+01	7.95E+01	2.41E-05	5.53E-05	
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)	52663-72-6	360.88	EPI	1.43E+00	EPI	0.5	E	1.10E+01	1.04E+01	7.30E+01	1.05E+01	5.00E+01	2.41E-05	5.53E-05	
2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)	69782-90-7	360.88	EPI	1.66E+00	EPI	0.5	E	1.10E+01	1.21E+01	9.76E+01	1.22E+01	5.02E+01	2.41E-05	5.53E-05	
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)	38380-08-4	360.88	EPI	1.66E+00	EPI	0.5	E	1.10E+01	1.21E+01	9.76E+01	1.22E+01	5.02E+01	2.41E-05	5.53E-05	
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)	32774-16-6	360.88	EPI	1.24E+00	EPI	0.5	E	1.10E+01	9.06E+00	5.53E+01	9.09E+00	4.97E+01	2.41E-08	5.53E-08	
2',3,4,4',5-Pentachlorobiphenyl (PCB 123)	65510-44-3	326.44	EPI	1.00E+00	EPI	0.6	E	7.07E+00	6.95E+00	3.32E+01	6.99E+00	3.15E+01	2.41E-05	5.53E-05	
2',3',4,4',5-Pentachlorobiphenyl (PCB 118)	31508-00-6	326.44	EPI	1.24E+00	EPI	0.6	E	7.07E+00	8.62E+00	5.02E+01	8.65E+00	3.18E+01	2.41E-05	5.53E-05	
2',3,3',4,4'-Pentachlorobiphenyl (PCB 105)	32598-14-4	326.44	EPI	7.51E-01	EPI	0.6	E	7.07E+00	5.22E+00	1.93E+01	5.27E+00	3.10E+01	2.41E-05	5.53E-05	
2,3,4,4',5-Pentachlorobiphenyl (PCB 114)	74472-37-0	326.44	EPI	1.00E+00	EPI	0.6	E	7.07E+00	6.95E+00	3.32E+01	6.99E+00	3.15E+01	2.41E-05	5.53E-05	

Chemical	CAS. NO.	MW (g/mole)	Ref.	Kp (cm/hr)	Ref.	FA (unitless)	Ref.	τ_{event} (hr/event)	B (unitless)	b	c	t* (hr)	DA_event carc	DA_event noncarc	DA_event mutagen
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)	57465-28-8	326.44	EPI	1.00E+00	EPI	0.6	E	7.07E+00	6.95E+00	3.32E+01	6.99E+00	3.15E+01	7.22E-09	1.66E-08	
3,3',4,4'-Tetrachlorobiphenyl (PCB 77)	32598-13-3	291.99	EPI	9.17E-01	EPI	0.6	E	4.53E+00	6.03E+00	2.54E+01	6.07E+00	2.01E+01	7.22E-06	1.66E-05	
3,4,4',5-Tetrachlorobiphenyl (PCB 81)	70362-50-4	291.99	EPI	5.84E-01	EPI	0.6	E	4.53E+00	3.84E+00	1.10E+01	3.91E+00	1.95E+01	2.41E-06	5.53E-06	
Propylene oxide	75-56-9	58.08	EPI	7.74E-04	EPI	1	E	2.22E-01	2.27E-03	3.05E-01	3.35E-01	5.33E-01	3.91E-04		
Pyrene	129-00-0	202.26	EPI	2.01E-01	EPI	1	E	1.43E+00	1.10E+00	1.55E+00	1.26E+00	5.53E+00		7.11E-02	
RDX	121-82-4	222.12	EPI	3.36E-04	EPI	1	E	1.84E+00	1.93E-03	3.04E-01	3.35E-01	4.42E+00	8.53E-04	7.11E-03	
Selenium	7782-49-2	78.96	P	1.00E-03	E	1	E	2.91E-01	3.42E-03	3.05E-01	3.36E-01	6.98E-01		1.19E-02	
Silver	7440-22-4	107.87	P	6.00E-04	E	1	E	4.22E-01	2.40E-03	3.05E-01	3.35E-01	1.01E+00		4.74E-04	
Strontium	7440-24-6	87.62	P	1.00E-03	E	1	E	3.25E-01	3.60E-03	3.05E-01	3.36E-01	7.80E-01		1.42E+00	
Styrene	100-42-5	104.15	EPI	3.72E-02	EPI	1	E	4.02E-01	1.46E-01	3.99E-01	4.37E-01	9.65E-01		4.74E-01	
Sulfolane	126-33-0	120.17	EPI	1.02E-04	EPI	1	EPI	4.94E-01	4.30E-04	3.04E-01	3.34E-01	1.19E+00		2.37E-03	
2,3,7,8-TCDD	1746-01-6	321.98	EPI	8.08E-01	EPI	0.5	E	6.67E+00	5.58E+00	2.19E+01	5.63E+00	2.94E+01	7.22E-10	1.66E-09	
2,3,7,8-TCDF	51207-31-9	305.98	EPI	6.57E-01	EPI	1	E	5.43E+00	4.42E+00	1.42E+01	4.48E+00	2.36E+01	7.22E-09		
1,2,4,5-Tetrachlorobenzene	95-94-3	215.89	EPI	1.17E-01	EPI	1	E	1.70E+00	6.61E-01	8.95E-01	8.62E-01	6.66E+00		7.11E-04	
1,1,1,2-Tetrachloroethane	630-20-6	167.85	EPI	1.59E-02	EPI	1	E	9.14E-01	7.92E-02	3.53E-01	3.88E-01	2.19E+00	3.61E-03	7.11E-02	
1,1,2,2-Tetrachloroethane	79-34-5	167.85	EPI	6.94E-03	EPI	1	E	9.14E-01	3.46E-02	3.25E-01	3.57E-01	2.19E+00	4.69E-04	4.74E-02	
Tetrachloroethene	127-18-4	165.83	EPI	3.34E-02	EPI	1	E	8.91E-01	1.65E-01	4.13E-01	4.51E-01	2.14E+00	4.47E-02	1.42E-02	
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	287.15	EPI	4.74E-04	EPI	1	E	4.26E+00	3.09E-03	3.05E-01	3.35E-01	1.02E+01		4.74E-03	
Thallium	7440-28-0	204.38	P	1.00E-03	E	1	E	1.46E+00	5.50E-03	3.07E-01	3.37E-01	3.52E+00		2.37E-05	
Toluene	108-88-3	92.14	EPI	3.11E-02	EPI	1	E	3.44E-01	1.15E-01	3.77E-01	4.14E-01	8.27E-01		1.90E-01	
Toxaphene	8001-35-2	413.82	EPI	5.18E-02	EPI	0.8	E	2.18E+01	4.05E-01	6.15E-01	6.42E-01	5.23E+01	8.53E-05		
Tribromomethane (Bromoform)	75-25-2	252.73	EPI	2.35E-03	EPI	1	E	2.73E+00	1.44E-02	3.12E-01	3.43E-01	6.56E+00	1.19E-02	4.74E-02	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.38	EPI	1.75E-02	EPI	1	E	1.18E+00	9.21E-02	3.62E-01	3.97E-01	2.82E+00		7.11E+01	
1,2,4-Trichlorobenzene	120-82-1	181.45	EPI	7.05E-02	EPI	1	E	1.09E+00	3.65E-01	5.77E-01	6.09E-01	2.62E+00	3.24E-03	2.37E-02	
1,1,1-Trichloroethane	71-55-6	133.41	EPI	1.26E-02	EPI	1	E	5.87E-01	5.60E-02	3.38E-01	3.72E-01	1.41E+00		4.74E+00	
1,1,2-Trichloroethane	79-00-5	133.41	EPI	5.04E-03	EPI	1	E	5.87E-01	2.24E-02	3.17E-01	3.48E-01	1.41E+00	1.65E-03	9.48E-03	
Trichloroethylene	79-01-6	131.39	EPI	1.16E-02	EPI	1	E	5.71E-01	5.11E-02	3.35E-01	3.68E-01	1.37E+00	2.04E-03	1.19E-03	4.36E-04
Trichlorofluoromethane	75-69-4	137.37	EPI	1.27E-02	EPI	1	E	6.17E-01	5.73E-02	3.39E-01	3.73E-01	1.48E+00		7.11E-01	
2,4,5-Trichlorophenol	95-95-4	197.45	EPI	3.62E-02	EPI	1	E	1.34E+00	1.96E-01	4.36E-01	4.74E-01	3.21E+00		2.37E-01	
2,4,6-Trichlorophenol	88-06-2	197.45	EPI	3.46E-02	EPI	1	E	1.34E+00	1.87E-01	4.29E-01	4.68E-01	3.21E+00	8.53E-03	2.37E-03	
1,1,2-Trichloropropane	598-77-6	147.43	EPI	9.60E-03	EPI	1	E	7.03E-01	4.48E-02	3.31E-01	3.64E-01	1.69E+00		1.19E-02	
1,2,3-Trichloropropane	96-18-4	147.43	EPI	7.52E-03	EPI	1	E	7.03E-01	3.51E-02	3.25E-01	3.57E-01	1.69E+00	3.13E-06	9.48E-03	1.01E-06
Triethylamine	121-44-8	101.19	EPI	3.90E-03	EPI	1	E	3.87E-01	1.51E-02	3.13E-01	3.43E-01	9.29E-01			
2,4,6-Trinitrotoluene	118-96-7	227.13	EPI	9.63E-04	EPI	1	E	1.96E+00	5.58E-03	3.07E-01	3.37E-01	4.71E+00	3.13E-03	1.19E-03	
Uranium (soluable salts)	--	238.03	P	1.00E-03	E	1	E	2.26E+00	5.93E-03	3.07E-01	3.37E-01	5.42E+00		7.11E-03	
Vanadium	7440-62-2	50.94	EPI	1.00E-03	E	1	E	2.03E-01	2.75E-03	3.05E-01	3.35E-01	4.86E-01		3.11E-04	

Chemical	CAS. NO.	MW (g/mole)	Ref.	Kp (cm/hr)	Ref.	FA (unitless)	Ref.	τ_{event} (hr/event)	B (unitless)	b	c	t* (hr)	DA_event carc	DA_event noncarc	DA_event mutagen
Vinyl acetate	108-05-4	86.09	P	1.57E-03	EPI	1	E	3.19E-01	5.60E-03	3.07E-01	3.37E-01	7.65E-01		2.37E+00	
Vinyl bromide	593-60-2	106.95	EPI	4.35E-03	EPI	1	E	4.17E-01	1.73E-02	3.14E-01	3.45E-01	1.00E+00			
Vinyl chloride	75-01-4	62.5	EPI	8.38E-03	EPI	1	E	2.35E-01	2.55E-02	3.19E-01	3.51E-01	5.64E-01	1.30E-04	7.11E-03	3.06E+05
m-Xylene	108-38-3	106.17	EPI	5.32E-02	EPI	1	E	4.13E-01	2.11E-01	4.47E-01	4.86E-01	9.91E-01		4.74E-01	
o-Xylene	95-47-6	106.17	EPI	5.00E-02	EPI	1	E	4.13E-01	1.98E-01	4.38E-01	4.76E-01	9.91E-01		4.74E-01	
Xylenes	1330-20-7	106.17	EPI	5.00E-02	EPI	1	E	4.13E-01	1.98E-01	4.38E-01	4.76E-01	9.91E-01		4.74E-01	
Zinc	7440-66-6	65.38	P	6.00E-04	E	1	E	2.44E-01	1.87E-03	3.04E-01	3.35E-01	5.86E-01		7.11E-01	

K_p – Dermal permeability coefficient in water
FA – Fraction absorbed
T_{event} – Lag time per event
B – Ratio of the permeability coefficient of chemical through the stratum corneum relative to its permeability coefficient across the viable epidermis
b, c – Correlation coefficients (see RAGS Part E).
t* - Time to reach steady state
DA_{event} Carc. – Absorbed dose per event, carcinogens
DA_{event} Noncarc – Absorbed dose per event, noncarcinogens
DA_{event} Mutagens – Absorbed dose per event, mutagens

E = US EPA. 2004. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Interim Guidance. Office of Solid Waste and Emergency Response, Washington, D.C. http://www.epa.gov/oswer/riskassessment/ragse/index.htm
EPI= US EPA. 2012. Estimation Programs Interface (EPI) Suite™ for Microsoft® Windows, v 4.11. Washington, DC, USA.

APPENDIX C

TOXICITY DATA

Table C-1: Human Health Benchmarks Used for Calculating SSLs

Chemical	SF_o (mg/kg-day)$^{-1}$	Ref.	IUR (ug/m^3)$^{-1}$	Ref.	RfD_o (mg/kg-day)	Ref.	RfCi (mg/m^3)	Ref.	Mutagen	GIABS	Ref.	Dermal ABS	Ref.
Acenaphthene					6.00E-02	IRIS				1	E	0.13	E
Acetaldehyde			2.20E-06	IRIS			9.00E-03	IRIS		1	E		
Acetone					9.00E-01	IRIS	3.10E+01	ATSDR		1	E		
Acrylonitrile	5.40E-01	IRIS	6.80E-05	IRIS	4.00E-02	ATSDR	2.00E-03	IRIS		1	E		
Acetophenone					1.00E-01	IRIS				1	E		
Acrolein					5.00E-04	IRIS	2.00E-05	IRIS		1	E		
Aldrin	1.72E+01	IRIS	4.90E-03	IRIS	3.00E-05	IRIS				1	E	0.1	E
Aluminum					1.00E+00	PPRTV	5.00E-03	PPRTV		1	E		
Anthracene					3.00E-01	IRIS				1	E	0.13	E
Antimony					4.00E-04	IRIS				0.15	E		
Arsenic	1.50E+00	IRIS	4.30E-03	IRIS	3.00E-04	IRIS	1.50E-05	CalEPA		1	E	0.03	E
Barium					2.00E-01	IRIS	5.00E-04	HEAST		0.07	E		
Benzene	5.50E-02	IRIS	7.80E-06	IRIS	4.00E-03	IRIS	3.00E-02	IRIS		1	E		
Benzidine	2.30E+02	IRIS	6.70E-02	IRIS	3.00E-03	IRIS			M	1	E	0.1	E
Benzo(a)anthracene	7.30E-01	PPRTV	1.10E-04	CalEPA					M	1	E	0.13	E
Benzo(a)pyrene	7.30E+00	IRIS	1.10E-03	CalEPA					M	1	E	0.13	E
Benzo(b)fluoranthene	7.30E-01	EPA TEF	1.10E-04	CalEPA					M	1	E	0.13	E
Benzo(k)fluoranthene	7.30E-02	EPA TEF	1.10E-04	CalEPA					M	1	E	0.13	E
Beryllium			2.40E-03	IRIS	2.00E-03	IRIS	2.00E-05	IRIS		0.007	E		
a-BHC (HCH)	6.30E+00	IRIS	1.80E-03	IRIS	8.00E-03	ATSDR				1	E	0.1	E
b-BHC (HCH)	1.80E+00	IRIS	5.30E-04	IRIS						1	E	0.1	E
g-BHC	1.10E+00	CalEPA	3.10E-04	CalEPA	3.00E-04	IRIS				1	E	0.04	E
1,1-Biphenyl	8.20E-03	IRIS			5.00E-01	IRIS	4.00E-04	PPRTV		1	E		
Bis(2-chloroethyl) ether	1.10E+00	IRIS	3.30E-04	IRIS						1	E		
Bis(2-chloroisopropyl) ether	7.00E-02	HEAST								1	E		
Bis(2-ethylhexyl) phthalate	1.40E-02	IRIS	2.40E-06	CalEPA	2.00E-02	IRIS				1	E	0.1	E
Bis(chloromethyl) ether	2.20E+02	IRIS	6.20E-02	IRIS						1	E		
Boron					2.00E-01	IRIS	2.00E-02	HEAST		1	E		
Bromodichloromethane	6.20E-02	IRIS	3.70E-05	CalEPA	2.00E-02	IRIS				1	E		
Bromomethane					1.40E-03	IRIS	5.00E-03	IRIS		1	E		
1,3-Butadiene	3.40E+00	CalEPA	3.00E-05	IRIS			2.00E-03	IRIS		1	E		
2-Butanone (Methyl ethyl ketone, MEK)					6.00E-01	IRIS	5.00E+00	IRIS		1	E		

Chemical	SF_o (mg/kg-day)$^{-1}$	Ref.	IUR (ug/m^3)$^{-1}$	Ref.	RfD_o (mg/kg-day)	Ref.	RfCi (mg/m^3)	Ref.	Mutagen	GIABS	Ref.	Dermal ABS	Ref.
tert-Butyl methyl ether (MTBE)	1.80E-03	CalEPA	2.60E-07	CalEPA			3.00E+00	IRIS		1	E		
Cadmium			1.80E-03	IRIS	1.00E-03	IRIS	1.00E-05	ATSDR		0.025	E	0.001	E
Carbon disulfide					1.00E-01	IRIS	7.00E-01	IRIS		1	E		
Carbon tetrachloride	7.00E-02	IRIS	6.00E-06	IRIS	4.00E-03	IRIS	1.00E-01	IRIS		1	E		
Chlordane	3.50E-01	IRIS	1.00E-04	IRIS	5.00E-04	IRIS	7.00E-04	IRIS		1	E	0.04	E
2-Chloroacetophenone							3.00E-05	IRIS		1	E	0.1	E
2-Chloro-1,3-butadiene			3.00E-04	IRIS	2.00E-02	HEAST	2.00E-02	IRIS		1	E		
1-Chloro-1,1-difluoroethane							5.00E+01	IRIS		1	E		
Chlorobenzene					2.00E-02	IRIS	5.00E-02	PPRTV		1	E		
1-Chlorobutane					4.00E-02	PPRTV				1	E		
Chlorodifluoromethane							5.00E+01	IRIS		1	E		
Chloroform	1.90E-02	IRIS	2.30E-05	IRIS	1.00E-02	IRIS	9.80E-02	ATSDR		1	E		
Chloromethane	1.30E-02	HEAST	1.80E-06	HEAST			9.00E-02	IRIS		1	E		
b-Chloronaphthalene					8.00E-02	IRIS				1	E		
o-Chloronitrobenzene	3.00E-01	PPRTV			3.00E-03	PPRTV	1.00E-05	PPRTV		1	E	0.1	E
p-Chloronitrobenzene	6.30E-03	PPRTV			1.00E-03	PPRTV	6.00E-04	PPRTV		1	E	0.1	E
2-Chlorophenol					5.00E-03	IRIS				1	E		
2-Chloropropane							1.00E-01	HEAST		1	E		
o-Chlorotoluene					2.00E-02	IRIS				1	E		
Chromium III					1.50E+00	IRIS				0.013	E		
Chromium VI	5.00E-01	NJ	8.40E-02	IRIS	3.00E-03	IRIS	1.00E-04	IRIS	M	0.025	E		
Chromium (Total)	7.14E-02	NJ, adjusted	1.20E-02	IRIS	1.29E+00	IRIS, adjusted	1.43E-05	IRIS, adjusted		0.013	E		
Chrysene	7.30E-03	EPA TEF	1.10E-05	CalEPA					M	1	E	0.13	E
Copper					4.00E-02	HEAST				1	E		
Crotonaldehyde	1.90E+00	HEAST			1.00E-03	PPRTV				1	E		
Cumene (isopropylbenzene)					1.00E-01	IRIS	4.00E-01	IRIS		1	E		
Cyanide					6.00E-04	IRIS	8.00E-04	IRIS		1	E		
Cyanogen					1.00E-03	IRIS				1	E		
Cyanogen bromide					9.00E-02	IRIS				1	E		
Cyanogen chloride					5.00E-02	IRIS				1	E		
DDD	2.40E-01	IRIS	6.90E-05	CalEPA						1	E	0.1	E
DDE	3.40E-01	IRIS	9.70E-05	CalEPA						1	E	0.1	E
DDT	3.40E-01	IRIS	9.70E-05	IRIS	5.00E-04	IRIS				1	E	0.03	E
Dibenz(a,h)anthracene	7.30E+00	EPA TEF	1.20E-03	CalEPA					M	1	E	0.13	E

Chemical	SF_o (mg/kg-day)$^{-1}$	Ref.	IUR (ug/m^3)$^{-1}$	Ref.	RfD_o (mg/kg-day)	Ref.	RfCi (mg/m^3)	Ref.	Mutagen	GIABS	Ref.	Dermal ABS	Ref.
1,2-Dibromo-3-chloropropane	8.00E-01	PPRTV	6.00E-03	PPRTV	2.00E-04	PPRTV	2.00E-04	IRIS	M	1	E	0.1	E
Dibromochloromethane	8.40E-02	IRIS	2.70E-05	CalEPA	2.00E-02	IRIS				1	E	0.1	E
1,2-Dibromoethane	2.00E+00	IRIS	6.00E-04	IRIS	9.00E-03	IRIS	9.00E-03	IRIS		1	E		
1,4-Dichloro-2-butene			4.20E-03	PPRTV						1	E		
1,2-Dichlorobenzene					9.00E-02	IRIS	2.00E-01	HEAST		1	E		
1,4-Dichlorobenzene	5.40E-03	CalEPA	1.10E-05	CalEPA	7.00E-02	ATSDR	8.00E-01	IRIS		1	E		
3,3-Dichlorobenzidine	4.50E-01	IRIS	3.40E-04	CalEPA						1	E	0.1	E
Dichlorodifluoromethane					2.00E-01	IRIS	1.00E-01	PPRTV		1	E		
1,1-Dichloroethane	5.70E-03	CalEPA	1.60E-06	CalEPA	2.00E-01	PPRTV				1	E		
1,2-Dichloroethane	9.10E-02	IRIS	2.60E-05	IRIS	6.00E-03	PPRTV	7.00E-03	PPRTV		1	E		
cis-1,2-Dichloroethene					2.00E-03	IRIS				1	E		
trans-1,2-Dichloroethene					2.00E-02	IRIS	6.00E-02	PPRTV		1	E		
1,1-Dichloroethene					5.00E-02	IRIS	2.00E-01	IRIS		1	E		
2,4-Dichlorophenol					3.00E-03	IRIS				1	E	0.1	E
1,2-Dichloropropane	3.60E-02	CalEPA	1.00E-05	CalEPA	9.00E-02	ATSDR	4.00E-03	IRIS		1	E		
1,3-Dichloropropene	1.00E-01	IRIS	4.00E-06	IRIS	3.00E-02	IRIS	2.00E-02	IRIS		1	E		
Dicyclopentadiene					8.00E-2	PPRTV	3.00E-4	PPRTV		1	E		
Dieldrin	1.60E+01	IRIS	4.60E-03	IRIS	5.00E-05	IRIS				1	E	0.1	E
Diethyl phthalate					8.00E-01	IRIS				1	E	0.1	E
Di-n-butyl phthalate (Dibutyl phthalate)					1.00E-01	IRIS				1	E	0.1	E
2,4-Dimethylphenol					2.00E-02	IRIS				1	E	0.1	E
4,6-Dinitro-o-cresol					8.00E-05	PPRTV				1	E	0.1	E
2,4-Dinitrophenol					2.00E-03	IRIS				1	E	0.1	E
2,4-Dinitrotoluene	3.10E-01	CalEPA	8.90E-05	CalEPA	2.00E-03	IRIS				1	E	0.102	E
2,6-Dintitrotoluene	1.50E+00	PPRTV			3.00E-04	PPRTV				1	E	0.099	E
2,4/2,6-Dintrotoluene Mixture	6.80E-01	IRIS								1	E	0.1	E
1,4-Dioxane	1.00E-01	IRIS	5.00E-06	IRIS	3.00E-02	IRIS	3.00E-02	IRIS		1	E	0.1	E
1,2-Diphenylhydrazine	8.00E-01	IRIS	2.20E-04	IRIS						1	E	0.1	E
Endosulfan					6.00E-03	IRIS				1	E	0.1	E
Endrin					3.00E-04	IRIS				1	E	0.1	E
Epichlorohydrin	9.90E-03	IRIS	1.20E-06	IRIS	6.00E-03	PPRTV	1.00E-03	IRIS		1	E		
Ethyl acetate					9.00E-01	IRIS	7.00E-02	PPRTV		1	E		
Ethyl acrylate	4.80E-02	HEAST								1	E		
Ethyl chloride							1.00E+01	IRIS		1	E		

Chemical	SF_o (mg/kg-day)$^{-1}$	Ref.	IUR (ug/m^3)$^{-1}$	Ref.	RfD_o (mg/kg-day)	Ref.	RfCi (mg/m^3)	Ref.	Mutagen	GIABS	Ref.	Dermal ABS	Ref.
Ethyl ether					2.00E-01	IRIS				1	E		
Ethyl methacrylate					9.00E-02	HEAST	3.00E-01	PPRTV		1	E		
Ethylbenzene	1.10E-02	CalEPA	2.50E-06	CalEPA	1.00E-01	IRIS	1.00E+00	IRIS		1	E		
Ethylene oxide	3.10E-01	CalEPA	8.80E-05	CalEPA			3.00E-02	CalEPA		1	E		
Fluoranthene					4.00E-02	IRIS				1	E	0.13	E
Fluorene					4.00E-02	IRIS				1	E	0.13	E
Fluoride					6.00E-02	IRIS	1.30E-02	CalEPA		1	E		
Furan					1.00E-03	IRIS				1	E	0.03	E
Heptachlor	4.50E+00	IRIS	1.30E-03	IRIS	5.00E-04	IRIS				1	E	0.1	E
Hexachlorobenzene	1.60E+00	IRIS	4.60E-04	IRIS	8.00E-04	IRIS				1	E	0.1	E
Hexachloro-1,3-butadiene	7.80E-02	IRIS	2.20E-05	IRIS	1.00E-03	PPRTV				1	E	0.1	E
Hexachlorocyclopentadiene					6.00E-03	IRIS	2.00E-04	IRIS		1	E	0.1	E
Hexachloroethane	4.00E-02	IRIS	1.10E-05	CalEPA	7.00E-04	IRIS	3.00E-02	IRIS		1	E	0.1	E
n-Hexane					6.00E-02	HEAST	7.00E-01	IRIS		1	E		
HMX					5.00E-02	IRIS				1	E	0.006	E
Hydrazine anhydride	3.00E+00	IRIS	4.90E-03	IRIS			3.00E-05	PPRTV		1	E	0.1	E
Hydrogen cyanide					6.00E-04	IRIS	8.00E-04	IRIS		1	E		
Indeno(1,2,3-c,d)pyrene	7.30E-01	EPA TEF	1.10E-04	CalEPA					M	1	E	0.13	E
Iron					7.00E-01	PPRTV				1	E		
Isobutanol (Isobutyl alcohol)					3.00E-01	IRIS				1	E	0.1	E
Isophorone	9.50E-04	IRIS			2.00E-01	IRIS	2.00E+00	CalEPA		1	E	0.1	E
Lead										1	E		
Lead (tetraethyl-)					1.00E-07	IRIS				1	E	0.1	E
Maleic hydrazide					5.00E-01	IRIS				1	E	0.1	E
Manganese					1.40E-01	IRIS	5.00E-05	IRIS		0.04	E		
Mercury (elemental)							3.00E-04	IRIS		1	E		
Mercury (methyl)					1.00E-04	IRIS				1	E		
Mercuric Chloride (Mercury Salts)					3.00E-04	IRIS	3.00E-05	CalEPA		0.07	E		
Methacrylonitrile					1.00E-04	IRIS	3.00E-02	PPRTV		1	E		
Methomyl					2.50E-02	IRIS				1	E	0.1	E
Methyl acetate					1.00E+00	PPRTV				1	E		
Methyl acrylate					3.00E-02	HEAST	2.00E-02	PPRTV		1	E		
Methyl isobutyl ketone					8.00E-02	HEAST	3.00E+00	IRIS		1	E		
Methyl methacrylate					1.40E+00	IRIS	7.00E-01	IRIS		1	E		

Chemical	SF_o (mg/kg-day)$^{-1}$	Ref.	IUR (ug/m^3)$^{-1}$	Ref.	RfD_o (mg/kg-day)	Ref.	RfCi (mg/m^3)	Ref.	Mutagen	GIABS	Ref.	Dermal ABS	Ref.
Methyl styrene (alpha)					7.00E-02	HEAST				1	E		
Methyl styrene (mixture)					6.00E-03	HEAST	4.00E-02	HEAST		1	E		
Methylcyclohexane							3.00E+00	HEAST		1	E		
Methylene bromide (Dibromomethane)					1.00E-02	HEAST	4.00E-03	PPRTV		1	E		
Methylene chloride	2.00E-03	IRIS	1.00E-08	IRIS	6.00E-03	IRIS	6.00E-01	IRIS	M	1	E		
Molybdenum					5.00E-03	IRIS				1	E		
Naphthalene			3.40E-05	CalEPA	2.00E-02	IRIS	3.00E-03	IRIS		1	E	0.13	E
Nickel (soluble salts)			2.60E-04	CalEPA	2.00E-02	IRIS	9.00E-05	ATSDR		0.04	E		
Nitrate					1.60E+00	IRIS				1	E		
Nitrite					1.00E-01	IRIS				1	E		
Nitrobenzene			4.00E-05	IRIS	2.00E-03	IRIS	9.00E-03	IRIS		1	E		
Nitroglycerin	1.70E-02	PPRTV			1.00E-04	PPRTV				1	E	0.1	E
N-Nitrosodiethylamine	1.50E+02	IRIS	4.30E-02	IRIS					M	1	E	0.1	E
N-Nitrosodimethylamine	5.10E+01	IRIS	1.40E-02	IRIS	8.00E-06	PPRTV	4.00E-05	PPRTV	M	1	E	0.1	E
N-Nitrosodi-*n*-butylamine	5.40E+00	IRIS	1.60E-03	IRIS						1	E	0.1	E
N-Nitrosodiphenylamine	4.90E-03	IRIS	2.60E-06	CalEPA						1	E	0.1	E
N-Nitrosopyrrolidine	2.10E+00	IRIS	6.10E-04	IRIS						1	E	0.1	E
m-Nitrotoluene					1.00E-04	PPRTV				1	E	0.1	E
o-Nitrotoluene	2.20E-01	PPRTV			9.00E-04	PPRTV				1	E		
p-Nitrotoluene	1.60E-02	PPRTV			4.00E-03	PPRTV				1	E	0.1	E
Pentachlorobenzene					8.00E-04	IRIS				1	E	0.1	E
Pentachlorophenol	4.00E-01	IRIS	5.10E-06	CalEPA	5.00E-03	IRIS				1	E	0.25	E
Perchlorate					7.00E-04	IRIS				1	E		
Phenanthrene					3.00E-02	IRIS				1	E	0.13	E
Phenol					3.00E-01	IRIS	2.00E-01	CalEPA		1	E	0.1	E
Polychlorinatedbiphenyls													
Aroclor 1016	7.00E-02	IRIS	2.00E-05	IRIS	7.00E-05	IRIS				1	E	0.14	E
Aroclor 1221	2.00E+00	IRIS	5.70E-04	IRIS						1	E	0.14	E
Aroclor 1232	2.00E+00	IRIS	5.70E-04	IRIS						1	E	0.14	E
Aroclor 1242	2.00E+00	IRIS	5.70E-04	IRIS						1	E	0.14	E
Aroclor 1248	2.00E+00	IRIS	5.70E-04	IRIS						1	E	0.14	E
Aroclor 1254	2.00E+00	IRIS	5.70E-04	IRIS	2.00E-05	IRIS				1	E	0.14	E
Aroclor 1260	2.00E+00	IRIS	5.70E-04	IRIS						1	E	0.14	E
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)	1.30E+01	WHO TEF	3.80E-03	WHO TEF	7.00E-06	WHO TEF	4.00E-04	WHO TEF		1	E	0.14	E

Chemical	SF_o (mg/kg-day)$^{-1}$	Ref.	IUR (ug/m^3)$^{-1}$	Ref.	RfD_o (mg/kg-day)	Ref.	RfCi (mg/m^3)	Ref.	Mutagen	GIABS	Ref.	Dermal ABS	Ref.
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)	1.30E+00	WHO TEF	3.80E-04	WHO TEF	7.00E-05	WHO TEF	4.00E-03	WHO TEF		1	E	0.14	E
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)	3.90E+03	WHO TEF	1.14E+00	WHO TEF	2.33E-08	WHO TEF	1.33E-06	WHO TEF		1	E	0.14	E
2',3,4,4',5-Pentachlorobiphenyl (PCB 123)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
2',3',4,4',5-Pentachlorobiphenyl (PCB 118)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
2',3,3',4,4'-Pentachlorobiphenyl (PCB 105)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
2,3,4,4',5-Pentachlorobiphenyl (PCB 114)	3.90E+00	WHO TEF	1.14E-03	WHO TEF	2.33E-05	WHO TEF	1.33E-03	WHO TEF		1	E	0.14	E
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)	1.30E+04	WHO TEF	3.80E+00	WHO TEF	7.00E-09	WHO TEF	4.00E-07	WHO TEF		1	E	0.14	E
3,3',4,4'-Tetrachlorobiphenyl (PCB 77)	1.30E+01	WHO TEF	3.80E-03	WHO TEF	7.00E-06	WHO TEF	4.00E-04	WHO TEF		1	E	0.14	E
3,4,4',5-Tetrachlorobiphenyl (PCB 81)	3.90E+01	WHO TEF	1.14E-02	WHO TEF	2.33E-06	WHO TEF	1.33E-04	WHO TEF		1	E	0.14	E
Propylene oxide	2.40E-01	IRIS	3.70E-06	IRIS			3.00E-02	IRIS		1	E		
Pyrene					3.00E-02	IRIS				1	E	0.13	E
RDX	1.10E-01	IRIS			3.00E-03	IRIS				1	E	0.015	E
Selenium					5.00E-03	IRIS	2.00E-02	CalEPA		1	E		
Silver					5.00E-03	IRIS				0.04	E		
Strontium					6.00E-01	IRIS				1	E		
Styrene					2.00E-01	IRIS	1.00E+00	IRIS		1	E		
Sulfolane					1.00E-03	PPRTV	2.00E-03	PPRTV		1	E	0.1	E
2,3,7,8-TCDD	1.30E+05	CalEPA	3.80E+01	CalEPA	7.00E-10	IRIS	4.00E-08	CalEPA		1	E	0.03	E
2,3,7,8-TCDF	1.30E+04	WHO TEF	3.80E+00	WHO TEF						1	E	0.03	E
1,2,4,5-Tetrachlorobenzene					3.00E-04	IRIS				1	E	0.1	E
1,1,1,2-Tetrachloroethane	2.60E-02	IRIS	7.40E-06	IRIS	3.00E-02	IRIS				1	E		
1,1,2,2-Tetrachloroethane	2.00E-01	IRIS	5.80E-05	CalEPA	2.00E-02	IRIS				1	E		
Tetrachloroethene	2.10E-03	IRIS	2.60E-07	IRIS	6.00E-03	IRIS	4.00E-02	IRIS		1	E		
Tetryl (Trinitrophenylmethylnitramine)					2.00E-03	PPRTV				1	E	0.00065	E
Thallium					1.00E-05	PPRTV				1	E		
Toluene					8.00E-02	IRIS	5.00E+00	IRIS		1	E		
Toxaphene	1.10E+00	IRIS	3.20E-04	IRIS						1	E	0.1	E
Tribromomethane (Bromoform)	7.90E-03	IRIS	1.10E-06	IRIS	2.00E-02	IRIS				1	E	0.1	E
1,1,2-Trichloro-1,2,2-trifluoroethane					3.00E+01	IRIS	3.00E+01	HEAST		1	E		
1,2,4-Trichlorobenzene	2.90E-02	PPRTV			1.00E-02	IRIS	2.00E-03	PPRTV		1	E		

Chemical	SF_o (mg/kg-day)$^{-1}$	Ref.	IUR (ug/m^3)$^{-1}$	Ref.	RfD_o (mg/kg-day)	Ref.	RfCi (mg/m^3)	Ref.	Mutagen	GIABS	Ref.	Dermal ABS	Ref.
1,1,1-Trichloroethane					2.00E+00	IRIS	5.00E+00	IRIS		1	E		
1,1,2-Trichloroethane	5.70E-02	IRIS	1.60E-05	IRIS	4.00E-03	IRIS	2.00E-04	PPRTV		1	E		
Trichloroethylene	4.6E-02	IRIS	4.10E-06	IRIS	5.00E-04	IRIS	2.00E-03	IRIS	M	1	E		
Trichlorofluoromethane					3.00E-01	IRIS	7.00E-01	HEAST		1	E		
2,4,5-Trichlorophenol					1.00E-01	IRIS				1	E	0.1	E
2,4,6-Trichlorophenol	1.10E-02	IRIS	3.10E-06	IRIS	1.00E-03	PPRTV				1	E	0.1	E
1,1,2-Trichloropropane					5.00E-03	IRIS				1	E		
1,2,3-Trichloropropane	3.00E+01	IRIS			4.00E-03	IRIS	3.00E-04	IRIS	M	1	E		
Triethylamine							7.00E-03	IRIS		1	E		
2,4,6-Trinitrotoluene	3.00E-02	IRIS			5.00E-04	IRIS				1	E	0.032	E
Uranium (soluable salts)					3.00E-03	IRIS	4.00E-05	ATSDR		1	E		
Vanadium					5.04E-03	IRIS	1.00E-04	ATSDR		0.026	E		
Vinyl acetate					1.00E+00	HEAST	2.00E-01	IRIS		1	E		
Vinyl bromide			3.20E-05	HEAST			3.00E-03	IRIS		1	E		
Vinyl chloride	7.20E-01	IRIS	4.40E-06	IRIS	3.00E-03	IRIS	1.00E-01	IRIS	M	1	E		
m-Xylene					2.00E-01	IRIS	1.00E-01	IRIS		1	E		
o-Xylene					2.00E-01	IRIS	1.00E-01	IRIS		1	E		
Xylenes					2.00E-01	IRIS	1.00E-01	IRIS		1	E		
Zinc					3.00E-01	IRIS				1	E		

Notes:
CSF_o – Oral Cancer Slope Factor
IUR– Inhalation Unit Risk
RfD_o – Oral Reference Dose
RfC – Inhalation Reference Concentration
Dermal ABS – Dermal absorption coefficient
GIABS – Gastrointestinal absorption coefficient adjusted – Toxicity data for total chromium has been adjusted based on a ratio of 6:1 (CrIII:CrVI)
E = US EPA. 2004. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Interim Guidance. Office of Solid Waste and Emergency Response, Washington, D.C. http://www.epa.gov/oswer/riskassessment/ragse/index.htm
EPA TEF – US EPA (1993) toxicity equivalency factors applied to polycyclic aromatic hydrocarbons
ATSDR – Agency for Toxic Substances and Disease Registry
Cal EPA – California Environmental Protection Agency
HEAST – Health Effects Assessment Summary Tables
IRIS – Integrated Risk Information System
PPTRV – Provisional Peer Reviewed Toxicity Value
NJ – New Jersey Department of Environmental Protection (2009)

WHO TEF – World Health Organization Toxicity Equivalency Factor

-Toxicity data for total chromium has been adjusted based on a ratio of 6:1 (CrIII:CrVI)

-For GI absorption, a value of 1 was used for all organics as directed in RAGS Part E. A default value of 1 was used for inorganics not listed in RAGS Part E.
-Pyrene toxicity data used as surrogate data for phenanthrene.
-Aroclor 1016 is considered the lowest risk, so it was assigned a "lowest risk" value from IRIS. All other Aroclors were assigned a "highest risk" value from IRIS.
-Toxicity data for total xylenes used as a surrogate for all other isomers of xylene (o-, m-, and p-xylene)
-The RfDo value for vanadium is based on RfD for vanadium pentoxide, and adjusted for molecular weight.
-The RfDo value for cadmium is based on the RfDo for food. An RfDo of 0.0005 mg/kg-d was used for the tap water pathways as directed in IRIS (US EPA, 2014).

APPENDIX D

Guidance for Risk-based Remediation of Polychlorinated Biphenyls (PCBs) at RCRA Corrective Action Sites

Guidance for Risk-based Remediation of Polychlorinated Biphenyls (PCBs) at RCRA Corrective Action Sites[3]

July 2014

[3]This document is intended as guidance for employees of the New Mexico Environment Department's (NMED) Hazardous Waste Bureau (HWB) and Resource Conservation and Recovery Act (RCRA)-regulated facilities within the State of New Mexico. This guidance does not constitute rule-making and may not be relied upon to create a right or benefit, substantive or procedural, enforceable at law or in equity, by any person. HWB may take action at variance to this guidance and reserves the right to modify this guidance at any time without public notice.

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ACRONYMNS AND ABBREVIATIONS

µg/g	microgram per gram
µg/L	microgram per liter
AOC	Area of Concern
AT	Averaging Time
BMP	Best Management Practices
BW	Body Weight
CSF	Cancer Slope Factor
CWA	Clean Water Act
DD	Daily Dose
ECD	Electron Capture Detector
ED	Exposure Duration
EF	Exposure Frequency
ELCD	Electrolytic Conductivity Detector
GC/MS	Gas Chromatography/Mass Spectral Detector
HR	High Resolution
HRGC	High Resolution Gas Chromatography
HRMS	High Resolution Mass Spectral Detector
HWB	Hazardous Waste Bureau
IR	Ingestion Rate
IRIS	Integrated Risk Information System
LADD	Lifetime Average Daily Dose
mg/m^3	milligram per cubic meter
mg/kg	milligram per kilogram
mg/L	milligram per liter
ng/L	nanogram per liter
NMED	New Mexico Environment Department
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzo-dioxins
PCDF	Polychlorinated Dibenzo-furans
pg/L	picogram per liter
ppb	parts per billion
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
SWMU	Solid Waste Management Unit
TCDD	2,3,7,8-tetrachloro-dibenzo-dioxin
TCDF	2,3,7,8-tetrachloro-dibenzo-furan
TEF	Toxicity Equivalency Factor
TEQ	Toxicity Equivalency Quotient

TRV Toxicity Reference Value
TSS Total Suspended Solids
US EPA United States Environmental Protection Agency

Guidance for Risk-based Remediation of Polychlorinated Biphenyls at RCRA Corrective Action Sites

1.0 SCOPE

This document focuses on remedial activities at sites where polychlorinated biphenyls (**PCBs**) have been identified or are suspected of being present as one of the contaminants of potential concern. The intent of this document is to expedite the remedial action process and provide a cost-effective and consistent method for the evaluation and reduction of the risk posed to human health and the environment by PCBs.

This document **does not** discuss the complex regulations governing PCBs or the sampling methodologies for PCBs or other associated contaminants. This document **does** assume that the nature and extent of PCB contamination have been defined using a site conceptual model and **does** discuss and recommend analytical methods applicable to evaluating the risk to human and ecological health for PCBs in environmental media.

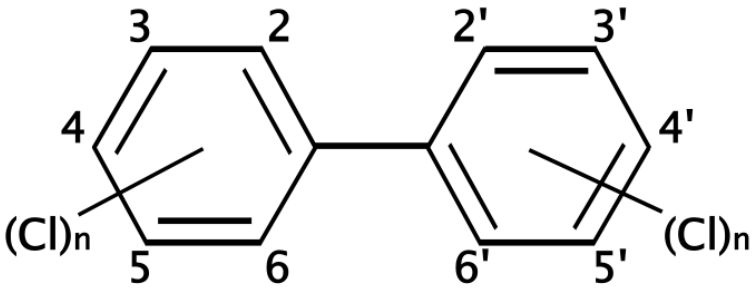
This paper **does not** discuss the risk posed to ground water quality by PCB contamination; state ground water standards and federal drinking water standards[4] exist for the protection of ground water. No state or federal soil/sediment standards exist to protect ground water from the transport of PCBs from contaminated soil/sediments; however, the risk associated with the transport of PCBs from contaminated soil/sediments to ground water should be evaluated to ensure that state and federal standards for ground water are not exceeded. Methods for the evaluation of this threat to ground water are **not**, at this time, specifically addressed in this document.

2.0 BACKGROUND INFORMATION

PCBs are a class of chlorinated organic compounds which found widespread application since their introduction into commerce in 1923. Their properties include thermal stability; resistance to acids, bases and oxidation; and resistance to direct electrical current. They were commonly used in transformers and capacitors, hydraulic and heat transfer equipment, compressors and vacuum pumps, plasticizers (surface coatings and sealants), and some paints and inks. Domestic production of commercial PCBs ceased in 1977; however, PCBs in existence at that time are still in use today.

The general chemical structure of chlorinated biphenyls is as follows:

[4]PCBs in ground water may not exceed the Safe Drinking Water Act's maximum contaminant level of 0.5 micrograms per liter (µg/L) in drinking water (Title 40 Code of Federal Regulations Parts 141-147 and 149) or the State of New Mexico's Water Quality Control Commission Regulations' standard of 1 µg/L in ground water with 10,000 milligrams per liter (mg/L) or less total dissolved solids (Title 20 New Mexico Annotated Code Chapter 6.2).



The number and position of chlorines in the biphenyl molecule determine the physical and chemical properties of the PCB molecule. There are a total of 209 possible *congeners*[5] of PCBs, each one resulting from the chlorination of different substitution positions and varying degrees of chlorination. In general, PCB molecules with higher degrees of chlorination are more resistant to biodegradation and are more persistent in the environment.

PCB congeners may be found in commercial preparations or complex mixtures known by the names Askarel, Aroclor, Clophen, Phenoclor, Kanechlor, and Pyralène. In the United States, PCB mixtures were marketed under the trade name of Aroclor. Each Aroclor has a four-digit numeric designation: the first two digits are "12" (indicating the biphenyl parent molecule) followed by two more digits indicating the percent chlorine content by weight in the mixture. For example, Aroclor 1254 has 54% chlorine by weight. Aroclor 1016 is the exception: it contains 41% chlorine by weight (ATSDR, 1995).

PCBs are a group of environmentally persistent organic chemicals that possess the inherent properties of compounds that bioaccumulate (i.e., high octanol/water partition coefficient and low water solubility). PCBs also have the following properties of environmental relevance: low vapor pressure and low flammability.

PCBs are toxic to humans and other animals (Eisler, 1986; ATSDR, 1995; and US EPA, 1996 and 1997a). PCBs adversely impact reproduction in wildlife and in experimental animals. Other common toxic effects in mammals and birds include thymic atrophy (a wasting syndrome), microsomal enzyme induction, porphyria (manifestations include intermittent nervous system dysfunction and/or sensitivity of skin to sunlight) and related liver damage, chloracne, estrogenic activity, immunosuppression, and tumor promotion. PCBs can be transferred to young mammals (including humans) transplacentally and in breast milk.

The United States Environmental Protection Agency (**US EPA**) and International Agency for Research on Cancer classified PCBs as Group B2; probable human carcinogens, based on sufficient evidence of carcinogenicity (manifested as hepatocellular carcinomas) in experimental animals and inadequate (due to confounding exposures to other potential carcinogens or lack of exposure quantification), yet suggestive evidence of excess risk of liver cancer in humans (US EPA, 2010 and US EPA, 2014). Recent studies have indicated that all PCB mixtures can cause

[5]*Congener* means any single, unique, well-defined chemical compound in the PCB category.

cancer; however, different mixtures exhibit different carcinogenic potencies (Cogliano, 1998). In addition, environmental processes may alter the PCB mixtures affecting its carcinogenic potency (see *Environmental Processes*).

The stability and lipophilicity of PCBs promote their biomagnification (i.e., the uptake of a chemical through ingestion resulting in the concentration of the chemical in tissue being greater than that of its food) once they enter the aquatic and terrestrial food chains. Through the food chain, living organisms selectively bioaccumulate persistent congeners of PCBs. Environmentally-aged PCB mixtures appear to be more toxic and persistent in the organism than commercial PCB mixtures. Biomagnification through trophic transfer governs PCB levels in animals, especially those occupying the top of the food web. Therefore, PCBs in food sources represent the most important exposure source to humans and wildlife.

In certain situations, PCBs can become contaminated with the far more toxic polychlorinated dibenzofurans (**PCDFs**) and chlorinated dibenzo-dioxins (**PCDDs**). Therefore, the presence of PCDFs and PCDDs should always be investigated if any of the following processes existed or are suspected of existing:

- Combustion or incineration of PCB-contaminated waste or waste oils, or highly variable waste streams (such as municipal and commercial waste for which PCB contamination is suspected);
- Manufacture of PCBs[6];
- Pyrolysis of PCBs;
- Photolysis of PCBs;
- Incidental fire of transformers and capacitors containing PCBs; or
- Treatment with chlorinating compounds (e.g., hydrochloric acid, chlorine, etc.).

3.0 ENVIRONMENTAL PROCESSES

PCBs occur as mixtures of congeners in the environment. *Partitioning*[7], chemical and biological transformation, and preferential bioaccumulation may change the composition of the PCB mixture over time: the environmentally-aged PCB mixture may vary considerably from the original congener composition (US EPA, 1996b and ATSDR, 1995). Altered PCB mixtures have been known to persist in the environment for many years.

PCBs adsorb to organic matter, sediments, and soil. Their affinity to adsorb increases with the chlorine content of the PCBs and the amount of organic matter present. PCBs can volatilize or disperse as aerosols providing an effective means of transport in the environment. Congeners with low chlorine content tend to be more volatile and more water soluble.

[6]The concentration of PCDFs in commercial PCB samples ranged from 0.2 mircrograms per gram (µg/g) to 13.6 µg/g (ATSDR, 1993). Eisler (1986) reported PCDFs impurities ranging from 0.8 to 33 milligrams per kilogram (mg/kg) in some domestic and foreign PCB mixtures.

[7]*Partitioning* includes environmental processes by which different fractions of a mixture separate into air, water, sediment, and soil.

The highly chlorinated Aroclors (Aroclor 1248, 1254, and 1260) resist both chemical and biological transformation (i.e., degradation) in the environment. Biological degradation of highly chlorinated Aroclors to lower chlorinated PCBs can occur under anaerobic conditions[8]. The extent of this dechlorination[9] is limited by the PCB chlorine content and soil/sediment PCB concentrations. Anaerobic bacteria in soil/sediments remove chlorines from low chlorinated PCBs (1 to 4 chlorines) and open the carbon rings through oxidation. PCBs with higher chlorine content are extremely resistant to oxidation and hydrolysis. Photolysis can also slowly break down highly chlorinated PCB congeners.

PCBs bioaccumulate and biomagnify through the food chain because they are highly lipid-soluble. The mixture of congeners found in biotic tissue will differ dramatically from the mixture of congeners originally released to the environment because bioaccumulation and biomagnification concentrate PCB congeners of higher chlorine content up through the food chain. This is because different congeners can exhibit different rates of metabolism and elimination in living organisms (Van den Berg, et al., 1998 and Cogliano, 1998).

By altering the congener composition of PCB mixtures, these environmental processes can substantially increase or decrease the toxicity of environmental PCBs mixture (Cogliano, 1998). Therefore, information on these environmental processes along with the results of congener-specific analyses of environmental and biota samples should be used to substantiate modeling of exposure to and health risks resulting from environmental PCBs.

4.0 PCB CLEANUP LEVELS

PCB-contaminated soil/sediments should be remediated to either 1) a default concentration of 1 mg/kg or part per million (**ppm**) *total PCBs* (defined as the sum of congeners, Aroclors or *homologues*[10]), 2) a risk-based generic screening level (see media-specific screening levels in Appendix A of Volume 1) or 3) a *site-specific risk-based PCB concentration level*[11] established through performing a health risk evaluation. Site-specific risk-based PCB concentrations may be calculated from equations presented in *Risk Evaluation*. Once the calculations have been completed for all receptors, the lowest computed risk-based PCB concentration in a medium would represent the PCB remediation goal for that medium. These PCB remediation goals may be refined, if necessary, in the higher-level, site-specific risk assessment.

[8]However, certain fungi have been demonstrated to degrade PCBs under aerobic conditions.

[9]Note that dechlorination is not synonymous with detoxification because it may result in the formation of carcinogenic congeners.

[10]A *homologue* is a subcategory of PCBs having an equal number of chlorine substituents. *Substituent* means an atom or group that replaces another atom or group in a molecule. PCB homologues can be quantified using EPA Method 680 or estimated using regression equations such as those found in NOAA, 1993.

[11]A *risk-based PCB concentration level* means the PCB concentration above which some adverse health effects may be produced in human and/or ecological receptors, and below which adverse health effects are unlikely to occur.

Table D-1 presents the corrective action cleanup options for the remediation of PCB-contaminated soil/sediments and data quality recommendations regarding the PCB analyses of environmental media samples.

Table D-1. PCB Cleanup Options In Soil/Sediment and Data Quality Recommendations[12]

Cleanup Option	Corrective Action Steps		Data Quality Recommendations
Default Option 1	1	Delineate the nature and horizontal and vertical extent of contamination	Estimate total PCBs as the sum of Aroclors or homologues (using a quantitation limit of 50 parts per billion [ppb] or 1 ppb, respectively) in environmental media
	2	Remediate to 1 ppm	
	3	Conduct post-remediation monitoring, as necessary	
Default Option 2	1	Delineate the nature and horizontal and vertical extent of contamination	Estimate total PCBs as the sum of Aroclors or homologues (using a quantitation limit of 50 parts per billion [ppb] or 1 ppb, respectively) in environmental media
	2	Remediate to generic risk-based screening level (See Appendix A of Volume 1))	
	3	Conduct post-remediation monitoring, as necessary	
Site-Specific, Risk-Based	1	Delineate the nature and horizontal and vertical extent of contamination	Estimate total PCBs as the sum of Aroclors or homologues (using a quantitation limit of 50 ppb or 1 ppb, respectively) and/or congener-specific environmental and biota concentrations (using a quantitation limit in the low parts per trillion)
	2	Perform health risk evaluation	
	3	Establish risk-based concentrations for all human and environmental receptors	
	4	Remediate to the lowest risk-based concentration	
	5	Conduct post-remediation monitoring, as necessary	

The following is a listing of potential PCB target analytes[13]. The 12 PCB congeners indicated in boldface italics are those which are recommended for quantitation as potential target analytes when performing a risk-based cleanup. The 16 additional congeners listed in plain text may provide valuable information, but are not required for the evaluation of risk. The analyses of all 209 congeners would greatly improve the estimate of total PCB concentrations.

[12]Modified from Valoppi, et al., 1999.

[13]The number in parentheses refers to the identification system used to specify a particular congener.

Table D-2. Potential PCB Target Analytes

2,4′-Dichlorobiphenyl (8)	2,2′,3,4,4′,5′-Hexachlorobiphenyl (138)
2,2′,5-Trichlorobiphenyl (18)	2,2′,4,4′,5,5′-Hexachlorobiphenyl (153)
2,4,4′-Trichlorobiphenyl (28)	***2,3,3′,4,4′,5-Hexachlorobiphenyl (156)***
2,2′,3,5′-Tetrachlorobiphenyl (44)	***2,3,3′,4,4′,5′-Hexachlorobiphenyl (157)***
2,2′,5,5′-Tetrachlorobiphenyl (52)	***2,3′,4,4′,5,5′-Hexachlorobiphenyl (167)***
2,3′,4,4′-Tetrachlorobiphenyl (66)	***3,3′,4,4′,5,5′-Hexachlorobiphenyl (169)***
3,3′,4,4′-Tetrachlorobiphenyl (77)	2,2′,3,3′,4,4′,5-Heptachlorobiphenyl (170)
3,4,4′,5-Tetrachlorobiphenyl (81)	2,2′,3,4,4′,5,5′-Heptachlorobiphenyl (180)
2,2′4,5,5′-Pentachlorobiphenyl (101)	2,2′,3,4′,5,5′,6-Heptachlorobiphenyl (187)
2,3,3′,4,4′-Pentachlorobiphenyl (105)	***2,3,3′,4,4′,5,5′-Heptachlorobiphenyl (189)***
2,3,4,4′,5-Pentachlorobiphenyl (114)	2,2′,3,3′,4,4′,5,6-Octachlorobiphenyl (195)
2,3′,4,4′,5-Pentachlorobiphenyl (118)	2,2′,3,3′,4,4′,5,5′,6-Nonachlorobiphenyl (206)
2′,3,4,4′,5′-Pentachlorobiphenyl (123)	2,2′,3,3′,4,4′,5,5′,6,6′-Decachlorobiphenyl (209)
3,3′,4,4′,5-Pentachlorobiphenyl(126) 2,2′,3,3′,4,4′-Hexachlorobiphenyl (128)	

The 16 PCB congeners in plain text have been indicated as target analytes by the National Oceanic and Atmospheric Administration based on their toxicity, ubiquitousness in the marine environment, presence in commercial Aroclor mixtures, etc. (NOAA, 1993).

5.0 ANALYTICAL METHODS

Aroclors are often used to characterize PCB exposures; however, the use of Aroclors in estimating the human health or ecological risk can be both imprecise and inappropriate because the PCB mixtures to which humans and other biota may be exposed may be considerably different from the original Aroclor mixtures released to the environment. In addition, traditional analytical methods for Aroclor analyses produce estimates that are prone to errors. Both qualitative and quantitative errors may arise from interpreting gas chromatography (**GC**) data.

GCs configured with electron capture detectors (**ECD**) or electrolytic conductivity detectors (**ELCD**) are particularly prone to error. The GC/ECD and GC/ELCD produce a chromatogram that is compared with the characteristic chromatographic patterns of the different Aroclors (US EPA, 1996a). For environmentally weathered and altered mixtures, an absence of these characteristic patterns can suggest the absence of Aroclors even if some congeners are present in high concentrations. Additionally, and commonly, the presence of interferents may also mask the characteristic response pattern of the Aroclors. The "pattern recognition" technique is inherently subjective, and different analysts may reach different conclusions regarding the presence or absence of Aroclors.

GCs configured with mass spectral detectors (**GC/MS**) allow identification of individual chemical compounds. GC/MS also produces a chromatogram, and additionally includes mass spectral information about the chemical identity of each peak in the chromatogram. Therefore, GC/MS adds a qualitative line of evidence above that included in GC/ECD or GC/ELCD techniques. GC/MS may be subject to interference, misinterpretation, or other problems.

High resolution (**HR**) isotope dilution GC/high resolution MS (**HRGC/HRMS**), while not as common technique as GC-ECD or GC-MS, is a specific GC/MS technique that has proven reliable for PCB analysis. In HRGC/HRMS exhaustive sample clean-up techniques are employed, and isotopic tracers are used to support identification.

Therefore, the HWB recommends the use of HRGC/HRMS analyses in evaluating health risks to humans and the environment. If HRGC/HRMS methods are not employed, then site specific data must be used to demonstrate that the methods employed are appropriate to the site, or HRGC/HRMS confirmation must be integrated into the analytical plan, for instance on a one in 20 sample basis, or a for a minimum number of samples, or as otherwise agreed. Both detections and non-detections should be confirmed.

Results of GC techniques may be expressed as Aroclors, congeners, homologues, or as total PCBs in units of weight/weight [mg/kg, µg/kg, nanogram per kilogram (ng/kg)] or weight/volume [µg/L or pictogram per liter (pg/L)]. It is necessary to specify the reporting requirements prior to analysis and negotiate the analytical list and reporting limits. Results must be reported on a dry weight basis for soil, sediment and waste samples (excluding liquids).

In addition to the traditional GC analysis, a number of biological and immunological assays are now available, as well as field GC. These may be suited for use as screening methods to guide day-to-day remediation efforts, but are not suited to evaluating health risks to humans and the environment as stand-alone methodologies.

Table D-3. Analytical Methods for PCBs

Method	Technology	Report As[1]	Approximate Detection Limits	Comments
SW-846 8082A	GC/ECD or GC/ELCD	Aroclors Congeners	50-100 µg/kg	Must supply site-specific performance data or use HRGC/HRMS confirmation
SW-8270D	GC/MS	Aroclors	>1000 µg/kg[2]	Detection limits may not support project data quality objectives
SW-846 8275A	GC/MS	Congeners	200 µg/kg	
Method 1668B	HRGC/HRMS	Congeners	<1µg/kg, often in the ng/kg range[2]	Use this method for confirmation

NOTES:
[1]Reporting types have been limited to those mentioned in the subject methods. Laboratories may offer additional reporting modalities, such as homologues and total PCBs.
[2]Detection Limits not specified in the method. Various sample preparation options and matrix effects may affect results

6.0 STORM WATER RUNOFF MONITORING RECOMMENDATIONS

The potential for transport to human or ecological receptors (including ground and surface water) should be evaluated for all corrective action sites impacted or suspected of being impacted by PCBs. PCB concentrations in storm water runoff resulting from contaminated soil/sediments should be monitored **and** the soils remediated to ensure that there is no release or runoff from the Solid Waste Management Unit (**SWMU**) or Area of Concern (**AOC**) which results in a total PCB concentration in excess of the Clean Water Act (**CWA**)-recommended freshwater aquatic life chronic criterion of 0.014 µg/L[14] (unfiltered water) to a *water of the State*.[15] Likewise, concentrations of PCB-contaminated stream bottom, lake or reservoir deposits should not result in total PCB concentrations in unfiltered water which exceeds the CWA-recommended freshwater aquatic life chronic criterion of 0.014 µg/L.

The evaluation of a site's PCB concentrations and erosion potential will aid in determining and prioritizing the corrective actions and best management practices (**BMPs**) necessary to protect surface water quality. Each facility should develop a method for evaluating the erosion potential[16] and present the methodology to the NMED HWB for approval prior to implementation. This evaluation should be conducted on all known or suspected PCB sites. All PCB sites with elevated erosion potentials should implement BMPs to reduce transport of PCB-contaminated sediments and soils. BMP effectiveness should be evaluated and monitored regularly through a formalized inspection and maintenance program. BMPs should be implemented as interim actions or stabilization measures which are consistent with a final remedy and should not be misconstrued as a final remedy.

NMED's HWB believes that controlling the total suspended solids (**TSS**) load of storm water runoff may effectively control PCB migration in surface water because PCBs are hydrophobic, tend to adsorb to soil and organic particles, and are transported in suspended sediments during storm runoff events. Therefore, the TSS should be monitored to aid in predicting and, therefore, potentially controlling the transport of PCBs into *watercourses*[17].

Storm water samples should be collected from storm water events which are greater than 0.1 inches in magnitude (US EPA, 1992). Grab samples should be collected within the first 30 minutes or as soon as practical, but not more than 1 hour after runoff discharge begins. A sufficient quantity of runoff should be collected (i.e., 5 liters) because additional analyses for PCBs may be required based upon the TSS analytical results. The runoff samples should be analyzed for TSS using Method 2540D of the most recent edition of the *Standard Methods for the Examination of Water and* Wastewater.

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[14]This concentration is the Clean Water Act §304(a) recommended chronic criterion for aquatic life (http://water.epa.gov/scitech/swguidance/standards/current/index.cfm).

[15]*Water(s) of the State* means all interstate and intrastate water including, natural ponds and lakes, playa lakes, reservoirs, perennial streams and their tributaries, intermittent streams, sloughs, prairie potholes and wetlands (Title 20 New Mexico Annotated Code Chapter 6.1).

[16]NMED HWB recommends the approach to evaluating erosion potential presented in the *Matrix Approach to Contaminant Transport Potential* (Mays and Veenis, 1998).

[17]*Watercourse* means any river, creek, arroyo, canyon, draw, or wash, or any other channel having definite banks and beds with visible evidence of the occasional flow of water (Title 20 New Mexico Annotated Code Chapter 6.1).

Grab samples should be used for monitoring. Composite samples may **not** be used for monitoring; however, flow-weighted composite samples may be used in the development and validation of storm water contaminant transport modeling.

The following bullets describe recommended trigger levels and actions based on the analytical results of TSS analyses:

- If TSS is less than 100 mg/L, no action is required.
- If TSS is greater than 100 mg/L, but less than 1,000 mg/L, then the effectiveness of existing BMPs should be evaluated and repaired as necessary, and additional BMPs may need to be implemented to reduce TSS loading
- If the TSS is greater than 1,000 mg/L, then the remaining portion of the sample should be centrifuged and the solids analyzed for PCBs using EPA SW-846 Method 8082 (US EPA, 1997d), EPA Method 680, or draft EPA Method 1668 (Alford-Stevens, et al., 1985 and US EPA, 1996a).

7.0 RISK EVALUATION

The risk to human health and the environment must be evaluated for all corrective action *solid waste management units/areas of concern*[18] (**SWMU/AOCs**) impacted or suspected of being impacted by PCBs and having a potential for transport to a human or ecological receptor. The risk posed by PCBs at these SWMU/AOCs may be modeled (based on adequate available data) and should be monitored to ensure an acceptable level of risk[19] (see *Storm Water Runoff Monitoring Recommendations).*

As discussed in *Environmental Processes*, the congener composition of environmentally-aged PCBs can dramatically differ from the original Aroclor mixture released to the environment. Consequently, environmental processes can affect both exposure to, and toxicity of, environmental PCBs. Therefore, the approach to evaluating health risks from environmental PCBs differs depending upon whether the PCB congener- or Aroclor-specific (or homologue-specific) data are available for the environmental media (see also *PCB Cleanup Levels*).

PCB congeners with chlorine atoms in positions 2 and 6 (ortho) are generally more readily metabolized, while those with chlorines in positions 4 and 4' (para) or positions 3, 4 or 3, 4, 5 on one or both rings tend to be more toxic and are retained mainly in fatty tissues (Eisler, 1986). Persistent congeners may retain biological activity long after the exposure. The most toxic PCB congeners can assume a conformation, generally similar to that of 2, 3, 7, 8-tetrachloro-dibenzo-dioxin (**TCDD**), and are approximate stereo analogs of this compound (Hoffman, et al., 1996).

[18]*SWMU* means "any discernable unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released." *AOC* "...refers to releases which warrant investigation or remediation under the authorities discussed above, regardless of whether they are associated with a specific SWMU..."

[19]A risk or hazard is considered *acceptable* if an estimated risk/hazard is below pre-established target risk and/or hazard levels.

These dioxin-like congeners share a common mechanism of toxicity involving binding to the aryl hydrocarbon receptor; the same mechanism of action is believed to induce the toxicity of PCDDs and PCDFs. These congeners were assigned toxicity equivalency factors (**TEFs**) expressed as a fraction of the toxicity of 2,3,7,8-TCDD. Therefore, when PCB congener-specific analytical data are available, risk evaluation of human and ecological health should consider both dioxin-like and other adverse health effects. Two sections within this document (*Human Health, Carcinogenic Effects, Dioxin-like Toxicity Approach* and *Ecological Health, Dioxin-like PCBs*) provide guidance for applying these TEFs where congener-specific analyses are available. If only Aroclor/homologue concentrations are available for a site, total PCB concentrations reported as the sum of Aroclor/homologue concentrations should be used to estimate the risk to human health and the environment.

If a health risk evaluation is based on total PCB concentrations (estimated as the sum of Aroclors or PCB homologues) and the individual congeners comprising the PCB mixtures cannot be identified, the uncertainty and potential bias in the resulting risk estimates should be described in the risk assessment report. For example, if total PCB concentrations have been estimated based on Aroclor analyses, conservative assumptions should be made about the mixture composition and toxicity: the assumption that congeners with greater than four chlorines per PCB molecule comprise greater than 0.5% of total PCBs present in a given abiotic medium at the site triggers the selection of the highest cancer slope factor from Table D-3. Whereas, total PCB concentrations estimated based on the results of PCB homologue analyses may allow for a refinement of these conservative assumptions. More detailed information on an approach to evaluating the health risk from environmental PCBs and PCB data requirements can be found in US EPA (1996b); Van den Berg, et al. (1998); Cogliano (1998); Giesy and Kannan (1998) and Valoppi, et al. (1999).

7.1 Human Health

Since PCBs may cause both carcinogenic and non-carcinogenic adverse human health effects, separate risk assessments must be performed for each of these health effects.

7.1.1 Carcinogenic Effects

The evaluation of carcinogenic risk from exposure to PCB mixtures (i.e., represented by total PCBs or PCB congeners) should follow the slope factor approach described in *PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures* (US EPA, 1996b) and as outlined below. This approach distinguishes among toxic potencies of different PCB mixtures by utilizing information regarding environmental processes. In the absence of PCB congener- or homologue-specific analyses (i.e., if total PCB concentrations were estimated based on Aroclor analyses), this approach requires conservative assumptions about the risk and persistence of PCB mixtures at the site.

If congener-specific concentrations are available and congener analyses indicate that congeners with more than 4 (four) chlorines comprise greater that 0.5 percent of total PCBs in a given

medium, the slope factor approach should be supplemented by the analysis of dioxin toxicity equivalency quotient (**TEQ**). Risk from *dioxin-like congeners*[20] should be added to the risk estimated for the rest of the PCB mixture which does not exhibit dioxin-like toxicity.

If other dioxin-like compounds (i.e., PCDDs and/or PCDFs) are present at a site in addition to PCBs, TEQs for dioxin-like PCBs should be added to TEQs calculated for those other dioxin-like compounds to yield a total TEQ. A slope factor for 2,3,7,8-TCDD should be applied to this total TEQ. Under these circumstances, the concentrations of dioxin-like PCBs should be subtracted from the total PCB concentration to avoid overestimating risks from dioxin-like PCBs by evaluating them twice.

7.1.1.1 Slope Factor Approach

Site-specific carcinogenic risk evaluations should be performed using PCB cancer potency or slope factors specific to the exposure scenarios and pathways at a particular site. Table D-4 provides the criteria for using these slope factors (categorized into high, medium, and low levels of risk and PCB persistence) that address a variety of exposure scenarios and the toxicity of PCB mixtures in the environment. A review of recent research on PCB toxicity that formed the basis for the derivation of these slope factors and a discussion of uncertainties surrounding toxicity information can be found in US EPA (1996b) and Cogliano (1998).

The slope factors in Table D-4 represent the upper-bound slopes that are recommended for evaluating human health risk from carcinogenic effects of PCBs. Both the upper-bound and central-estimate slopes are available from the US EPA's Integrated Risk Information System (**IRIS**). The central-estimate slopes can be used to support the analysis of uncertainties inherent in available toxicity information on PCBs.

[20] *Dioxin-like congeners* of PCBs are those with dioxin-like health effects and are evaluated using dioxin TEQs (Van den Berg, et al., 1998). A complete listing of PCB congeners can be found at http:\\www.epa.gov/grtlakes/toxteam/pcbid/table.htm (US EPA's Great Lakes website).

Table D-4. PCB Cancer Slope Factor Values by Level of Risk and Persistence[21]

CRITERIA FOR USE	LEVEL OF RISK AND PERSISTENCE	PCB CANCER SLOPE FACTOR VALUES[22] [risk per mg/kg-day]
Food chain exposure	High	2.0
Sediment/soil ingestion		
Dust/aerosol inhalation		
Dermal exposure (if an absorption factor has been applied)		
Presence of dioxin-like, tumor-promoting, or persistent congeners		
Early-life (less than 6 years old) exposure by all pathways and to all mixtures		
Congeners with greater than four chlorines per PCB molecule comprise greater than 0.5% of the total PCBs present		
Congeners with greater than four chlorines per PCB molecule comprise less than 0.5% of the total PCBs present (all pathways except soil ingestion by adults)		
Ingestion of water-soluble (less chlorinated) congeners	Medium	0.4
Inhalation of evaporated (less chlorinated) congeners		
Dermal exposure (if no absorption factor has been applied)		
Congeners with greater than four chlorines per PCB molecule comprise less than 0.5% of the total PCBs present (soil ingestion by adults only)	Low	0.07

The cancer slope factors in Table D-4 characterize the toxic potency of different environmental mixtures of PCBs. Information on potential exposure pathways and PCB mixture composition at a given site guides in the selection of the appropriate cancer slope factors for risk assessment.

The highest slope factor in Table D-4 (2.0 per mg/kg-day) corresponds to the high risk and persistence of environmental PCB mixtures and, as such, should be selected for pathways (including food chain exposures, ingestion of soil and sediment, inhalation of dust or aerosol,

[21]Modified from Cogliano, 1998 and US EPA, 1996b and 1998c.

[22]See IRIS (US EPA, 2014).

exposure to dioxin-like, tumor-promoting or persistent congeners, and early-life exposure) where environmental processes act to increase risk.

A lower slope factor (0.4 per mg/kg-day) corresponds to the low risk and persistence of environmental PCB mixtures and is appropriate for exposure pathways (such as ingestion of water-soluble congeners and inhalation of evaporated congeners) where environmental processes act to decrease risk.

Finally, the lowest slope factor in Table D-4 (0.07 per mg/kg-day) corresponds to the lowest risk and persistence of environmental PCB mixtures and should be selected for soil ingestion by adults when congener or homologue analyses confirm that congeners with greater than four chlorine atoms per PCB molecule comprise less than 0.5% of the total PCBs present at the site.

Once the appropriate slope factor has been selected, it is multiplied by a lifetime average daily dose (**LADD**) to estimate the risk of cancer (see US EPA, 1996b for sample risk calculations). Because the use of Aroclors to characterize PCB exposures can be both imprecise and inappropriate, total PCBs or congener analyses should be used in the following LADD calculation:

$$\mathbf{LADD = (C_T \times IR \times ED \times EF) / (BW \times AT)} \qquad \textit{Equation D-1}$$

Where:

LADD =	Lifetime average daily dose (mg/kg-day)
C_T =	Total PCBs or total non-dioxin-like congener concentration in a medium (mg/L [water], mg/kg [soil], or milligram per cubic meter (mg/m^3) [air])
IR =	Intake rate (L/day [water], mg/day [soil], or mg/m^3 [air])
ED =	Exposure duration (years)
EF=	Exposure frequency (days/year)
BW =	Average body weight of the receptor over the exposure period (kg)
AT=	Averaging time - the period over which exposure is averaged (days)[23]

The cancer slope factors and recommended Aroclor fate and transport properties (Table D-5), should be used to evaluate the carcinogenic risk posed by PCB mixtures or PCB congeners which do not exhibit a dioxin-like toxicity.

[23]For carcinogens, the averaging time is 25,550 days based on a lifetime exposure of 70 years.

Table D-5. Cancer Slope Factors and Fate & Transport Properties For PCBs

	CRITERIA: Congeners with equal to or greater than four (4) chlorines comprise . . .	CARCINOGENIC EFFECTS	
		Dioxin-like PCBs	**Other PCB Congeners[24]**
CANCER SLOPE FACTORS[25] (mg/kg-day)$^{-1}$	. . . **greater than 0.5%** of the total PCBs present	1.3E+05[26]	2.0
	. . . **less than 0.5%** of the total PCBs present	NA[27]	0.07
FATE & TRANSPORT PROPERTIES	. . . **greater than 0.5%** of the total PCBs present	Aroclor 1254	Aroclor 1254
	. . . **less than 0.5%** of the total PCBs present	Aroclor 1016	Aroclor 1016

For example, if a PCB mixture contains 45% congeners with greater than four chlorines, the cancer slope factor for 2,3,7,8-TCDD and the fate and transport properties of Aroclor 1254 would be used.

If the following special exposure conditions exist, a slope factor of 0.4 may be applied to PCBs which do not exhibit dioxin-like toxicity: ingestion of water-soluble congeners, inhalation of evaporated congeners or dermal exposure (with no applied absorption factor).

7.1.1.2 Dioxin-like Toxicity Approach

Dioxin-like PCBs are some of the moderately chlorinated PCB congeners (see Table D-5) which have been demonstrated to produce dioxin-like effects[28] in humans. The dioxin-like toxicity approach should be implemented **only** when congener-specific concentrations are available for environmental media at a site. In this approach, individual dioxin-like PCB congener concentrations are multiplied by TEFs that represent the potency of a given congener relative to 2,3,7 8-TCDD (see Table 2-2 in Volume I).

[24]*Other PCB congeners* mean those congeners which do not exhibit dioxin-like toxicity.

[25]PCB cancer slope factors can be found in IRIS (US EPA, 2014).

[26]US EPA, 2014

[27]*NA* means not applicable. Do not evaluate dioxin-like PCBs if they comprise less than 0.5% of the total PCBs present; evaluate the other PCB congeners.

[28]Dioxin-like congeners can react with the aryl hydrocarbon receptor, the toxicity mechanism that is believed to initiate the adverse effects of PCDDs and PCDFs.

Table 2-2 of Volume I lists the TEF values derived for dioxin-like PCB congeners. Using TEF values in the risk evaluation allows for the estimation of a combined risk resulting from an exposure to a mixture of dioxin-like PCB congeners (assuming that the risks are additive).

The carcinogenic risk resulting from exposure to dioxin-like PCBs should be estimated by calculating the TEQ. The TEQ is the sum of each congener-specific concentration in the medium multiplied by its corresponding congener-specific TEF value. Multiplying the congener-specific medium concentration by the corresponding congener-specific TEF value provides a relative (i.e., "toxicity-weighted") measure of the dioxin concentration within a medium.

The TEQ for dioxin-like PCBs should be calculated as indicated in the following equation:

$$\mathbf{TEQ = \Sigma\ (C_{mi} \times TEF_i)} \qquad \textit{Equation D-2}$$

Where:

TEQ	=	Toxicity equivalency quotient (mg/L [water] or mg/kg [soil or sediment])
C_{mi}	=	Concentration of *i*th congener in medium (mg/L [water] or mg/kg [soil or sediment])
TEF_i	=	Toxicity equivalency factor for *i*th congener (unitless)

Once the dioxin TEQ has been determined, the LADD should be calculated using the following equation:

$$\mathbf{LADD = (TEQ \times IR \times ED \times EF) / (BW \times AT)} \qquad \textit{Equation D-3}$$

Where:

LADD	=	Lifetime average daily dose (mg/kg-day)
TEQ	=	Toxicity equivalency quotient (mg/L [water], mg/kg [soil], or mg/m^3 [air])
IR	=	Intake rate (L/day [water], mg/day [soil], or mg/m^3 [air])
ED	=	Exposure duration (years)
EF	=	Exposure frequency (days/year)
BW	=	Average body weight of the receptor over the exposure period (kg)
AT	=	Averaging time - the period over which exposure is averaged (days)

The following equation can be used to estimate carcinogenic risk from dioxin-like PCBs:

$$\mathbf{Cancer\ Risk = LADD \times CSF_{TCDD}} \qquad \textit{Equation D-4}$$

Where:

LADD =Lifetime average daily dose (mg/kg-day)
CSF_{TCDD} =Cancer slope factor for 2,3,7,8-TCDD[29]

7.1.2 Non-Carcinogenic Effects

For Aroclors having reference doses (**RfDs**) specified in IRIS (e.g., Aroclor 1254, 1016, etc.), the non-carcinogenic risk should also be evaluated. The evaluation of non-carcinogenic risk should follow the approach typical for other non-PCB chemicals. However, fate and transport properties of the recommended Aroclor (see Table D-6) should be used to evaluate the risk posed.

Table D-6. Toxicological and Fate & Transport Properties For PCBs With Human Health Non-Carcinogenic Effects and Ecological Health Non-Dioxin-Like Effects

CRITERIA: Congeners with equal to or greater than four (4) chlorines comprise . . .	**NON-CARCINOGENIC EFFECTS AND FATE AND TRANSPORT PROPERTIES**
. . . **greater than 0.5%** of the total PCBs present	Aroclor 1254
. . . **less than 0.5%** of the total PCBs present	Aroclor 1016

The RfD derived for Aroclor 1254 should typically be used when conducting a risk assessment. The RfD derived for Aroclor 1016 can be used when at least 99.5% of the mass of the PCB mixture has fewer than four (4) chlorine atoms per molecule as determined by a chromatography/spectroscopy analytical method. Using Table D-6, determine which Aroclor most accurately represents the PCB mixture of concern. Use the RfD and fate and transport properties of this Aroclor as a surrogate to evaluate the non-carcinogenic effects of the PCB mixture.

7.2 Ecological Health

Since PCBs adversely impact both community- and class-specific guild measurement receptors, risks must be estimated for each receptor within both groups. Plants and invertebrates should be evaluated as community measurement receptors (see *Exposure Assessment for Community Measurement Receptors, Section 7.2.1.1*).

[29]The cancer slope factor for 2,3,7,8-TCDD should be obtained from the most recent IRIS (US EPA, 2014). The current oral cancer slope factor for 2,3,7,8-TCDD of 1.3E+05 $(mg/kg\text{-}day)^{-1}$ is based on the administered dose from a 105-week dietary rat study and was adopted for inhalation exposure (US EPA, 2014).

When congener-specific concentrations are available, risk from exposure to dioxin-like PCBs should be estimated separately and added to the risk estimated for the remainder of the PCB mixture which does not exhibit dioxin-like toxicity. The resulting risk is likely to be overestimated if toxicity data from total PCBs is applied to those congeners which do not exhibit dioxin-like toxicity. This overestimation of risk should be addressed within the uncertainty analysis of the risk assessment report.

In the absence of PCB congener-specific data, total PCB concentrations, reported as the sum of Aroclor or homologue concentrations, should be used to estimate receptor exposure to PCBs and the toxicity value of the most toxic Aroclor present should be used in the site-specific ecological risk assessment.

7.2.1 Dioxin-like PCBs

Ecological risks to community- and class-specific guild measurement receptors from dioxin-like PCBs should be estimated by calculating a TEQ and then dividing it by the toxicity value for 2,3,7,8-TCDD (which is assumed to be the most toxic dioxin).

If in addition to PCBs, other dioxin-like compounds (i.e., PCDDs and/or PCDFs) are present at a site, TEQs for dioxin-like PCBs should be added to the TEQs calculated for those other dioxin-like compounds to yield a total TEQ. The 2,3,7,8-TCDD toxicity value should be applied to this total TEQ. For this evaluation, the concentrations of dioxin-like PCBs should be subtracted from the total PCB concentrations to avoid overestimating risks from dioxin-like PCBs by evaluating them twice.

The TEF values listed in Table 2-1 of Volume I and in Table D-7 below should be used in the TEQ calculation to convert the exposure media concentration of individual congeners to a relative measure of concentration within a medium.

Table D-7. Fish Toxicity Equivalency Factor Values For Dioxin-Like PCBs[30]

CONGENER	FISH TOXICITY EQUIVALENCY FACTOR VALUES[31]
3,3′,4,4′-Tetrachlorobiphenyl (77)[11]	0.0001
3,4,4′,5-Tetrachlorobiphenyl (81)	0.0005
2,3,3′,4,4′-Pentachlorobiphenyl (105)	<0.000005[32]
2,3,4,4′,5-Pentachlorobiphenyl (114)	<0.000005
2,3′,4,4′,5-Pentachlorobiphenyl (118)	<0.000005
2′,3,4,4′,5′-Pentachlorobiphenyl (123)	<0.000005
3,3′,4,4′,5-Pentachlorobiphenyl (126)	0.005
2,3,3′,4,4′,5-Hexachlorobiphenyl (156)	<0.000005
2,3,3′,4,4′,5′-Hexachlorobiphenyl (157)	<0.000005
2,3′,4,4′,5,5′-Hexachlorobiphenyl (167)	<0.000005
3,3′,4,4′,5,5′-Hexachlorobiphenyl (169)	<0.000005
2,3,3′,4,4′,5,5′-Heptachlorobiphenyl (189)	<0.000005

Because congener-specific fate and transport data are not available for each of the dioxin-like PCBs listed in Table 2-1 of Volume I and Table D-7, the fate and transport properties of Aroclor 1254 should be used in exposure modeling.

7.2.1.1 Exposure Assessment for Community Measurement Receptors

To evaluate the exposure of water, sediment and soil communities to dioxin-like PCBs, a media-specific TEQ should be calculated. The TEQ is the sum of each congener-specific concentration (in the respective media to which the community is exposed) multiplied by its corresponding congener-specific TEF value derived for fish (Table D-7).

The TEQ for community measurement receptors exposed to dioxin-like PCBs should be calculated as indicated in the following equation:

$$\mathbf{TEQ = \Sigma\ (C_{mi}\ x\ TEF_i)} \qquad \textit{Equation D-5}$$

Where:

[30]Modified from the *Report from the Workshop on the Application of 2,3,7,8-TCDD Toxicity Equivalency Factors to Fish and Wildlife* (US EPA, 1998b).

[31]The surrogate TEF values for fish are presented because invertebrate-specific TEF values have not yet been developed.

[32]For all fish TEFs of "<0.000005," use the value of 0.000005 as a conservative estimate.

TEQ = Toxicity equivalency quotient (µg/L [water] or µg/kg [dry weight soil or sediment])
C_{mi} = Concentration of *i*th congener in abiotic media (µg/L [water] or µg/kg [dry weight soil or sediment])
TEF_i = Toxicity equivalency factor (fish) for *i*th congener (unitless) (Table D-7)

Risk to the water, sediment or soil community is subsequently evaluated by comparing the media-specific TEQ to the media-specific toxicity value for 2,3,7,8-TCDD:

$$\textbf{Risk} = \textbf{TEQ} / \textbf{TRV}_{TCDD} \qquad \textit{Equation D-6}$$

where:

TEQ = Toxicity equivalency quotient (µg/L [water] or µg/kg [dry weight soil or sediment])
TRV_{TCDD} = Toxicity reference value for 2,3,7,8-TCDD (µg/L [water] or µg/kg [dry weight soil or sediment])

7.2.1.2 Exposure Assessment for Class-Specific Guild Measurement Receptors

To evaluate the exposure of class-specific guild measurement receptors to dioxin-like PCBs, congener-specific daily doses of food items (i.e., abiotic media, plants, animals, etc.) ingested by a measurement receptor ($\mathbf{DD_i}$) should be converted to a TEQ-based daily dose ($\mathbf{DD_{TEQ}}$). This DD_{TEQ} can subsequently be compared to the 2,3,7,8-TCDD toxicity values for an evaluation of the risk posed to class-specific guild measurement receptors.

The DD_{TEQ} for each measurement receptor should be calculated as shown in the following equation:

$$\mathbf{DD_{TEQ} = \Sigma\ DD_i\ x\ TEF_{MR}} \qquad \textit{Equation D-7}$$

Where:

DD_{TEQ} = Daily dose of PCB TEQ (µg/kg fresh body weight-day)
DD_i = Daily dose of *i*th congener (µg/kg fresh body weight-day)
TEF_{MR} = Toxicity equivalency factor (specific to measurement receptor) (unitless) (Table D-8)

Risk to the class-specific guild being evaluated can be estimated by dividing the DD_{TEQ} by the toxicity reference value for 2,3,7,8-TCDD:

$$\textbf{Risk} = \textbf{TEQ} / \textbf{TRV}_{TCDD} \qquad \textit{Equation D-8}$$

Where:

[33]The congener-specific daily doses of food items ingested by a measurement receptor should be calculated in accordance with the most current EPA and/or State guidance.

DD_{TEQ} = Daily dose of PCB TEQ (µg/kg fresh body weight-day)
TRV_{TCDD} = Toxicity reference value for 2,3,7,8-TCDD (µg/kg fresh body weight-day)

7.2.2 Other PCB Congeners

In addition to the dioxin-like PCB congeners, the remaining PCBs should be evaluated like other bioaccumulating organic contaminants by assessing ecological risks to community- and class-specific guild measurement receptors. The fate and transport properties of Aroclor 1254[34] should be used in the exposure modeling when evaluating the risk from PCB mixtures containing congeners with equal to or greater than 4 chlorines in quantities **greater** than 0.5% of the total PCBs. And, the fate and transport properties of Aroclor 1016[35] should be used in the exposure modeling when evaluating risks from PCB mixtures containing **less** than 0.5 % of PCB congeners with more than 4 chlorines (see Table D-6).

8.0 CONCLUSION

PCBs, which are a class of organic compounds that are persistent in the environment, are toxic to both humans and biota. PCBs may in certain instances become contaminated with more toxic PCDFs and PCDDs. Therefore, the potential presence of these compounds should also be evaluated and possibly investigated.

Based on federal and state regulations and standards, the NMED recommends that PCB-contaminated sediment/soils be remediated to either 1 mg/kg total PCBs or the most stringent of the calculated health risk-based concentrations in order to adequately protect human health and the environment.

Unless soil/sediments are remediated to 1 mg/kg total PCBs, the risk posed by PCBs to human health and the environment should be evaluated using a risk-based approach. All corrective action SWMU/AOCs impacted or suspected of being impacted by PCBs and having a potential for transport to a human or ecological receptor should be evaluated and monitored, as necessary, to protect human health and the environment.

PCB concentrations in soil/sediments should also be protective of both surface water and ground water resources; PCB concentrations in surface water should not exceed 0.014 µg/L and PCB concentrations in ground water cannot exceed 0.5 µg/L (drinking water) or 1 µg/L in ground water with 10,000 mg/L or less total dissolved solids).

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[34]Approximately 77% of Aroclor 1254 is composed of PCB congeners with more than 4 chlorines.

[35]Approximately 99% of Aroclor 1016 is comprised of PCB congeners with 4 or less chlorines.

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VOLUME 2
SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENTS

PHASE I
Scoping Assessment

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Acronymns and Abbreviations

AOC	Areas of Concern
AUF	Area Use Factor
BAF	Bioaccumulation/Biomagnification Factor
bgs	below ground surface
COPEC	Constituent of Potential Ecological Concern
EPC	Exposure Point Concentration
ESL	Ecological Screening Level
ft	foot
GAERPC	Guidance for Assessing Ecological Risks Posed by Chemicals
HI	Hazard Index
HQ	Hazard Quotient
kg	kilogram
LOAEL	Lowest-observed adverse effect level
LULC	land use and land cover
mg	milligram
NMED	New Mexico Environment Department
NOAEL	No-observed adverse effect level
PCSEM	Preliminary Conceptual Site Exposure Model
PUF	Plant Uptake Factor
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SLERA	Screening Level Ecological Risk Assessment
SLHQ	Screening Level Hazard Quotient
SSG	Soil Screening Guidance
SWMU	Solid Waste Management Unit
T&E	Threatened and Endangered
TRV	Toxicity Reference Value
UCL	Upper Confidence Level
US EPA	United States Environmental Protection Agency

1.0 INTRODUCTION

The purpose of an ecological risk assessment is to evaluate the potential adverse effects that chemical contamination has on the plants and animals that make up ecosystems. The risk assessment process provides a way to develop, organize and present scientific information so that it is relevant to environmental decisions.

The New Mexico Environment Department (NMED) has developed a tiered procedure for the evaluation of ecological risk. Volume II of this *Risk Assessment Guidance for Investigations and Remediation* (SSG) outlines the steps for the Phase I Assessment, to include a qualitative scoping assessment and a quantitative screening assessment. If more detailed assessments are required or the Phase II Assessment is needed, additional guidance may be found in the *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Risk Assessment* (GAERPC) (NMED, 2014). Briefly, the tiers of the procedure are organized as follows:

PHASE I – SCOPING AND SCREENING ASSESSMENTS

- Scoping Assessment
- Screening Assessment (Tier 1 and 2)

PHASE II - SITE-SPECIFIC ASSESSMENTS

- Site-Specific Ecological Risk Assessment (Tier 3)

As discussed above and illustrated in Figure 1, the Scoping Assessment is the first phase of the Screening-Level Ecological Risk Assessment process as defined by the NMED GAERPC. This document provides specific procedures to assist the facility in conducting the first phase (Scoping and Screening Assessments), Screening-Level Ecological Risk Assessment process outlined in the GAERPC. The purpose of the Scoping Assessment is to gather information, which will be used to determine if there is "any reason to believe that ecological receptors and/or complete exposure pathways exist at or in the locality of the site" (NMED, 2014). The scoping assessment step also serves as the initial information-gathering phase for sites clearly in need of a more detailed assessment of potential ecological risk. This document outlines the methodology for conducting a Scoping Assessment, and includes a Site Assessment Checklist (Attachment A), which serves as tool for gathering information about the facility property and surrounding areas. Although the GAERPC provides a copy of the US Environmental Protection Agency (US EPA) Checklist for Ecological Assessment/Sampling (US EPA, 1997), the attached Site Assessment Checklist provides an expanded, user-friendly template, which both guides the user as to what information to collect and furnishes an organized structure in which to enter the information.

After the Site Assessment Checklist has been completed, the assessor must use the collected information to generate a Scoping Assessment Report and Preliminary Conceptual Site Exposure Model (PCSEM). Guidance for performing these tasks is provided in this document, and in the GAERPC. The Scoping Assessment Report and PCSEM are subsequently used to address the first in a series of Technical Decision Points of the tiered GAERPC process. Technical Decision Points are questions which must be answered by the assessor after the completion of certain

phases in the process. The resulting answer to the question determines the next step to be undertaken by the facility. The first Technical Decision Point, as illustrated in Figure 1, is to decide: *Is Ecological Risk Suspected?*

If the answer to the first Technical Decision Point is "no" (that is, ecological risk is not suspected), the assessor may use the Exclusion Criteria Checklist and Decision Tree (Attachment B) to help confirm or deny that possibility. However, it is unlikely that any site containing potential ecological habitat or receptors will meet the Site Exclusion Criteria.

If ecological risk is suspected, the facility will usually be directed to proceed to the Tier 1 Screening Level Ecological Risk Assessment (SLERA) and refined Tier 2 SLERA. A SLERA is a simplified risk assessment that can be conducted with limited site-specific data by defining assumptions for parameters that lack site-specific data (US EPA, 1997). Values used for screening are consistently biased in the direction of overestimating risk to ensure that sites that might pose an ecological risk are properly identified. The completed Site Assessment Checklist is a valuable source of information needed for the completion of the SLERA. Additional information on performing a SLERA can be found in the GAERPC (NMED, 2014) and in a number of EPA guidance documents (e.g., US EPA, 1997; US EPA, 1998).

2.0 SCOPING ASSESSMENT

The Scoping Assessment serves as the initial information gathering and evaluation for the Phase I process. A Scoping Assessment consists of the following steps:

- Compile and Assess Basic Site Information (using Site Assessment Checklist)
- Conduct Site Visit
- Identify Preliminary Contaminants of Potential Ecological Concern
- Develop a Preliminary Conceptual Site Exposure Model
- Prepare a Scoping Assessment Report

The following subsections provide guidance for completing each step of the Scoping Assessment. For additional guidance, readers should refer to the GAERPC (NMED, 2014).

2.1 Compile and Assess Basic Site Information

The first step of the Scoping Assessment process is to compile and assess basic site information. Since the purpose of the Scoping Assessment is to determine if ecological habitats, receptors, and complete exposure pathways are likely to exist at the site, those items are the focus of the information gathering. The Site Assessment Checklist (Attachment A) should be used to complete this step. The questions in the Site Assessment Checklist should be addressed as completely as possible with the information available before conducting a site visit.

In many cases, a large portion of the Site Assessment Checklist can be completed using reference materials and general knowledge of the site. A thorough file search should be conducted to

compile all potential reference materials. Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) and Facility Investigation (RFI) reports, inspection reports, RCRA Part B Permit Applications, and facility maps can all be good sources of the information needed for the Site Assessment Checklist.

Habitats and receptors which may be present at the site can be identified by contacting local and regional natural resource agencies. Habitat types may be determined by reviewing land use and land cover maps (LULC), which are available via the Internet at http://www.nationalatlas.gov/scripts. Additional sources of general information for the identification of ecological receptors and habitats are listed in the introduction section of the Site Assessment Checklist (Attachment A).

After all available information has been compiled and entered into the Site Assessment Checklist, the assessor should review the checklist and identify data gaps. Plans should then be made to obtain the missing information by performing additional research and/or by observation and investigation during the site visit.

2.2 Site Visit

When performing a Scoping Assessment, at least one site visit should be conducted to directly assess ecological features and conditions. As discussed in the previous section, completion of the Site Assessment Checklist should have begun during the compilation of basic site information. The site visit allows for verification of the information obtained from the review of references and other information sources. The current land and surface water usage and characteristics at the site can be observed, as well as direct and indirect evidence of receptors. In addition to the site, areas adjacent to the site and all areas where ecological receptors are likely to contact site-related chemicals (i.e., all areas which may have been impacted by the release or migration of chemicals from the site) should be observed or visited and addressed in the Site Assessment Checklist. The focus of the habitat and receptor observations should be on a community level. That is, dominant plant and animal species and habitats (e.g., wetlands, wooded areas) should be identified during the site visit. Photographs should be taken during the site visit and attached to the Scoping Assessment Report. Photographs are particularly useful for documenting the nature, quality, and distribution of vegetation, other ecological features, potential exposure pathways, and any evidence of contamination or impact. While the focus of the survey is on the community level, the U.S. Fish and Wildlife Service and the New Mexico Natural Heritage Program should be contacted prior to the site visit. The intent is to determine if state listed and/or federal listed Threatened & Endangered (T&E) species or sensitive habitats may be present at the site, or if any other fish or wildlife species could occur in the area (as indicated in the Site Assessment Checklist, Section IIID). A trained biologist or ecologist should conduct the biota surveys to appropriately characterize major habitats and to determine whether T&E species are present or may potentially use the site. The site assessment should also include a general survey for T&E species and any sensitive habitats (e.g. wetlands, perennial waters, breeding areas), due to the fact that federal and state databases might not be complete.

Site visits should be conducted at times of the year when ecological features are most apparent (i.e., spring, summer, early fall). Visits during winter might not provide as much evidence of the presence or absence of receptors and potential exposure pathways.

In addition to observations of ecological features, the assessor should note any evidence of chemical releases (including visual and olfactory clues), drainage patterns, areas with apparent erosion, signs of groundwater discharge at the surface (such as seeps or springs), and any natural or anthropogenic site disturbances.

2.3 Identify Contaminants of Potential Ecological Concern

Contaminants of Potential Ecological Concern (COPECs) are chemicals which may pose a threat to individual species or biological communities. For the purposes of the Scoping Assessment, all chemicals known or suspected of being released at the site are considered COPECs. The identification of COPECs is usually accomplished by the review of historical information in which previous site activities and releases are identified, or by sampling data which confirm the presence of contaminants in environmental media at the site. If any non-chemical stressors such as mechanical disturbances or extreme temperature conditions are known to be present at the site, they too are to be considered in the assessment.
After the COPECs have been identified, they should be summarized and organized (such as in table or chart form) for presentation in the Scoping Assessment Report.

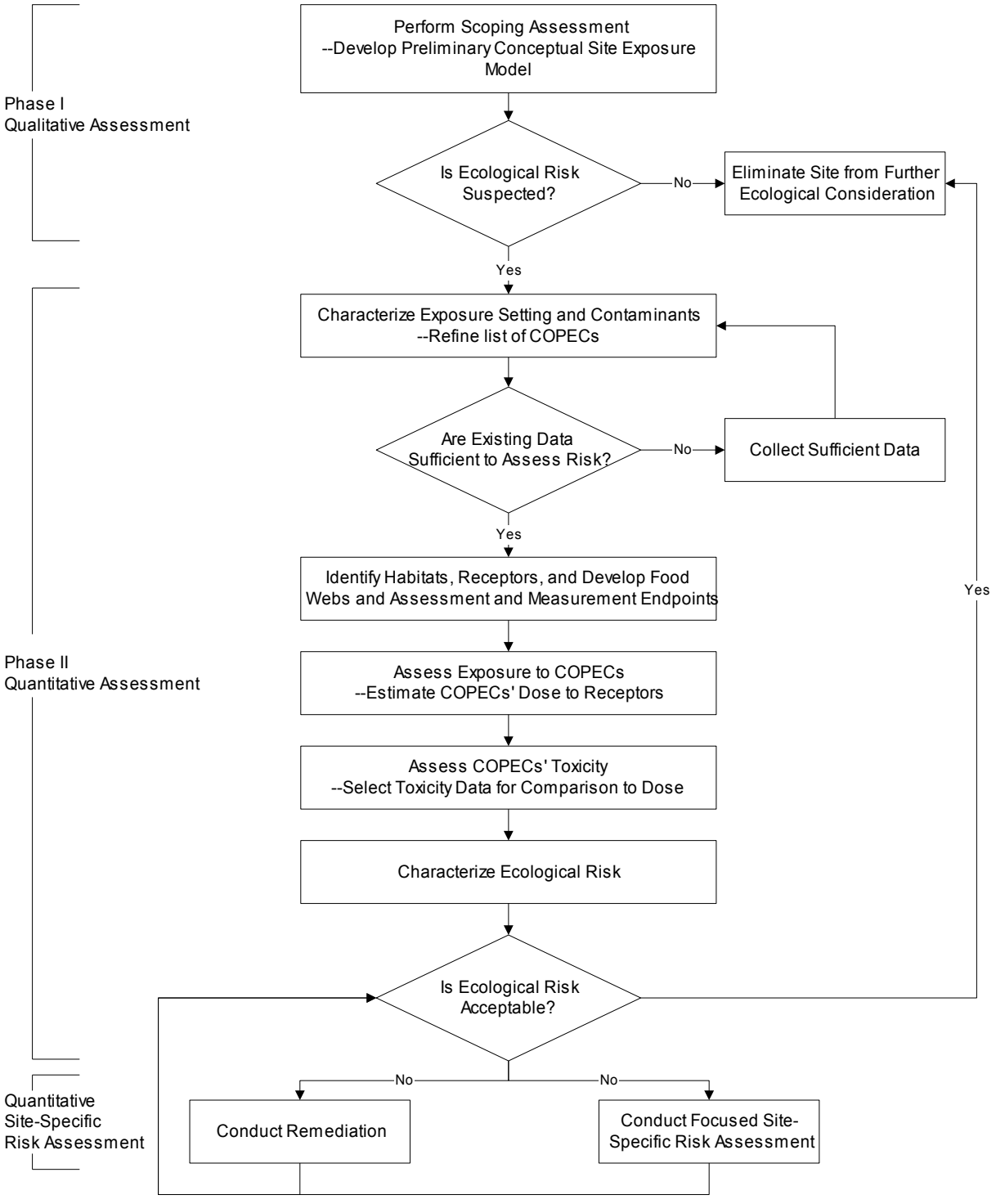
2.4 Developing the Preliminary Conceptual Site Exposure Model

A PCSEM provides a summary of potentially complete exposure pathways, along with potentially exposed receptor types. The PCSEM, in conjunction with the scoping report, is used to determine whether further ecological assessment (i.e., Screening-Level Assessment, Site-Specific Assessment) and/or interim measures are required.

A complete exposure pathway is defined as a pathway having all of the following attributes (US EPA, 1998; NMED, 2014):

- A source and mechanism for hazardous waste/constituent release to the environment
- An environmental transport medium or mechanism by which a receptor can come into contact with the hazardous waste/constituent
- A point of receptor contact with the contaminated media or via the food web, and
- An exposure route to the receptor.

If any of the above components are missing from the exposure pathway, it is not a complete pathway for the site. A discussion regarding all possible exposure pathways and the rationale/justification for eliminating any pathways should be included in the PCSEM narrative and in the Scoping Assessment Report.



Adapted from GAERPC (NMED 2000).

Figure 1. NMED Ecological Risk Assessment Process

The PCSEM is presented as both a narrative discussion and a diagram illustrating potential contaminant migration and exposure pathways to ecological receptors. A sample PCSEM diagram is presented in Figure 2. On the PCSEM diagram, the components of a complete exposure pathway are grouped into three main categories: sources, release mechanisms, and potential receptors. As a contaminant migrates and/or is transformed in the environment, sources and release mechanisms can be defined as primary, secondary, and tertiary.

For example, Figure 2 depicts releases from a landfill that migrate into soils, and reach nearby surface water and sediment via storm water runoff. In this situation, the release from the landfill is considered the primary release, with infiltration as the primary release mechanism. Soil becomes the secondary source, and storm water runoff is the secondary release mechanism to surface water and sediments, the tertiary source.

Subsequent ecological exposures to terrestrial and aquatic receptors will result from this release. The primary exposure routes to ecological receptors are direct contact, ingestion, and possibly inhalation. For example, plant roots will be in direct contact with contaminated sediments, and burrowing mammals will be exposed via dermal contact with soil and incidental ingestion of contaminated soil. In addition, exposures for birds and mammals will occur as they ingest prey items through the food web.

Although completing the Site Assessment Checklist will not provide the user with a readymade PCSEM, a majority of the components of the PCSEM can be found in the information provided by the Site Assessment Checklist. The information gathered for the completion of Section II of the Site Assessment Checklist, can be used to identify sources of releases. The results of Section III, Habitat Evaluation, can be used to both identify secondary and tertiary sources and to identify the types of receptors which may be exposed. The information gathered for completion of Section IV, Exposure Pathway Evaluation, will assist users in tracing the migration pathways of releases in the environment, thus helping to identify release mechanisms and sources.

Once all of the components of the conceptual model have been identified, complete exposure pathways and receptors that have the potential for exposure to site releases can be identified.

For further guidance on constructing a PCSEM, consult the GAERPC (NMED, 2014), and US EPA guidance on corrective action, to include the site conceptual exposure model builder (http://www.epa.gov/osw/hazard/correctiveaction/resources/guidance/index.htm).

2.5 Assembling the Scoping Assessment Report

After completion of the previously described activities of the scoping assessment, the Scoping Assessment Report should be assembled to summarize the site information and present an evaluation of receptors and pathways at the site. The Scoping Assessment Report should be designed to support the decision made regarding the first Technical Decision Point (Is Ecological Risk Suspected?). The Scoping Assessment Report should, at a minimum, contain the following information:

- Existing Data Summary
- Site Visit Summary (including a completed Site Assessment Checklist)

- Evaluation of Receptors and Pathways
- Recommendations
- Attachments (e.g. photographs, field notes, telephone conversation logs with natural resource agencies)
- References/Data Sources

After completion, the Scoping Assessment Report and PCSEM should be submitted to NMED for review and approval. These documents will serve as a basis for decisions regarding future actions at the site.

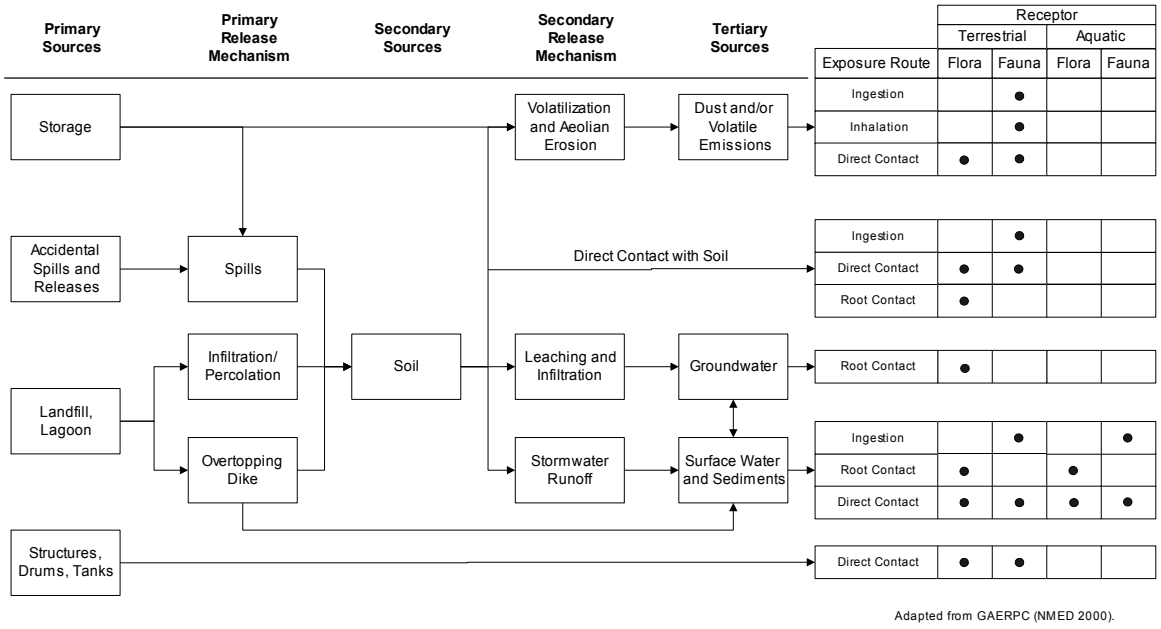


Figure 2. Example Preliminary Conceptual Site Exposure Model Diagram for a Hypothetical Site

2.6 Site Exclusion Criteria

If the assessor believes that the answer to the first Technical Decision Point (Is Ecological Risk Suspected?) is "no" based on the results of the PCSEM and Scoping Assessment Report, it should be determined whether the facility meets the NMED Site Exclusion Criteria.

Exclusion criteria are defined as those conditions at an affected property which eliminate the need for a SLERA. The three criteria are as follows:

- Affected property does not include viable ecological habitat.
- Affected property is not utilized by potential receptors.
- Complete or potentially complete exposure pathways do not exist due to affected property setting or conditions of affected property media.

The Exclusion Criteria Checklist and associated Decision Tree (Attachment B) can be used as a tool to help the user determine if an affected site meets the exclusion criteria. The checklist assists in making a conservative, qualitative determination of whether viable habitats, ecological receptors, and/or complete exposure pathways exist at or in the locality of the site where a release of hazardous waste/constituents has occurred. Thus, meeting the exclusion criteria means that the facility can answer "no" to the first Technical Decision Point.

If the affected property meets the Site Exclusion Criteria, based on the results of the checklist and decision tree, the facility must still submit a Scoping Assessment Report to NMED which documents the site conditions and justification for how the criteria have been met. Upon review and approval of the exclusion by the appropriate NMED Bureau, the facility will not be required to conduct any further evaluation of ecological risk. However, the exclusion is not permanent; a future change in circumstances may result in the affected property no longer meeting the exclusion criteria.

2.7 Technical Decision Point: Is Ecological Risk Suspected?

As discussed in the beginning of this document, the Scoping Assessment is the first phase of the GAERPC ecological risk assessment process (Figure 1). Following the submission of the Scoping Assessment Report and PCSEM, NMED will decide upon one of the following three recommendations for the site:

- No further ecological investigation at the site, or
- Continue the risk assessment process, and/or
- Undertake a removal or remedial action.

If the information presented in the Scoping Assessment Report supports the answer of "no" to the first Technical Decision Point, and the site meets the exclusion criteria, the site will likely be excused from further consideration of ecological risk. However, this is only true if it can be documented that a complete exposure pathway does not exist and will not exist in the future at the site based on current conditions. For those sites where valid pathways for potential exposure exist or are likely to exist in the future, further ecological risk assessment (usually in the form of

a SLERA) will be required. However, if the Scoping Assessment indicates that a detailed assessment is warranted, the facility would not be required to conduct a SLERA. Instead the facility would move directly to Phase II and the Site-Specific Ecological Risk Assessment (Tier 3).

3.0 TIER 1 SCREENING LEVELS ECOLOGICAL RISK ASSESSMENT (SLERA)

If the PSCEM indicates complete exposure pathways, a SLERA is most likely the next step. The data collected during the scoping assessment is used to define facility-wide conditions and define the steps needed for the SLERA and includes the below items. The SLERA should contain a detailed discussion of each of these items.

- Characterization of the environmental setting, including current and future land uses. Ecological assessments must include the evaluation of present day conditions and land uses but also evaluate future land uses.
- Identification of known or likely chemical stressors (chemicals of potential ecological concern, COPECs). The characterization data from the site (e.g., facility investigation) is evaluated to determine what constituents are present in which media. Selection of COPEC should follow the same methodology as outlined in Volume I.
- Identification of the fate and transport pathways that are complete. This includes an understanding of how COPECs may be mobilized from one media to another.
- Identification of the assessment endpoints that should be used to assess impact of the receptors; what is the environmental value to be protected.
- Identification of the complete exposure pathways and exposure routes (as identified in the example in Figure 2). What are the impacted media (soil, surface water, sediment, groundwater, and/or plants) and how might the representative receptors be exposed (direct ingestion, inhalation, and/or direct contact)?
- Species likely to be impacted and selection of representative receptors. From the list of species likely to be present on-site, what species are to be selected to represent specific trophic levels?

3.1 Selection of Representative Species

Sites may include a wide range of terrestrial, semi-aquatic, and aquatic wildlife. A generalized food web is shown in Figure 3. Wildlife receptors for the SLERA should be selected to represent the trophic levels and habitats present or potentially present at the site and include any Federal threatened and endangered species and State sensitive species.

As there are typically numerous species of wildlife and plants present at a given facility or site and in the surrounding areas, only a few key receptors need to be selected for quantitative evaluation in the SLERA, which are representative of the ecological community and varying

trophic levels in the food web. Possible receptors that may be evaluated in the SLERAs at each site include the following:

- Plant community,
- Deer mouse,
- Horned lark,
- Kit fox (evaluated at sites greater than 267 acres),
- Pronghorn (evaluated at sites greater than 342 acres), and
- Red-tailed hawk (evaluated at sites greater than 177 acres).

The above key receptors selected as the representative species represent the primary producers as well as the three levels of consumer (primary, secondary, and tertiary).

3.1.1 Plants

The plant community will be evaluated quantitatively in the SLERAs at all sites. Specific species of plants will not be evaluated separately; rather the plant community will be evaluated as a whole. The plant community provides a necessary food source directly or indirectly through the food web for wildlife receptors.

3.1.2 Deer Mouse

The deer mouse (Peromyscus maniculatus) is a common rodent throughout much of North America and it can thrive in a variety of habitats. The deer mouse was selected as a representative receptor because it is prevalent in the vicinity of most sites in New Mexico, and it represents one of the several species of omnivorous rodents that may be present at sites. Small rodents are also a major food source for larger omnivorous and carnivorous species. The deer mouse receptor will be evaluated at all sites, regardless of size. The deer mouse has a relatively small home range and could therefore be substantially exposed to COPECs at sites if their home range is located within a solid waste management unit (SWMU) or other corrective action site.

Based on a review of literature (OEHHA, 1999) and from the Natural Diversity Information Source (CDW, 2011), a dietary composition consisting of 26% invertebrates and 74% plant matter will be assumed for the deer mouse.

3.1.3 Horned Lark

The horned lark (*Eremophila alpestris*) is a common widespread terrestrial bird. It spends much of its time on the ground and its diet consists mainly of insects and seeds. The horned lark receptor was chosen because it is prevalent in New Mexico and represents one of the many small terrestrial bird species that could be present. Since the horned lark spends most of its time on the ground, it also provides a conservative measure of effect since it has a higher rate of incidental ingestion of soil than other song birds. The horned lark is also a major food source for

omnivorous intermediate species, and top avian carnivores. The horned lark will be evaluated based on an omnivorous diet of invertebrates and plant matter. The horned lark receptor will be evaluated at all sites, regardless of size. The horned lark has a relatively small home range and could therefore be substantially exposed to COPECs at sites if their home range is located within a SWMU or other corrective action unit.

It will be assumed that the horned lark's diet consists of 75% plant matter, and 25% animal matter based on a study conducted by Doctor, *et al*, 2000.

3.1.4 Kit Fox

The kit fox (*Vulpes macrotis*) is native to the western United States and Mexico. Its diet consists of mostly small mammals. Although the kit fox's diet may also consist of plant matter during certain times of the year, the kit fox will be evaluated as a carnivore, with a diet consisting of 100% prey items. It was selected as a key receptor because it is sensitive species and is common in New Mexico, and the surrounding area at most sites in New Mexico provides suitable habitat for the kit fox. The kit fox also is representative of a mammalian carnivore within the food web.

The kit fox will only be evaluated at sites that are larger than 276 acres. A kit fox has a large home range size (2767 acres) (Zoellick & Smith, 1992) and it is assumed that risks are negligible from exposure to COPECs at sites that are less than 10% of the receptors home range. Unless the area use factor (AUF) is at least 10%, food items potentially contaminated with COPECs and incidental soil ingestion at the site would not contribute significantly to the receptor's diet and exposure to COPECs. The kit fox diet will be based on composition of 100% prey.

3.1.5 Red-Tailed Hawk

The red-tailed hawk (*Buteo jamaicensis*) was selected as a top carnivore avian key receptor. The red-tailed hawk is widespread throughout New Mexico and is one of the most common birds of prey. It hunts primarily rodents, rabbits, birds, and reptiles. The red-tailed hawk was chosen as a key receptor since it is a common species through New Mexico. The red-tailed hawk will only be evaluated at sites that are larger than 177 acres. The red-tailed hawk has a large home range size (1770 acres) (US EPA, 1993b), and risks to the red-tailed hawk from exposure to COPECs at sites smaller than 177 acres (10% of the home range) would be negligible. The red-tailed hawk diet will be based on composition of 100% prey.

3.1.6 Pronghorn Antelope

The pronghorn (*Antilocapra Americana*) is a popular big game species that occurs in western Canada, United States, and northern Mexico. Its diet consists mainly of sagebrush and other shrubs, grasses, and forbs. The pronghorn was selected as a key receptor representative of large herbivorous species of wildlife. The pronghorn will only be evaluated at sites that are larger than 342 acres. The pronghorn has a large home range size (3422 acres) (Reynolds, 1984), and risks to the pronghorn from exposure to COPECs at sites smaller than 342 acres (10% of the home range) would be negligible. It is assumed that 100% of the diet is from grazing.

3.2 Exposure Pathways

The scoping survey will provide a summary of potentially complete exposure pathways, along with potentially exposed receptor types. A complete exposure pathway is defined as a pathway having all of the following attributes:

- A source and mechanism for hazardous waste/constituent release to the environment,
- An environmental transport medium or mechanism by which a receptor can come into contact with the hazardous waste/constituent,
- A point of receptor contact with the contaminated media or via the food web, and
- An exposure route to the receptor.

If any of the above components are missing from the exposure pathway, it is not a complete pathway for the site. A discussion regarding all possible exposure pathways and the rationale/justification for eliminating any pathways will be included in the risk assessment.

Affected media that ecological receptors may be exposed to at sites are soil, biota, and surface water or groundwater (through springs). Surface water, sediment, and groundwater should be evaluated based on site-specific conditions.

Wildlife receptors could be exposed to COPECs that have been assimilated into biota. Ingestion of contaminated plant and animal matter, as a necessary component of the receptor's diet, will be evaluated quantitatively in the SLERAs. However, for the Tier-1 SLERA, it will conservatively be assumed that 100% of the wildlife receptors' dietary intake consists of site soil.

For soil, two soil intervals should be evaluated:

- For all non-burrowing receptors, the soil interval to be considered is between zero (0) and five (5) feet below ground surface (ft bgs).
- For all burrowing receptors and plants, the soil interval to be evaluated is 0 – 10 ft bgs.

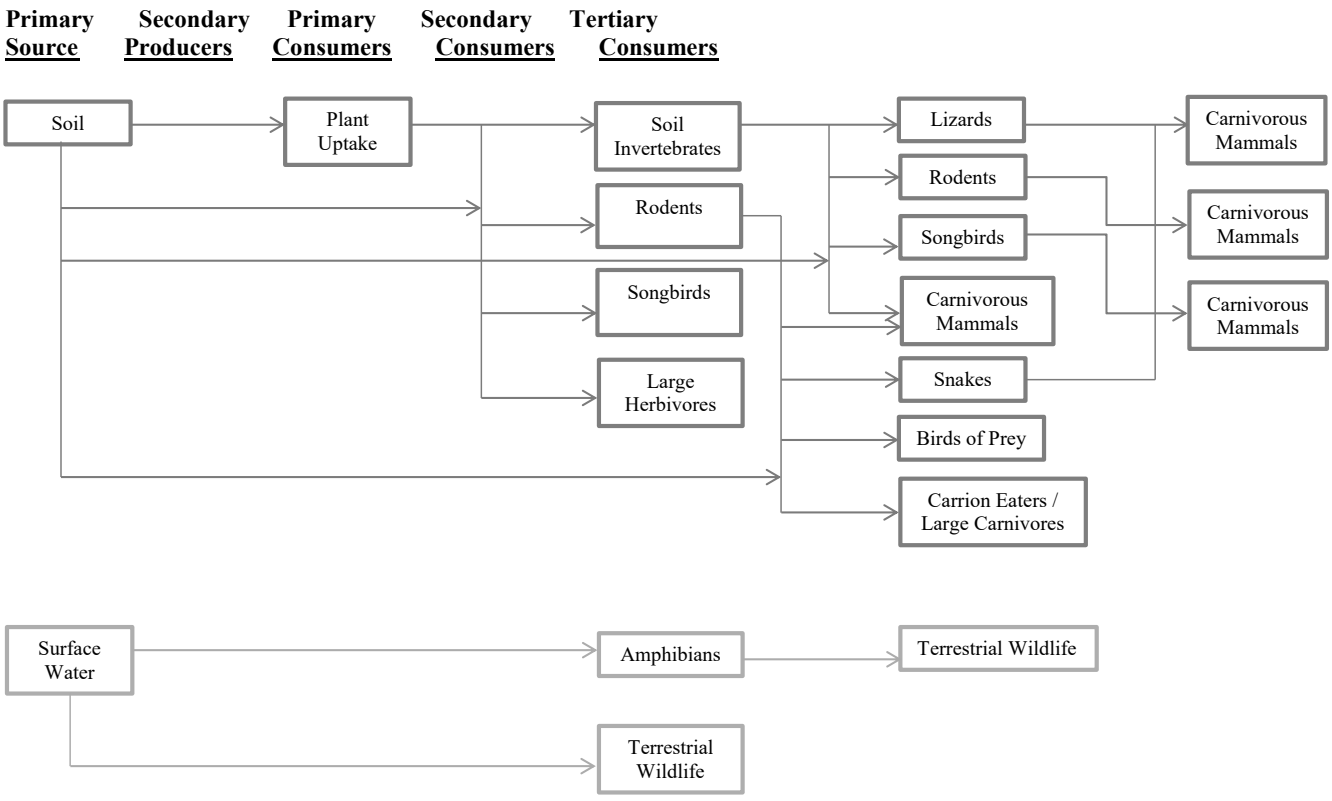


Figure 3. Generic Food Web.

3.3 SLERA Exposure Estimation

For the initial SLERA, conservative assumptions should be applied as follows:

- Maximum detected concentrations (0-10 ft bgs for all receptors) will be utilized in calculating exposure doses.
- 100% of the diet is assumed to contain the maximum concentration of each COPEC detected in the site media.
- Minimum reported body weights should be applied.
- Maximum dietary intake rates should be used.
- It will be assumed that 100% of the diet consists of direct ingestion of contaminated soil.
- It is assumed that the bioavailability is 100% at each site.
- Foraging ranges are initial set equal to the size of the site being evaluated. This means that the AUF in the SLERA is set to a value of one.

The equation and exposure assumptions for calculating the Tier 1 exposure doses for the deer mouse are presented in Equation 1.

Equation 1. Calculation of Tier 1 Exposure Dose for COPECs in Soil; Deer Mouse

$$Exposure\ Dose = \frac{(C_s \times (IR * ww{:}dw)\ \times AUF)}{BW}$$

Parameter	Definition (units)	Value	Reference
Exposure Dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	calculated	--
C_s	Chemical concentration in soil (mg/kg)	Site-specific	Maximum detected concentration (0-10 ft bgs)
IR	Ingestion rate (kg food [ww]/day)	0.007	Maximum reported total dietary intake (US EPA, 1993b)
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
AUF	Area use factor (the ratio of the site exposure area to the receptor foraging range) (unitless)	1	Maximum possible value
BW	Body weight (kg)	0.014	Minimum reported adult body weight (CDW, 2011)

The equation and exposure assumptions for calculating the Tier 1 exposure dose for the horned lark are presented in Equation 2.

Equation 2. Calculation of Tier 1 Exposure Dose for COPECs in Soil; Horned Lark

$$Exposure\ Dose = \frac{(C_s \times (IR * ww{:}dw) \times AUF)}{BW}$$

Parameter	Definition (units)	Value	Reference
Exposure Dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	Calculated	--
C_s	Chemical concentration in soil (mg/kg)	Site-specific	Maximum detected concentration (0-10 ft bgs)
IR	Ingestion rate (kg food [ww]/day)	0.024	Maximum reported total dietary intake; American robin (US EPA, 1993b)
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
AUF	Area use factor (the ratio of the site exposure area to the receptor foraging range) (unitless)	1	Maximum possible value
BW	Body weight (kg)	0.025	Minimum reported adult body weight (Trost, 1972)

The equation and exposure assumptions for calculating the Tier 1 exposure doses for the kit fox are presented in Equation 3.

Equation 3. Calculation of Tier 1 Exposure Dose for COPECs in Soil; Kit Fox

$$Exposure\ Dose = \frac{(C_s \times (IR * ww{:}dw) \times AUF)}{BW}$$

Parameter	Definition (units)	Value	Reference
Exposure Dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	calculated	--
C_s	Chemical concentration in soil (mg/kg)	Site-specific	Maximum detected concentration (0-10 ft bgs)
IR	Ingestion rate (kg food [ww]/day)	0.18	Maximum reported total dietary intake (OEHHA, 2003)
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
AUF	Area use factor (the ratio of the site exposure area to the receptor foraging range) (unitless)	1	Maximum possible value
BW	Body weight (kg)	1.6	Minimum reported adult body weight (OEHHA, 2003)

The equation and exposure assumptions for calculating the Tier 1 exposure doses for the red-tailed hawk are presented in Equation 4.

Equation 4 Calculation of Tier 1 Exposure Dose for COPECs in Soil; Red-tailed Hawk

$$Exposure\ Dose = \frac{(C_s \times (IR * ww{:}dw) \times AUF)}{BW}$$

Parameter	Definition (units)	Value	Reference
Exposure Dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	Calculated	--
C_s	Chemical concentration in soil (mg/kg)	Site-specific	Maximum detected concentration (0-10 ft bgs)
IR	Ingestion rate (kg food [ww]/day)	0.12	Maximum reported total dietary intake (US EPA, 1993b)
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
AUF	Area use factor (the ratio of the site exposure area to the receptor foraging range) (unitless)	1	Maximum possible value
BW	Body weight (kg)	0.96	Minimum reported adult body weight (US EPA, 1993b)

The equation and exposure assumptions for calculating the Tier 1 exposure doses for the pronghorn are presented in Equation 5.

Equation 5. Calculation of Tier 1 Exposure Dose for COPECs in Soil; Pronghorn

$$Exposure\ Dose = \frac{(C_s \times (IR * ww{:}dw) \times AUF)}{BW}$$

Parameter	Definition (units)	Value	Reference
Exposure Dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	calculated	--
C_s	Chemical concentration in soil (mg/kg)	Site-specific	Maximum detected concentration (0-10 ft bgs)
IR	Ingestion rate (kg wet matter/day) Based on equation: IR=a(BW)^b where: a=2.606, b=0.628	0.74	Dry matter intake rate for herbivores (based on Nagy, 2001)
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
AUF	Area use factor (the ratio of the site exposure area to the receptor foraging range) (unitless)	1	Maximum possible value
BW	Body weight (kg)	47	Minimum reported adult body weight (O'Gara, 1978)

Exposure doses will not be calculated for plants. For the Tier 1 exposure assessment, it will be assumed that the exposure concentrations for plants are equal to the maximum detected concentrations of COPECs in soil (0-10 ft bgs).

3.4 Effects Assessment

The effects assessment evaluated the potential toxic effects on the receptors being exposed to the COPECs. The effects assessment includes selection of appropriate toxicity reference values (TRVs) for the characterization and evaluation of risk. TRVs are receptor and chemical specific exposure rates at which no adverse effects have been observed, or at which low adverse effects are observed. TRVs that are based on studies with no adverse effects are called no observed adverse effects levels (NOAELs). TRVs that are based on studies with low adverse effects are termed lowest observed adverse effects levels (LOAELs).

For the initial SLERA, the preference for TRVs is based on chronic or long term exposure, when available. The TRVs should be selected from peer-reviewed toxicity studies and from primary literature. Initial risk characterization should be conducted using the lowest appropriate chronic NOAEL for non-lethal or reproductive effects. If a TRV is not available and/or no surrogate data could be identified, the exclusion of potential toxicity associated with the COPEC will be qualitatively addressed in the uncertainty analysis of the risk assessment. Other factors that may be included in this discussion is frequency of detection, depth of detections, and special analysis of the detections. Attachment C, Tables C1 through C6, contains NOAEL- and LOAEL-based TRVs for the key ecological receptors.

3.5 Risk Characterization

Assessment endpoints are critical values to be protected (US EPA, 1997c). The assessment endpoint will be to ensure the survival and reproduction of all ecological receptors to maintain populations. This will be accomplished by determining whether COPECs at each site are present at levels that would adversely affect the population size of ecological receptors by limiting their abilities to reproduce.

For plants, the Tier 1 screening level hazard quotients for plants will be calculated by comparing exposure doses (i.e., maximum detected concentrations of COPECs; 0-10 ft bgs) to an effect concentration. The equation for screening level hazad quotient (SLHQ) for plants is shown in Equation 6. Attachment C, Table C-6, lists effect concentrations to be used in screening for plants.

Equation 6. Calculation of Screening-Level Hazard Quotients for Plant Receptors
$$SLHQ = \frac{C_s}{Effect\ Concentration}$$

Parameter	Definition (units)
SLHQ	Screening level hazard quotient (unitless)
C_s	Chemical concentration in soil (mg COPEC / kg soil dry weight)
Effect Concentration	Concentration at which adverse effects are not expected (mg/kg), see Attachment C, Table C-6.

Tier 1 SLHQs for wildlife receptors will be calculated by comparing estimated exposure doses derived using Equations 1 through 5 for each of the key receptors determined to have complete habitat and exposure pathways at the site to NOAEL-based TRVs. The derivation of SLHQ for the key receptors (except plants) is shown in Equation 7.

Equation 7 Calculation of Screening-Level Hazard Quotients for Wildlife Receptors

$$SLHQ = \frac{Dose}{TRV}$$

OR

$$SLHQ = \frac{C_s}{ESL}$$

Parameter	Definition (Units)
SLHQ	Screening-level hazard quotient (unitless)
Dose	Estimated receptor-specific contaminant intake, from Equations 1 through 5 (mg/kg of body weight/day)
TRV	NOAEL-based TRV (mg/kg/day), Refer to Attacment C, Tables C1 through C5
C_s	Chemical concentration in soil (mg COPEC / kg soil dry weight)
ESL	Ecological Screening Level (refer to Attacment C)

Rearraning the terms for the SLHQ in Equation 7, an Ecological Screening Level (ESL) was derived for comparison to chemical concentrations in soil. Equation 8. For the Tier 1 assessment, the maximum detected site concentration is applies as the chemical concentration in soil. Attachment C, Tables C-1 through C-5, contain the Tier 1 ESLs for the deer mouse, horned lark, kit fox, red-tailed hawk, and pronghorn antelope.

Equation 8 Use of the ESLs to Determine the SLHQ

$$SLHQ = \frac{C_s}{ESL}$$

Parameter	Definition (Units)
SLHQ	Screening-level hazard quotient (unitless)
C_s	Chemical concentration in soil (mg COPEC / kg soil dry weight)

ESL	Ecological Screening Level (refer to Attacment C, Table C1 through C5))

HQs are calculated for each receptor and each COPEC. For each receptor, additive risk must be evaluated. For the initial screening assessment, it is assumed that all COPECs have equal potential risk to the receptor. The overall hazard index (HI) is then calculated for each receptor using Equation 9:

$$HI = HQ_x + HQ_Y + \ldots + HQ_z \qquad \text{Equation 9}$$

Where:

HI = Hazard Index (unitless)
HQ_x = Hazard quotient for each COPEC (unitless)

NMED applies a target risk level for ecological risk assessments of 1.0. If the HI for any receptor is above this target risk level, then there is a potential for adverse effects on ecological receptors and additional evaluation following the Tier 2 SLERA process is required.

As with all risk assessments, the SLERA should include a discussion of the uncertainties. More detailed information may be found in the *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Risk Assessment (NMED, 2014).*

4.0 TIER 2 SLERA

The Tier 2 exposure assessment will consist of calculating refined estimates of exposure doses which will utilize exposure assumptions that are more realistic. The following assumptions will apply to Tier 2 exposure doses:

- Exposure Point Concentration (EPC) – 95 % upper confidence level of the mean (UCLs) will be utilized as the EPC (if sufficient data are available – refer to Volume I for determination of EPCs and UCLs).
- AUF – Site-specific value between 0 and 1, based on the ratio of the exposure area (size of SWMU or corrective action site) to the receptor's average home range size, as shown in Equation 1; if a receptor's home range size is less than the exposure area, a value of 1 will be assumed.

$$AUF = \frac{Exposure\ Area\ of\ Site\ (acres)}{Average\ Home\ Range\ (acres)} \qquad \textbf{Equation 10}$$

- Bioavailability – It will be assumed that the bioavailability is 100% at each site.
- Body weight – The average reported adult body weight will be applied.
- Ingestion rate – The average reported ingestion rate will be applied.
- Dietary composition – Receptor-specific percentages of plant, animal, and soil matter will be considered. Concentrations of COPECs in dietary elements (plant and animal matter) will be predicted by the use of bio-uptake and bioaccumulation modeling.

- Wet-weight to dry-weight conversion factor – Because body weight is reported as wet-weight (kg), and soil concentrations are reported as dry-weight (mg/kg), a wet-weight to dry-weight conversion factor will also be applied when calculating exposure doses.

The Tier 2 exposure doses for wildlife receptors will include one, two or all three of the following elements, depending on the receptor being evaluated: 1) ingestion of plant matter; 2) ingestion of animal (or invertebrate) matter; and 3) incidental ingestion of soil. Bio-uptake and bioaccumulation modeling will be utilized to predict the concentrations of COPECs in plants and animal/invertebrate matter that could be ingested by wildlife receptors. Evaluation of surface and/or groundwater should be discussed with NMED.

Plant uptake factors (PUFs) will be used to predict the concentrations of COPECs in plants. The PUFs for inorganic constituents are summarized in Table 1. For organic COPECs, the PUFs are based on the octanol-water partition coefficient (K_{ow}), which will be obtained from US EPA databases or primary literature.

If a PUF is not available, then a value of one (1) will be applied which assumes 100% assimilation. The equation and variables that will be used to predict COPEC concentrations in plants are shown in Equation 11.

Equation 11. Calculation of COPEC Concentrations in Plants

$$C_{plant} = C_{soil} \times PUF$$

Parameter	Definition (Units)	Value
C_{plant}	COPEC concentration in plant (mg/kg dry weight)	Calculated
C_{soil}	Concentration of COPEC in soil (EPC) (mg/kg dry weight)	Site-specific
PUF	Plant-uptake factor (unitless)	For inorganics (see Table 1) For organic constituents (Travis and Arms, 1988): PUF = 1.588 – 0.578 log K_{ow} K_{ow}- obtain from EPA, 2011b or most current

Table 1. Plant Uptake Factors for Inorganics

Analyte	Plant Uptake Factor (PUF)	Analyte	Plant Uptake Factor (PUF)
Aluminum	4.0E-03	Magnesium	1.0E+00
Antimony	2.0E-01	Manganese	2.5E-01
Arsenic	4.0E-02	Mercury	9.0E-01
Barium	1.5E-01	Molybdenum	2.5E-01
Beryllium	1.0E-02	Nickel	6.0E-02

Analyte	Plant Uptake Factor (PUF)	Analyte	Plant Uptake Factor (PUF)
Boron	4.0E+00	Potassium	1.0E+00
Cadmium	5.5E-01	Selenium	2.5E-02
Calcium	3.5E+00	Silver	4.0E-01
Chromium	7.5E-03	Sodium	7.5E-02
Cobalt	2.0E-02	Thallium	4.0E-03
Copper	4.0E-01	Tin	3.0E-02
Iron	4.0E-03	Vanadium	5.5E-03
Lead	4.5E-02	Zinc	1.5E+00
From Baes, *et.al,* 1994			

Concentrations of COPECs in animal matter (invertebrates and prey species) will be predicted by applying bioaccumulation or biomagnification factors (BAFs). The BAFs will be selected from primary literature sources. If BAF data are not available, a default value of 1 will be used, which will conservatively assume 100% assimilation. Methodology for determining BAFs for soil to plants, soil to earthworms, and soil to small mammals may be found in US EPA (2003(b) and 2005). The equation and variables for predicting concentrations in animal matter are shown in Equation 12.

Equation 12. Calculation of COPEC Concentrations in Prey

$$C_{prey} = C_{soil} \times BAF$$

Parameter	Definition (Units)	Value
C_{prey}	COPEC concentration in prey (mg/kg dry weight)	Calculated
C_{soil}	Concentration of COPEC in soil (EPC) (mg/kg dry weight)	Site-specific
BAF	Bioaccumulation/Biomagnification factor	Chemical-specific (see US EPA 2003(b) and 2005)

The equation and exposure assumptions that will be used to calculate the Tier 2 exposure doses for the deer mouse are shown in Equation 13.

Equation 13. Calculation of Tier 2 Exposure Dose for COPECs in Soil; Deer Mouse

$$Exposure\ Dose = \frac{\left[\left(C_{plant} \times \frac{IR_{plant}}{ww:dw}\right) + \left(C_{invert} \times \frac{IR_{invert}}{1/ww:dw}\right) + (C_{soil} \times IR_{soil} \times ST) \times AUF\right]}{BW}$$

Parameter	Definition (Units)	Value	Reference

Exposure dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	Calculated	--
C_{plant}	COPEC concentration in plants (mg final COPEC/kg plant dry weight)	Calculated	See Equation 11
IR_{total}	Receptor-specific average ingestion rate based on total dietary intake (kg wet weight/day)	0.004	US EPA 1993b
IR_{plant}	Receptor-specific plant-matter ingestion rate (kg food wet weight/day)	0.003	Based on an average ingestion rate of 0.004 kg/day (US EPA, 1993b) and a diet of 74% plant matter (OEHHA, 1999)
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
C_{invert}	Invertebrate EPC (mg final COPEC/kg invertebrate dry weight)	Calculated	See Equation 12
IR_{invert}	Receptor-specific animal matter ingestion rate (kg food wet weight/day)	0.001	Based on an average ingestion rate of 0.004 kg/day (US EPA, 1993b) and a diet of 26% invertebrate matter (OEHHA, 1999)
C_{soil}	Surface-soil EPC (mg final COPEC/kg soil dry weight)	Site-specific	95% UCL if available, or maximum (0-0.5 ft bgs)
IR_{soil}	Receptor-specific incidental soil ingestion rate (kg soil dry weight/day)	0.000018	Based on < 2% (Beyer et. al, 1994); Average ingestion rate of (0.004 kg/day wet weight * 0.22 ww:dw) * 2%.
ST	Bioavailability factor for constituents ingested in soil (assumed to be 1.0 for all constituents)	1.0	Conservative default (assume 100% bioavailability)
AUF	area use factor (maximum value = 1); ratio of area of site to average receptor foraging range (0.3 acres for deer mouse)	Site-specific	US EPA, 1993b
BW	average adult body weight (kg)	0.02	CDW, 2011

The equation and exposure assumptions that will be used to calculate the Tier 2 exposure doses for the horned lark are shown in Equation 14.

Equation 14. Calculation of Tier 2 Exposure Dose for COPECs in Soil; Horned Lark

$$Exposure\ Dose = \frac{\left[\left(C_{plant} \times \frac{IR_{plant}}{ww:dw}\right) + \left(C_{invert} \times \frac{IR_{invert}}{1/ww:dw}\right) + (C_{soil} \times IR_{soil} \times ST) \times AUF\right]}{BW}$$

Parameter	Definition (Units)	Value	Reference
Exposure dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	Calculated	--
C_{plant}	COPEC concentration in plants (mg final	Calculated	See Equation 11

	COPEC/kg plant dry weight)		
IR_{total}	Receptor-specific average ingestion rate based on total dietary intake (kg food wet weight/day)	0.035	US EPA 1993b; based on average ingestion rate for American robin adjusted for horned lark body weight.
IR_{plant}	Receptor-specific plant-matter ingestion rate (kg food wet weight/day)	0.026	Based on average ingestion rate of 0.035 kg/day (US EPA 1993b) and a diet of 75% plant matter (Doctor, *et* al, 2000) and US EPA, 1993b
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
C_{invert}	Invertebrate EPC (mg final COPEC / kg invertebrate dry weight)	Site-specific	See Equation 12
IR_{invert}	Receptor-specific animal matter ingestion rate (kg food wet weight/day)	0.009	Based on average ingestion rate of 0.035 kg/day (US EPA 1993b) and a diet of 25% invertebrates (Doctor, et al, 2000) and US EPA, 1993b
C_{soil}	Surface-soil EPC (mg final COPEC / kg soil dw)	Site-specific	95% UCL if available, or maximum (0-0.5 ft bgs)
IR_{soil}	Receptor-specific incidental soil ingestion rate (kg/day dry weight)	0.00077	Based on 10% (Baer, *et al*, 1994). Average ingestion rate of (0.035 kg/day (wet weight) * 0.22 ww:dw) * 10%).
ST	Bioavailability factor for constituents ingested in soil (assumed to be 1 for all constituents)	1	Conservative default (assume 100% bioavailability)
AUF	Area use factor (maximum value = 1); ratio of area of site to average receptor foraging range (4 acres for horned lark)	Area of site (acres) / 4 acres	Beason, 1995
BW	Average adult body weight (kg)	0.033	Trost, 1972

The equation and exposure assumptions that will be used to calculate the Tier 2 exposure doses for the kit fox are shown in Equation 15.

Equation 15. Calculation of Tier 2 Exposure Dose for COPECs in Soil; Kit Fox

$$Exposure\ Dose = \frac{\left[\left(C_{prey} \times \frac{IR_{prey}}{1/ww:dw}\right) + (C_{soil} \times IR_{soil} \times ST) \times AUF\right]}{BW}$$

Parameter	Definition (Units)	Value	Reference
Exposure dose	Estimated receptor-specific contaminant intake	Calculated	--

	(mg/kg of body weight/day)		
C_{prey}	Prey EPC (mg final COPEC / kg prey dry weight)	Calculated	See Equation 12
IR_{prey}	Receptor-specific animal matter ingestion rate (kg food wet weight/day)	0.13	Based on an average ingestion rate of 0.13 kg/day (OEHHA, 2003) and a diet of 100% animal matter
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
C_{soil}	Surface and subsurface-soil (0-10 ft bgs) EPC (mg final COPEC / kg soil dw)	Site-specific	95% UCL if available, or maximum (0-10 ft bgs)
IR_{soil}	Receptor-specific incidental soil ingestion rate (kg soil dry weight/day)	0.0008	Based on 2.8% (Beyer et.al., 1994). Average ingestion rate of (0.13 kg/day (wet weight) *0.22 ww:dw) * 2.8%).
ST	Bioavailability factor for constituents ingested in soil (assumed to be 1for all constituents)	1	Conservative default (assume 100% bioavailability)
AUF	Area use factor (maximum value = 1); ratio of area of site to average receptor foraging range (1713 acres for kit fox)	Site-specific	--
BW	Average adult body weight (kg)	2.0	OEHHA, 2003

The equation and exposure assumptions that will be used to calculate the Tier 2 exposure doses for the red-tailed hawk are shown in Equation 16.

Equation 16. Calculation of Tier 2 Exposure Dose for COPECs in Soil; Red-Tailed Hawk

$$Exposure\ Dose = \frac{\left[\left(C_{prey} \times \frac{IR_{prey}}{1/ww:dw}\right) + (C_{soil} \times IR_{soil} \times ST) \times AUF\right]}{BW}$$

Parameter	Definition (Units)	Value	Reference
Exposure dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	Calculated	--
C_{prey}	Prey EPC (mg final COPEC / kg prey dry weight)	Calculated	See Equation 12
IR_{prey}	receptor-specific animal matter ingestion rate (kg food wet weight/day)	0.1	Based on an average ingestion rate of 0.1 kg/day (US EPA 1993b) and a diet of 100% animal matter
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
C_{soil}	surface-soil EPC (mg final COPEC / kg soil dw)	Site-specific	95% UCL if available, or maximum (0-0.5 ft bgs)
IR_{soil}	receptor-specific incidental soil ingestion rate	0.0004	Based on < 2% (Beyer

	(kg soil dry weight/day)		et. al., 1994). Average ingestion rate of (0.12 kg/day (wet weight) *0.22) * 2%).
ST	bioavailability factor for constituents ingested in soil (assumed to be 1 for all constituents)	1	Conservative default (assume 100% bioavailability)
AUF	area use factor (maximum value = 1); ratio of area of site to average receptor foraging range (1770 acres for red-tailed hawk)	Site-specific	--
BW	average adult body weight (kg)	1.1	US EPA, 1993b

The equation and exposure assumptions that will be used to calculate the Tier 2 exposure doses for the pronghorn are shown in Equation 17.

Equation 17. Calculation of Tier 2 Exposure Dose for COPECs in Soil; Pronghorn

$$Exposure\ Dose = \frac{\left[\left(C_{plant} \times \frac{IR_{plant}}{1/ww:dw}\right) + (C_{soil} \times IR_{soil} \times ST) \times AUF\right]}{BW}$$

Parameter	Definition (Units)	Value	Reference
Exposure dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)	Calculated	--
C_{plant}	COPEC concentration in plants (mg final COPEC/kg plant dry weight)	Calculated	See Equation 11
IR_{plant}	receptor-specific plant-matter ingestion rate (kg food wet weight/day)	1.4	Based on an average ingestion rate of 1.4 kg/day (US FWS, 2005) and a diet of 100% plant matter
ww:dw	Wet-weight to dry weight conversion factor for ingested matter	0.22	78-percent moisture
C_{soil}	surface-soil EPC (mg final COPEC / kg soil dw)		95% UCL if available, or maximum (0-0.5 ft bgs)
IR_{soil}	receptor-specific incidental soil ingestion rate (kg soil dry weight/day)	0.006	Based on < 2% (Beyer et. al., 1994). Average ingestion rate of (1.4 kg/day (wet weight) * 0.22 ww:dw) * 2%).
ST	bioavailability factor for constituents ingested in soil (assumed to be 1.0 for all constituents)	1	Conservative default (assume 100% bioavailability)
AUF	area use factor (maximum value = 1); ratio of area of site to average receptor foraging range (3422 acres for pronghorn)	Site-specific	Zoellick & Smith, 1992
BW	Average adult body weight (kg)	50	O'Gara, 1978

4.1.1 Toxicity Assessment – Tier 2

The Tier 2 TRVs will be based on LOAELs. The LOAEL will be used as it is more representative of population risks. Attachment C, Tables C1 through C6 lists Tier 2 TRVs for select constituents for each of the key ecological receptors.

4.1.2 Risk Characterization – Tier 2

Risk characterization for Tier 2 will be conducted by calculating HQs for plant and wildlife receptors using a similar method as in the Tier 1 SLERA. The equation and assumptions for calculating the Tier 2 HQs for wildlife receptors are shown in Equation 18.

Equation 18. Calculation of Tier 2 Hazard Quotients for Wildlife Receptors

$$HQ = \frac{Dose}{TRV}$$

Parameter	Definition (Units)
HQ	Hazard quotient (unitless)
Dose	Estimated receptor-specific contaminant intake (mg/kg of body weight/day)
TRV	Toxicity reference value (mg/kg/day) based on lowest observed adverse effects level (LOAEL), Refer to Attachment C

For plants, a qualitative discussion of the potential for adverse risk will be provided in the assessment. Comparison of TRVs to soil concentrations based on the 95% UCL may be provided.

Summation of HQs will be added for COPECs that have a similar receptor-specific mode of toxicity. If the Tier 2 HI is less than one, adverse ecological effects are not expected and no further action will be taken.

For sites that have an HI equal to or greater than one, the site may require: 1) additional evaluation under a weight-of-evidence analysis; 2) a Tier 3 ERA; or 3) a corrective measures study.

Per US EPA (1997c), Tier 2 ecological risk characterization should include a discussion of the uncertainties since many assumptions may or may not accurately reflect site conditions. Therefore, a discussion of the uncertainties associated with the Tier 2 SLERA will be included in the report.

5.0 TIER 3: PHASE II - QUANTITATIVE ASSESSMENT

In the event that the SLERA does not show that levels of contamination in the impacted media are below the target level of 1.0, additional quantitative analyses may be warranted. This may include incorporation of biota studies to evaluate impact at the site. NMED should be consulted prior to conducting a Tier 3 assessment.

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ATTACHMENT A
SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT
SCOPING ASSESSMENT
SITE ASSESSMENT CHECKLIST

INTRODUCTION

This checklist has been developed as a tool for gathering information about the facility property and surrounding areas, as part of the scoping assessment. Specifically, the checklist assists in the compilation of information on the physical and biological aspects of the site including the site environmental setting, usage of the site, releases at the site, contaminant fate and transport mechanisms, and the area's habitats, receptors, and exposure pathways. The completed checklist can then be used to construct the preliminary conceptual site exposure model (PCSEM) for the site. In addition, the checklist and PCSEM will serve as the basis for the scoping assessment report. Section III of this document provides further information on using the completed checklist to develop the PCSEM.

In general, the checklist is designed for applicability to all sites; however, there may be unusual circumstances which require professional judgment in order to determine the need for further ecological evaluation (*e.g.,* cave-dwelling receptors). In addition, some of the questions in the checklist may not be relevant to all sites. Some facilities may have large amounts of data available regarding contaminant concentrations and hydrogeologic conditions at the site, while other may have only limited data. In either case, the questions on the checklist should be addressed as completely as possible with the information available.

Habitats and receptors, which may be present at the site, can be identified by direct or indirect[36] observations and by contacting local and regional natural resource agencies. Habitat types may be determined by reviewing land use and land cover maps (LULC), which are available via the Internet at http://www.nationalatlas.gov/mapit.html. With regard to receptors, it should be noted that receptors are often present at a site even when they are not observed. Therefore, for the purposes of this checklist, it should be assumed that receptors are present if viable habitat is present. The presence of receptors should be confirmed by contacting one or several of the organizations listed below.

Sources of general information available for the identification of ecological receptors and habitats include:

- U.S. Fish and Wildlife Service (http://www.fws.gov)
- Biota Information System of New Mexico (BISON-M) maintained by the New Mexico Department of Game and Fish (NMGF) (http://151.199.74.229/states/nm.htm)
- U.S. Forest Service (USFS) (http://www.fs.fed.us/)
- New Mexico Forestry Division (NMFD) of the Energy, Minerals and Natural Resources Department (http://www.emnrd.state.nm.us/forestry/index.htm)
- U.S. Bureau of Land Management (USBLM) (http://www.blm.gov/nhp/index.htm) or (http://www.nm.blm.gov/www/new_home_2.html)
- United States Geological Service (USGS) (http://www.usgs.gov)

36 Examples of indirect observations that indicate the presence of receptors include: tracks, feathers, burrows, scat

- National Wetland Inventory Maps (http://wetlands.fws.gov)
- National Audubon Society (http://www.audobon.com)
- National Biological Information Infrastructure (http://biology.usgs.gov)
- Sierra Club (http://www.sierraclub.org)
- National Geographic Society (http://www.nationalgeographic.com)
- New Mexico Natural Heritage Program (http://nmnhp.unm.edu/)
- State and National Parks System
- Local universities
- Tribal organizations

INSTRUCTIONS FOR COMPLETING THE CHECKLIST

The checklist consists of four sections: Site Location, Site Characterization, Habitat Evaluation, and Exposure Pathway Evaluation. Answers to the checklist should reflect existing conditions and should not consider future remedial actions at the site. Completion of the checklist should provide sufficient information for the preparation of a PCSEM and scoping report and allow for the identification of any data gaps.

Section I - Site Location, provides general site information, which identifies the facility being evaluated, and gives specific location information. Site maps and diagrams, which should be attached to the completed checklist, are an important part of this section. The following elements should be clearly illustrated: 1) the location and boundaries of the site relative to the surrounding area, 2) any buildings, structures or important features of the facility or site, and 3) all ecological areas or habitats identified during completion of the checklist. It is possible that several maps will be needed to clearly and adequately illustrate the required elements. Although topographical information should be illustrated on at least one map, it is not required for every map. Simplified diagrams (preferably to scale) of the site and surrounding areas will usually suffice.

Section II - Site Characterization, is intended to provide additional temporal and contextual information about the site, which may have an impact on determining whether a certain area should be characterized as ecologically viable habitat or contains receptors. Answers to the questions in Section II will help the reviewer develop a broader and more complete evaluation of the ecological aspects of a site.

Section III - Habitat Evaluation, provides information regarding the physical and biological characteristics of the different habitat types present at or in the locality of the site. Aquatic features such as lakes, ponds, streams, arroyos and ephemeral waters can be identified by reviewing aerial photographs, LULC and topographic maps and during site reconnaissance visits. In New Mexico, there are several well-defined terrestrial communities, which occur naturally. Typical communities include wetlands, forest (e.g., mixed conifer, ponderosa pine and pinyon juniper), scrub/shrub, grassland, and desert. Specific types of vegetation characterize each of these communities and can be used to identify them. Field guides are often useful for identifying vegetation types. A number of sites may be in areas that have been disturbed by human activities and may no longer match any of the naturally occurring communities typical of the southwest.

Particularly at heavily used areas at facilities, the two most common of these areas are usually described as "weed fields" and "lawn grass". Vegetation at "weed fields" should be examined to determine whether the weeds consist primarily of species native to the southwest or introduced species such as Kochia. Fields of native weeds and lawn grass are best evaluated using the short grass prairie habitat guides.

The applicable portions of Section III of the checklist should be completed for each individual habitat identified. For example, the questions in Section III.A of the checklist should be answered for each wetland area identified at or in the locality of the site and the individual areas must be identified on a map or maps.

Section IV- Exposure Pathway Evaluation is used to determine if contaminants at the site have the potential to impact habitat identified in Section III. An exposure pathway is the course a chemical or physical agent takes from a source to an exposed organism. Each exposure pathway includes a source (or release from a source), an environmental transport mechanism, an exposure point, and an exposure route. A complete exposure pathway is one in which each of these components, as well as a receptor to be exposed, is present. Essentially, this section addresses the fate and transport of contaminants that are known or suspected to have been released at the site. In most cases, without a complete exposure pathway between contaminants and receptors, additional ecological evaluation is not warranted.

Potential transport pathways addressed in this checklist include migration of contaminants via air dispersion, leaching into groundwater, soil erosion/runoff, groundwater discharge to surface water, and irradiation. Due to New Mexico's semi-arid climate, vegetation is generally sparse. The sparse vegetation, combined with the intense nature of summer storms in New Mexico, results in soil erosion that occurs sporadically over a very brief time frame. Soil erosion may be of particular concern for sites located in steeply sloped areas. Several questions within Section IV of this checklist have been developed to aid in the identification of those sites where soil erosion/runoff would be an important transport mechanism.

USING THE CHECKLIST TO DEVELOP THE PRELIMINARY CONCEPTUAL SITE EXPOSURE MODEL

The completed Site Assessment Checklist can be used to construct the PCSEM. An example PCSEM diagram is presented in Figure 1. The CSM illustrates actual and potential contaminant migration and exposure pathways to associated receptors. The components of a complete exposure pathway are simplified and grouped into three main categories: sources, release mechanisms, and potential receptors. As a contaminant migrates and/or is transformed in the environment, sources and release mechanisms may expand into primary, secondary, and tertiary levels. For example, Figure 1 illustrates releases from inactive lagoons (primary sources) through spills (primary release mechanism), which migrate to surface and subsurface soils (secondary sources), which are then leached (secondary release mechanism) to groundwater (tertiary source). Similarly, exposures of various trophic levels to the contaminant(s) and consequent exposures via the food chain may lead to multiple groups of receptors. For example, Figure 1 illustrates groups of both aquatic and terrestrial receptors which may be exposed and subsequently serve as tertiary release mechanisms to receptors which prey on them.

Although completing the checklist will not provide the user with a readymade PCSEM, a majority of the components of the PCSEM can be found in the answers to the checklist. It is then up to the user to put the pieces together into a comprehensive whole. The answers from Section II of the checklist, Site Characterization, can be used to identify sources of releases. The answers to Section IV, Exposure Pathway Evaluation, will assist users in tracing the migration pathways of releases in the environment, thus helping to identify release mechanisms and sources. The results of Section III, Habitat Evaluation, can be used to both identify secondary and tertiary sources and to identify the types of receptors which may be exposed. Appendix B of the NMED's *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Assessment* also contains sample food webs which may be used to develop the PCSEM.

Once all of the components have been identified, one can begin tracing the steps between the primary releases and the potential receptors. For each potential receptor, the user should consider all possible exposure points (e.g., prey items, direct contact with contaminated soil or water, etc.) then begin eliminating pathways, which are not expected to result in exposure to the contaminant at the site. Gradually, the links between the releases and receptors can be filled in, resulting in potential complete exposure pathways.

For further guidance on constructing a PCSEM, consult the NMED's *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Assessment* (2000), and EPA's Office of Solid Waste and Emergency *Response's Soil Screening Guidance: User's Guide* (1996).

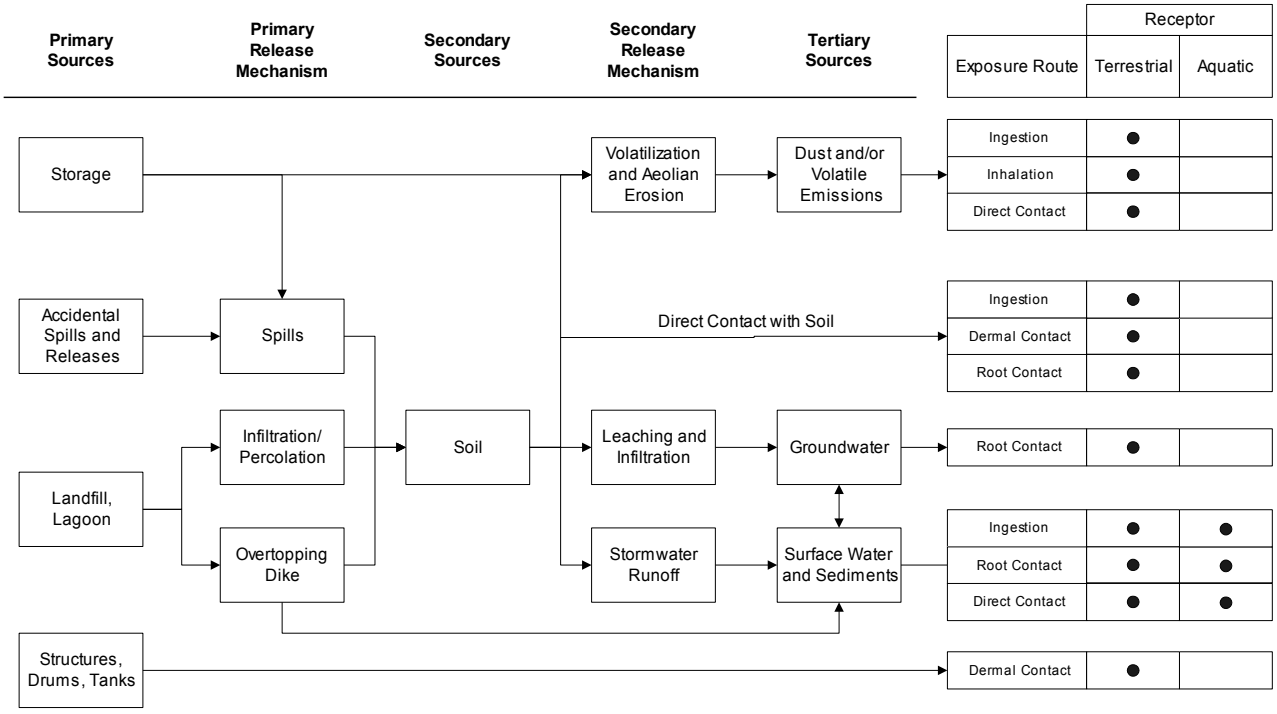


Figure 1. Example Preliminary Conceptual Site Exposure Model Diagram

NEW MEXICO ENVIRONMENT DEPARTMENT
SITE ASSESSMENT CHECKLIST

I. SITE LOCATION

1. Site
   Name:_____
   US EPA I.D.
   Number:_____
   Location:_____
   County:_____
   City:_____State:_____

2. Latitude:_____ Longitude:_____

3. Attach site maps, including a topographical map, a diagram which illustrates the layout of the facility (e.g., site boundaries, structures, etc.), and maps showing all habitat areas identified in Section III of the checklist. Also, include maps which illustrate known release areas, sampling locations, and any other important features, if available.

II. SITE CHARACTERIZATION

1. Indicate the approximate area of the site (i.e., acres or sq. ft)
   _____

2. Provide an approximate breakdown of the land uses on the site:

_____% Heavy Industrial	_____% Light Industrial	_____% Urban
_____% Residential	_____% Rural	_____% Agricultural[b]
_____% Recreational[a]	_____% Undisturbed	_____% Other[c]

[a]For recreational areas, please describe the usage of the area (e.g., park, playing field, etc.):
_____

[b]For agricultural areas, please list the crops and/or livestock which are present:
_____

[c]For areas designated as "other", please describe the usage of the area:
_____

3. Provide an approximate breakdown of the land uses in the area surrounding the site. Indicate the radius (in miles) of the area described: _____

_____% Heavy Industrial	_____% Light Industrial	_____% Urban
_____% Residential	_____% Rural	_____% Agricultural[b]
_____% Recreational[a]	_____% Undisturbed	_____% Other [c]

[a]For recreational areas, please describe the usage of the area (e.g., park, playing field, golf course, etc.):

_____

[b]For agricultural areas, please list the crops and/or livestock which are present:

_____

[c]For areas designated as "other", please describe the usage of the area:

_____
_____

4. Describe reasonable and likely future land and/or water use(s) at the site.

_____
_____
_____
_____
_____
_____

5. Describe the historical uses of the site. Include information on chemical releases that may have occurred as a result of previous land uses. For each chemical release, provide information on the form of the chemical released (i.e., solid, liquid, vapor) and the known or suspected causes or mechanism of the release (i.e., spills, leaks, material disposal, dumping, explosion, etc.).

_____
_____
_____
_____
_____

6. If any movement of soil has taken place at the site, describe the degree of the disturbance. Indicate the likely source of any disturbances (e.g., erosion, agricultural, mining, industrial activities, removals, etc.) and estimate when these events occurred.

_____
_____
_____

7. Describe the current uses of the site. Include information on recent (previous 5 years) disturbances or chemical releases that have occurred. For each chemical release, provide information on the form of the chemical released and the causes or mechanism of the release.

_____
_____
_____
_____
_____

8. Identify the location or suspected location of chemical releases at the site. Provide an estimate of the distance between these locations and the areas identified in Section III.

_____
_____
_____
_____
_____

9. Identify the suspected contaminants of concern (COCs) at the site. If known, include the maximum contaminant levels. Please indicate the source of data cited (e.g., RFI, confirmatory sampling, etc.).

_____
_____
_____
_____
_____
_____

10. Identify the media (e.g., soil (surface or subsurface), surface water, air, groundwater) which are known or suspected to contain COCs._____
_____

11. Indicate the approximate depth to groundwater (in feet below ground surface [(bgs)].

_____

12. Indicate the direction of groundwater flow (e.g., north, southeast, etc.)

_____

III. HABITAT EVALUATION

III.A Wetland Habitats

Are any wetland[37] areas such as marshes or swamps on or adjacent to the site?

☐ Yes ☐ No

If yes, indicate the wetland area on the attached site map and answer the following questions regarding the wetland area. If more than one wetland area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual wetland area. Distinguish between wetland areas by using names or other designations (such as location), and clearly identify each area on the site map. Also, obtain and attach a National Wetlands Inventory Map (or maps) to illustrate each wetland area.

Identify the sources of the observations and information (e.g., National Wetland Inventory, Federal or State Agency, USGS topographic maps) used to make the determination that wetland areas are or are not present.

_____
_____
_____
_____

If no wetland areas are present, proceed to Section III.B.

Wetland Area Questions

☐ Onsite ☐ Offsite

Name or
Designation:_____

1. Indicate the approximate area of the wetland (acres or ft^2)_____

2. Identify the type(s) of vegetation present in the wetland.

- ❑ Submergent (i.e., underwater) vegetation
- ❑ Emergent (i.e., rooted in the water, but rising above it) vegetation
- ❑ Floating vegetation
- ❑ Scrub/shrub

37Wetlands are defined in 40 CFR §232.2 as " Areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Examples of typical wetlands plants include: cattails, cordgrass, willows and cypress trees. National wetland inventory maps may be available at http:\\nwi.fws.gov. Additional information on wetland delineation criteria is also available from the Army Corps of Engineers.

- ❑ Wooded
- ❑ Other (Please describe):_____

3. Estimate the vegetation density of the wetland area.

   - ❑ Dense (i.e., greater than 75% vegetation)
   - ❑ Moderate (i.e., 25% to 75% vegetation)
   - ❑ Sparse (i.e., less than 25% vegetation)

4. Is standing water present? ☐ Yes ☐ No

   If yes, is the water primarily: ☐ Fresh or ☐ Brackish
   Indicate the approximate area of the standing water (ft^2):

   _____
   Indicate the approximate depth of the standing water, if known (ft. or in.)_____

5. If known, indicate the source of the water in the wetland.

   - ❑ Stream/River/Creek/Lake/Pond
   - ❑ Flooding
   - ❑ Groundwater
   - ❑ Surface runoff

6. Is there a discharge from the facility to the wetland? ☐ Yes ☐ No
   If yes, please describe:_____
   _____
   _____
   _____
   _____
   _

Wetland Area Questions (Continued)

7. Is there a discharge from the wetland? ☐ Yes ☐ No
If yes, indicate the type of aquatic feature the wetland discharges into:

- ❑ Surface stream/River (Name:_____)
- ❑ Lake/Pond (Name:_____)
- ❑ Groundwater
- ❑ Not sure

8. Does the area show evidence of flooding? ☐ Yes ☐ No
If yes, indicate which of the following are present (mark all that apply):

- ❑ Standing water
- ❑ Water-saturated soils
- ❑ Water marks
- ❑ Buttressing
- ❑ Debris lines
- ❑ Mud cracks
- ❑ Other (Please describe):_____

9. Animals observed in the wetland area or suspected to be present based on indirect evidence or file material:

- ❑ Birds
- ❑ Fish
- ❑ Mammals
- ❑ Reptiles (e.g., snakes, turtles)
- ❑ Amphibians (e.g., frogs, salamanders)
- ❑ Sediment-dwelling invertebrates (e.g., mussels, crayfish, insect nymphs)

Specify species, if known:

_____
_____
_____
_____

III.B Aquatic Habitats
III.B.1 Non-Flowing Aquatic Features

Are any non-flowing aquatic features (such as ponds or lakes) located at or adjacent to the site?

☐ Yes ☐ No

If yes, indicate the aquatic feature on the attached site map and answer the following questions regarding the non-flowing aquatic features. If more than one non-flowing aquatic feature is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual aquatic feature. Distinguish between aquatic features by using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.B.2.

Non-Flowing Aquatic Feature Questions

☐ Onsite ☐ Offsite

Name or Designation:_____

1. Indicate the type of aquatic feature present:

   - ❑ Natural (e.g., pond or lake)
   - ❑ Man-made (e.g., impoundment, lagoon, canal, etc.)

2. Estimate the approximate size of the water body (in acres or sq. ft.)_____

3. If known, indicate the depth of the water body (in ft. or in.)._____

Non-Flowing Aquatic Feature Questions (Continued)

4. Indicate the general composition of the bottom substrate. Mark all sources that apply from the following list.

☐ Bedrock	☐ Sand	☐ Concrete
☐ Boulder (>10 in.)	☐ Silt	☐ Debris
☐ Cobble (2.5 - 10 in.)	☐ Clay	☐ Detritus
☐ Gravel (0.1 - 2.5 in.)	☐ Muck (fine/black)	

☐ Other (please specify):_____

5. Indicate the source(s) of the water in the aquatic feature. Mark all sources that apply from the following list.

- ❑ River/Stream/Creek
- ❑ Groundwater
- ❑ Industrial Discharge
- ❑ Surface Runoff
- ❑ Other (please specify):_____

6. Is there a discharge from the facility to the aquatic feature? ☐ Yes ☐ No

If yes, describe the origin of each discharge and its migration path:

_____
_____
_____
_____

7. Does the aquatic feature discharge to the surrounding environment? ☐ Yes ☐ No

If yes, indicate the features from the following list into which the aquatic feature discharges, and indicate whether the discharge occurs onsite or offsite:

- ❑ River/Stream/Creek ☐ onsite ☐ offsite
- ❑ Groundwater ☐ onsite ☐ offsite
- ❑ Wetland ☐ onsite ☐ offsite
- ❑ Impoundment ☐ onsite ☐ offsite
- ❑ Other (please describe)_____

Non-Flowing Aquatic Feature Questions (Continued)

8. Animals observed in the vicinity of the aquatic feature or suspected to be present based on indirect evidence or file material:

   - ❑ Birds
   - ❑ Fish
   - ❑ Mammals
   - ❑ Reptiles (e.g., snakes, turtles)
   - ❑ Amphibians (e.g., frogs, salamanders)
   - ❑ Sediment-dwelling invertebrates (e.g., mussels, crayfish, insect nymphs)

   Specify species, if known:

   _____
   _____
   _____
   _____

III.B.2 Flowing Aquatic Features

Are any flowing aquatic features (such as streams or rivers) located at or adjacent to the site?

☐ Yes ☐ No

If yes, indicate the aquatic feature on the attached site map and answer the following questions regarding the flowing aquatic features. If more than one flowing aquatic feature is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual aquatic feature. Distinguish between aquatic features by using names or other designations, and clearly identify each area on the site map

If no, proceed to Section III.C.

Flowing Aquatic Feature Questions

☐ Onsite ☐ Offsite

Name or Designation:_____

1. Indicate the type of flowing aquatic feature present.

   - ❑ River
   - ❑ Stream
   - ❑ Creek
   - ❑ Brook
   - ❑ Dry wash
   - ❑ Arroyo
   - ❑ Intermittent stream
   - ❑ Artificially created (ditch, etc.)
   - ❑ Other (specify)
   - ❑

2. Indicate the general composition of the bottom substrate.

☐ Bedrock	☐ Sand	☐ Concrete
☐ Boulder (>10 in.)	☐ Silt	☐ Debris
☐ Cobble (2.5 - 10 in.)	☐ Clay	☐ Detritus
☐ Gravel (0.1 - 2.5 in.)	☐ Muck (fine/black)	

   ☐ Other (please specify):_____

3. Describe the condition of the bank (e.g., height, slope, extent of vegetative cover) of the aquatic feature.

   _____
   _____
   _____
   _____

4. Is there a discharge from the facility to the aquatic feature? ☐ Yes ☐ No
   If yes, describe the origin of each discharge and its migration path:

   _____
   _____
   _____
   _____

5. Indicate the discharge point of the water body. Specify name, if known.

Flowing Aquatic Feature Questions (Continued)

6. If the flowing aquatic feature is a dry wash or arroyo, answer the following questions.
   - ❑Check here if feature is not a dry wash or arroyo

   If known, specify the average number of days in a year in which flowing water is present in the feature: _____

   Is standing water or mud present? Check all that apply.
   - ❑Standing water
   - ❑Mud
   - ❑Neither standing water or mud

   Does the area show evidence of recent flow (e.g., flood debris clinging to vegetation)?
   - ❑Yes
   - ❑No
   - ❑Not sure
7. Animals observed in the vicinity of the aquatic feature or suspected to be present based on indirect evidence or file material:

   - ❑ Birds
   - ❑ Fish
   - ❑ Mammals
   - ❑ Reptiles (e.g., snakes, turtles)
   - ❑ Amphibians (e.g., frogs, salamanders)
   - ❑ Sediment-dwelling invertebrates (e.g., mussels, crayfish, insect nymphs)

   Specify species, if known:

   _____
   _____
   _____
   _____

III.C Terrestrial Habitats
III.C.1 Wooded

Are any wooded areas on or adjacent to the site? ☐ Yes ☐ No

If yes, indicate the wooded area on the attached site map and answer the following questions. If more than one wooded area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual wooded area. Distinguish between wooded areas by using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.C.2.

Wooded Area Questions

☐ On-site ☐ Off-site

Name or Designation:_____

1. Estimate the approximate size of the wooded area (in acres or sq. ft.)_____

2. Indicate the dominant type of vegetation in the wooded area.

   - ❑ Evergreen
   - ❑ Deciduous
   - ❑ Mixed

   Dominant plant species, if known:_____

3. Estimate the vegetation density of the wooded area.

   ❑Dense (i.e., greater than 75% vegetation)
   ❑Moderate (i.e., 25% to 75% vegetation)
   ❑Sparse (i.e., less than 25% vegetation)

4. Indicate the predominant size of the trees at the site. Use diameter at chest height.

   - ❑ 0-6 inches
   - ❑ 6-12 inches
   - ❑ >12 inches
   - ❑ No single size range is predominant

5. Animals observed in the wooded area or suspected to be present based on indirect evidence or file material:

   - ❑ Birds
   - ❑ Mammals
   - ❑ Reptiles (e.g., snakes, lizards)
   - ❑ Amphibians (e.g., toads, salamanders)

   Specify species, if known:

   _____
   _____
   _____
   _____

III.C.2 Shrub/Scrub

Are any shrub/scrub areas on or adjacent to the site? ☐ Yes ☐ No

If yes, indicate the shrub/scrub area on the attached site map and answer the following questions. If more than one shrub/scrub area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual shrub/scrub area. Distinguish between shrub/scrub areas, using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.C.3.

Shrub/Scrub Area Questions

☐ Onsite ☐ Offsite

Name or Designation:_____

1. Estimate the approximate size of the shrub/scrub area (in acres or sq. ft.)._____

2. Indicate the dominant type of shrub/scrub vegetation present, if known.

_____
_____
_____
_____

3. Estimate the vegetation density of the shrub/scrub area.

   - ❑ Dense (i.e., greater than 75% vegetation)
   - ❑ Moderate (i.e., 25% to 75% vegetation)
   - ❑ Sparse (i.e., less than 25% vegetation)

4. Indicate the approximate average height of the scrub/shrub vegetation.

   - ❑ 0-2 feet
   - ❑ 2-5 feet
   - ❑ >5 feet

5. Animals observed in the shrub/scrub area or suspected to be present based on indirect evidence or file material:
   ❑Birds
   ❑Mammals
   ❑Reptiles (e.g., snakes, lizards)
   ❑Amphibians (e.g., toads, salamanders)

   Specify species, if known:

_____
_____
_____
_____

III.C.3 Grassland

Are any grassland areas on or adjacent to the site? ☐ Yes ☐ No

If yes, indicate the grassland area on the attached site map and answer the following questions. If more than one grassland area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual grassland area. Distinguish between grassland areas by using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.C.4.

Grassland Area Questions

☐ Onsite ☐ Offsite

Name or Designation:_____

1. Estimate the approximate size of the grassland area (in acres or sq. ft.)._____

2. Indicate the dominant plant type, if known.

_____
_____
_____
_____

3. Estimate the vegetation density of the grassland area.

- ❑ Dense (i.e., greater than 75% vegetation)
- ❑ Moderate (i.e., 25% to 75% vegetation)
- ❑ Sparse (i.e., less than 25% vegetation)

4. Indicate the approximate average height of the dominant plant type (in ft. or in.)_

5. Animals observed in the grassland area or suspected to be present based on indirect evidence or file material:

❑Birds
❑Mammals
❑Reptiles (e.g., snakes, lizards)
❑Amphibians (e.g., toads, salamanders)

Specify species, if known:

III.C.4 Desert

Are any desert areas on or adjacent to the site? ☐ Yes ☐ No

If yes, indicate the desert area on the attached site map and answer the following questions. If more than one desert area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual desert area. Distinguish between desert areas by using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.C.5.

Desert Area Questions

☐ Onsite ☐ Offsite

Name or Designation:_____

1. Estimate the approximate size of the desert area (in acres or sq. ft.)._____

2. Describe the desert area (e.g., presence or absence of vegetation, vegetation types, presence/size of rocks, sand, etc.)

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

3. Animals observed in the desert area or suspected to be present based on indirect evidence or file material:

❑Birds
❑Mammals
❑Reptiles (e.g., snakes, lizards)
❑Amphibians (e.g., toads, salamanders)

Specify species, if known:

_____

III.C.5 Other

1. Are there any other terrestrial communities or habitats on or adjacent to the site which were not previously described?

☐ Yes ☐ No

If yes, indicate the "other" area(s) on the attached site map and describe the area(s) below. Distinguish between onsite and offsite areas. If no, proceed to Section III.D.

III.D Sensitive Environments and Receptors

1. Do any other potentially sensitive environmental areas[38] exist adjacent to or within 0.5 miles of the site? If yes, list these areas and provide the source(s) of information used to identify sensitive areas. *Do not answer "no" without confirmation from the U.S. Fish and Wildlife Service and appropriate State of New Mexico division.*

3 Areas that provide unique and often protected habitat for wildlife species. These areas are typically used during critical life stages such as breeding, hatching, rearing of young and overwintering. Refer to **Table 1** at the end of this document for examples of sensitive environments.

2. Are any areas on or near (i.e., within 0.5 miles) the site which are owned or used by local tribes? If yes, describe. *Contact the Tribal Liaison in the Office of the Secretary (505)827-2855 to obtain this information.*

4. Does the site serve or potentially serve as a habitat, foraging area, or refuge by rare, threatened, endangered, candidate and/or proposed species (plants or animals), or any otherwise protected species? If yes, identify species. *This information should be obtained from the U.S. Fish and Wildlife Service and appropriate State of New Mexico division.*

5. Is the site potentially used as a breeding, roosting or feeding area by migratory bird species? If yes, identify which species.

6. Is the site used by any ecologically[39], recreationally, or commercially important

39 Ecologically important species include populations of species which provide a critical (i.e., not replaceable) food resource for higher organisms and whose function as such would not be replaced by more tolerant species; or perform a critical ecological function (such as organic matter decomposition) and whose functions will not be replaced by other species. Ecologically important species include pest and opportunistic species that populate an area if they serve as a food source for other species, but do not include domesticated animals (e.g., pets and livestock) or plants/animals whose existence is maintained by continuous human interventions (e.g., fish hatcheries, agricultural crops, etc.,)

species? If yes, explain.

_____
_____
_____
_____
_____

IV. EXPOSURE PATHWAY EVALUATION

1. Do existing data provide sufficient information on the nature, rate, and extent of contamination at the site?

   - ❑ Yes
   - ❑ No
   - ❑ Uncertain

   Please provide an explanation for your answer:_____

_____
_____
_____
_____

2. Do existing data provide sufficient information on the nature, rate, and extent of contamination in offsite affected areas?

   - ❑ Yes
   - ❑ No
   - ❑ Uncertain
   - ❑ No offsite contamination

   Please provide an explanation for your answer:_____

_____
_____
_____
_____

3. Do existing data address potential migration pathways of contaminants at the site?

   - ❑ Yes
   - ❑ No
   - ❑ Uncertain

Please provide an explanation for your answer:_____

_

_____

_____

_____

_____

4. Do existing data address potential migration pathways of contaminants in offsite affected areas?

   - ❑ Yes
   - ❑ No
   - ❑ Uncertain
   - ❑ No offsite contamination

   Please provide an explanation for your answer:_____

_____
_____
_____
_____

5. Are there visible indications of stressed habitats or receptors on or near (i.e., within 0.5 miles) the site that may be the result of a chemical release? If yes, explain. Attach photographs if available.

   _____

_____
_____
_____
_____
_____

6. Is the location of the contamination such that receptors might be reasonably expected to come into contact with it? For soil, this means contamination in the soil 0 to 5 feet below ground surface (bgs). If yes, explain.

   _____

_____
_____
_____
_____
_____
_____

7. Are receptors located in or using habitats where chemicals exist in air, soil, sediment or surface water? If yes, explain.

   _____

_____
_____
_____
_____

8. Could chemicals reach receptors via groundwater? Can chemicals leach or dissolve to groundwater? Are chemicals mobile in groundwater? Does groundwater discharge into receptor habitats? If yes, explain.

_____
_____
_____
_____
_____
_____
_____

9. Could chemicals reach receptors through runoff or erosion? Answer the following questions:

   What is the approximate distance from the contaminated area to the nearest watercourse or arroyo?

   - ❑ 0 feet (i.e., contamination has reached a watercourse or arroyo)
   - ❑ 1-10 feet
   - ❑ 11-20 feet
   - ❑ 21-50 feet
   - ❑ 51-100 feet
   - ❑ 101-200 feet
   - ❑ > 200 feet
   - ❑ > 500 feet
   - ❑ > 1000 feet

   What is the slope of the ground in the contaminated area?

   - ❑ 0-10%
   - ❑ 10-30%
   - ❑ > 30%

   What is the approximate amount of ground and canopy vegetative cover in the contaminated area?

   - ❑ < 25%
   - ❑ 25-75%
   - ❑ > 75%

   Is there visible evidence of erosion (e.g., a rill or gully) in or near the contaminated area?

   - ❑ Yes
   - ❑ No
   - ❑ Do not know

Do any structures, pavement, or natural drainage features direct run-on flow (i.e., surface flows originating upstream or uphill from the area of concern) into the contaminated area?

- ❑ Yes
- ❑ No
- ❑ Do not know

10. Could chemicals reach receptors through the dispersion of contaminants in air (e.g., volatilization, vapors, fugitive dust)? If yes, explain.

11. Could chemicals reach receptors through migration of non-aqueous phase liquids (NAPLs)? Is a NAPL present at the site that might be migrating towards receptors or habitats? Could NAPL discharge contact receptors or their habitat?

12. Could receptors be impacted by external irradiation at the site? Are gamma emitting radionuclides present at the site? Is the radionuclide contamination buried or at the surface?

PHOTOGRAPHIC DOCUMENTATION

During the site visit(s), photographs should be taken to document the current conditions at the site and to support the information entered in the checklist. For example, photographs may be used to document the following:

- The nature, quality, and distribution of vegetation at the site
- Receptors or evidence of receptors
- Potentially important ecological features, such as ponds and drainage ditches
- Potential exposure pathways
- Any evidence of contamination or impact

The following space may be used to record photo subjects.

SUMMARY OF OBSERVATIONS AND SITE SETTING

Include information on significant source areas and migration pathways that are likely to constitute complete exposure pathways.

_____

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Checklist Completed by_____

Affiliation_____

Author Assisted by_____

Date_____

TABLE 1
EXAMPLES OF SENSITIVE ENVIRONMENTS

National Parks and National Monuments

Designated or Administratively Proposed Federal Wilderness Areas

National Preserves

National or State Wildlife Refuges

National Lakeshore Recreational Areas

Federal land designated for protection of natural ecosystems

State land designated for wildlife or game management

State designated Natural Areas

Federal or state designated Scenic or Wild River

All areas that provide or could potentially provide critical habitat[1] for state and federally listed Threatened or Endangered Species, those species that are currently petitioned for listing, and species designated by other agencies as sensitive or species of concern

All areas that provide or could potentially provide habitat for state protected species as defined in the Wildlife Code, Chapter 17 of the New Mexico Statutes

All areas that provide or could potentially provide habitat for migratory birds as protected by the Migratory Bird Treaty Act (16 U.S.C. §§ 703-712)

All areas that provide or could potentially provide habitat for bald eagles and golden eagles as protected by the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)

All areas that provide or could potentially provide habitat for song birds as protected by the State of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-13)

---

1 Critical habitats are defined by the Endangered Species Act (50 CFR §424.02(d)) as:

> 1) Specific areas within the geographical area currently occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (I) essential to the conservation of the species and (ii) that may require special management considerations or protection, and 2) Specific areas outside the geographical area occupied by a species at the time it is listed upon a determination by the Secretary [of Interior] that such areas are essential for the conservation of the species.

All areas that provide or could potentially provide habitat for hawks, vultures and owls as protected by the State of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-14)

All areas that provide or could potentially provide habitat for horned toads and Bullfrogs as protected by the State of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-15 and 16, resp.)

All perennial waters (e.g., rivers, lakes, playas, sloughs, ponds, etc)

All ephemeral drainage (e.g., arroyos, puddles/pools, intermittent streams, etc) that provide significant wildlife habitat or that could potentially transport contaminants off site to areas that provide wildlife habitat

All riparian habitats

All perennial and ephemeral wetlands (not limited to jurisdictional wetlands)

All areas that are potentially important breeding, staging, and overwintering habitats as well as other habitats important for the survival of animals during critical periods of their life cycle.

ATTACHMENT B
ECOLOGICAL SITE EXCLUSION CRITERIA CHECKLIST AND DECISION TREE

NEW MEXICO ECOLOGICAL EXCLUSION CRITERIA CHECKLIST

The following questions are designed to be used in conjunction with the Ecological Exclusion Criteria Decision Tree (Figure 1). After answering each question, refer to the Decision Tree to determine the appropriate next step. In some cases, questions will be omitted as the user is directed to another section as indicated by the flow diagram in the Decision Tree. For example, if the user answers "yes" to Question 1 of Section I, he or she is directed to proceed to Section II.

I. Habitat

In the following questions, "affected property" refers to all property on which a release has occurred or is believed to have occurred, including off-site areas where contamination may have occurred or migrated.

1. Are any of the below-listed sensitive environments at, adjacent to, or in the locality[1] of the affected property?

   - National Park or National Monument
   - Designated or administratively proposed Federal Wilderness Area
   - National Preserve
   - National or State Wildlife Refuge
   - Federal or State land designated for wildlife or game management
   - State designated Natural Areas
   - All areas that are owned or used by local tribes
   - All areas that are potentially important breeding, staging, and overwintering habitats as well as other habitats important for the survival of animals during critical periods of their life cycle
   - All areas that provide or could potentially provide habitat for state and federally listed Threatened or Endangered Species, those species that are currently petitioned for listing, and species designated by other agencies as sensitive or species of concern
   - All areas that provide or could potentially provide habitat for state protected species as defined in the Wildlife Code, Chapter 17 of the New Mexico Statutes
   - All areas that provide or could potentially provide habitat for migratory birds as protected by the Migratory Bird Treaty Act (16 U.S.C. §§ 703-712)
   - All areas that provide or could potentially provide habitat for bald eagles and golden eagles as protected by the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)
   - All areas that provide or could potentially provide habitat for song birds as protected by the state of New Mexico statute (New Mexico Statute, 1978, Chapter

1 *Locality* of the site refers to any area where an ecological receptor is likely to contact site-related chemicals. The locality of the site considers the likelihood of contamination migrating over time and places the site in the context of its general surrounding. Therefore, the locality is typically larger than the site and the areas adjacent to the site.

17, Game and Fish, 17-2-13)
- All areas that provide or could potentially provide habitat for hawks, vultures and owls as protected by the state of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-14)
- All areas that provide or could potentially provide habitat for horned toads and bullfrogs as protected by the state of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-15 and 16, respectively)

2. Does the affected property contain land areas which were not listed in Question 1, but could be considered viable ecological habitat? The following are examples (but not a complete listing) of viable ecological habitats:

- Wooded areas
- Shrub/scrub vegetated areas
- Open fields (prairie)
- Other grassy areas
- Desert areas
- Any other areas which support wildlife and/or vegetation, excluding areas which support only opportunistic species (such as house mice, Norway rats, pigeons, etc.) that do not serve as prey to species in adjacent habitats.

The following features are <u>not</u> considered ecologically viable:

- Pavement
- Buildings
- Paved areas of roadways
- Paved/concrete equipment storage pads
- Paved manufacturing or process areas
- Other non-natural surface cover or structure

3. Does the affected property contain any perennial or ephemeral aquatic features which were not listed in Question 1?

II. Receptors

1. Is any part of the affected property used for habitat, foraging area, or refuge by any rare, threatened, or endangered species (plant *or* animal), or otherwise protected species (e.g., raptors, migratory birds)?

2. Is any part of the affected property used for habitat, foraging area, or refuge by any species used as a recreational (e.g., game animals) and/or commercial resource?

3. Is any part of the affected property used for habitat, foraging area, or refuge by any plant or animal species? This includes plants considered "weeds" and opportunistic insect and animal species (such as cockroaches and rats) if they are used as a food source for other species in the area.

III. Exposure Pathways

1. Could receptors be impacted by contaminants via direct contact?
   Is a receptor located in or using an area where it could contact contaminated air, soil[3], or surface water?

For Questions 2 and 3, note that one must answer "yes" to all three bullets in order to be directed to the "exclusion denied" box of the decision tree. This is because answering "no" to one of the questions in the bullet list indicates that a complete exposure pathway is not present. For example, in Question 2, if the chemical cannot leach or dissolve to groundwater (bullet 1), there is no chance of ecological receptors being exposed to the chemical through contact with contaminated groundwater. Similarly, the responses to the questions in Question 4 determine whether a complete pathway exists for exposure to NAPL.

2. Could receptors contact contaminants via groundwater?
   - Can the chemical leach or dissolve to groundwater[4]?
   - Can groundwater mobilize the chemical?
   - Could (does) contaminated groundwater discharge into known or potential receptor habitats?

3. Could receptors contact contaminants via runoff (i.e., surface water and/or suspended sediment) or erosion by water or wind?
   - Are chemicals present in surface soils?
   - Can the chemical be leached from or eroded with surface soils?
   - Is there a receptor habitat located downgradient of the leached/eroded surface soil?

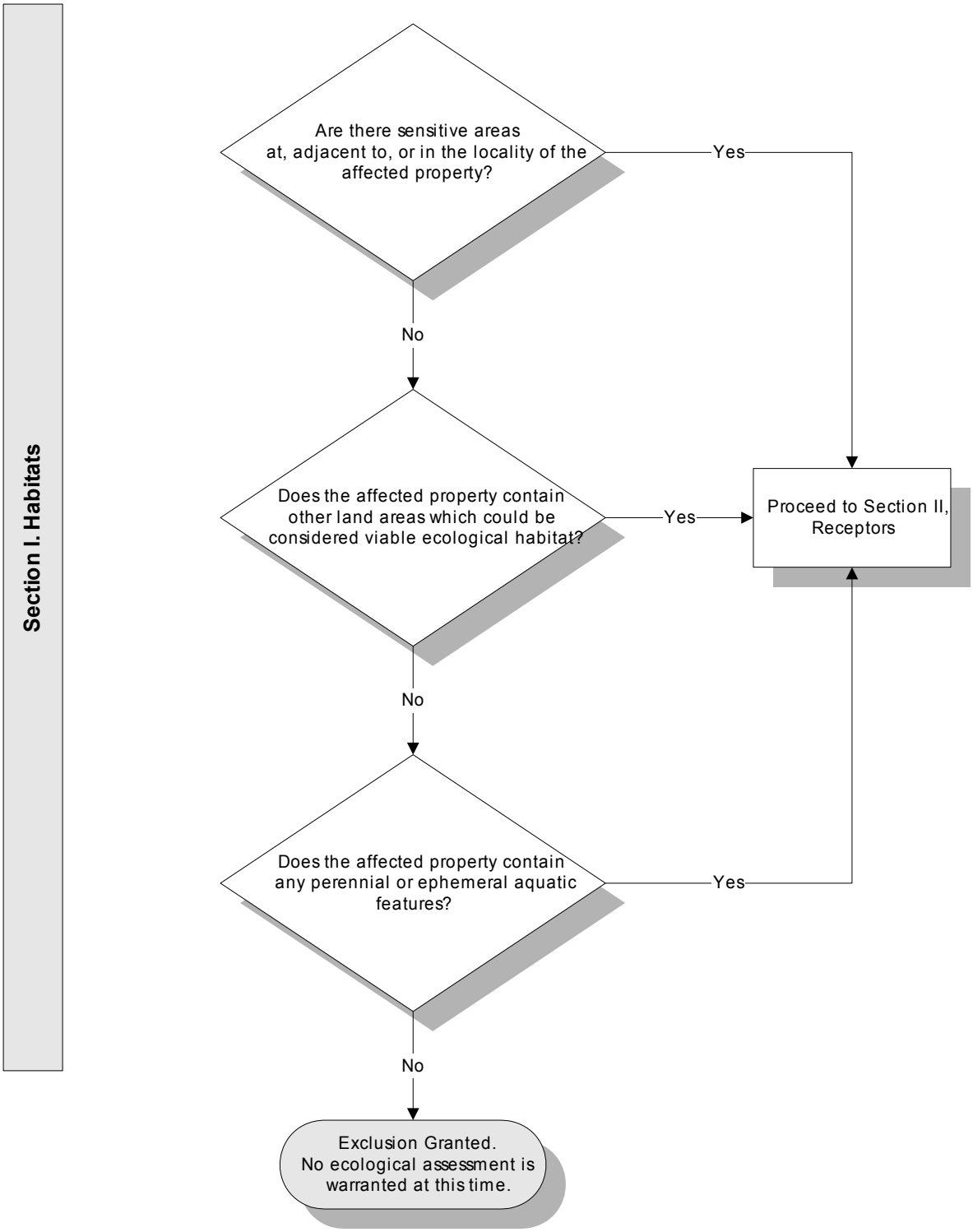
4. Could receptors contact contaminants via migration of non-aqueous phase liquids (NAPL)?
   - Is NAPL present at the site?
   - Is NAPL migrating toward potential receptors or habitats?
   - Could NAPL discharge impact receptors or habitats?

3 For soil, this means contamination less than 5 feet below ground surface (bgs).

4 Information on the environmental fate of specific chemicals can be found on the Internet at *http://www.epa.gov/opptintr/chemfact/* or at a local library in published copies of the *Hazardous Substances Data Bank*.

Figure 1 -Ecological Exclusion Criteria Decision Tree
(Refer to corresponding checklist for the full text of each question)

Figure 1 - Exclusion Criteria Decision Tree (continued)



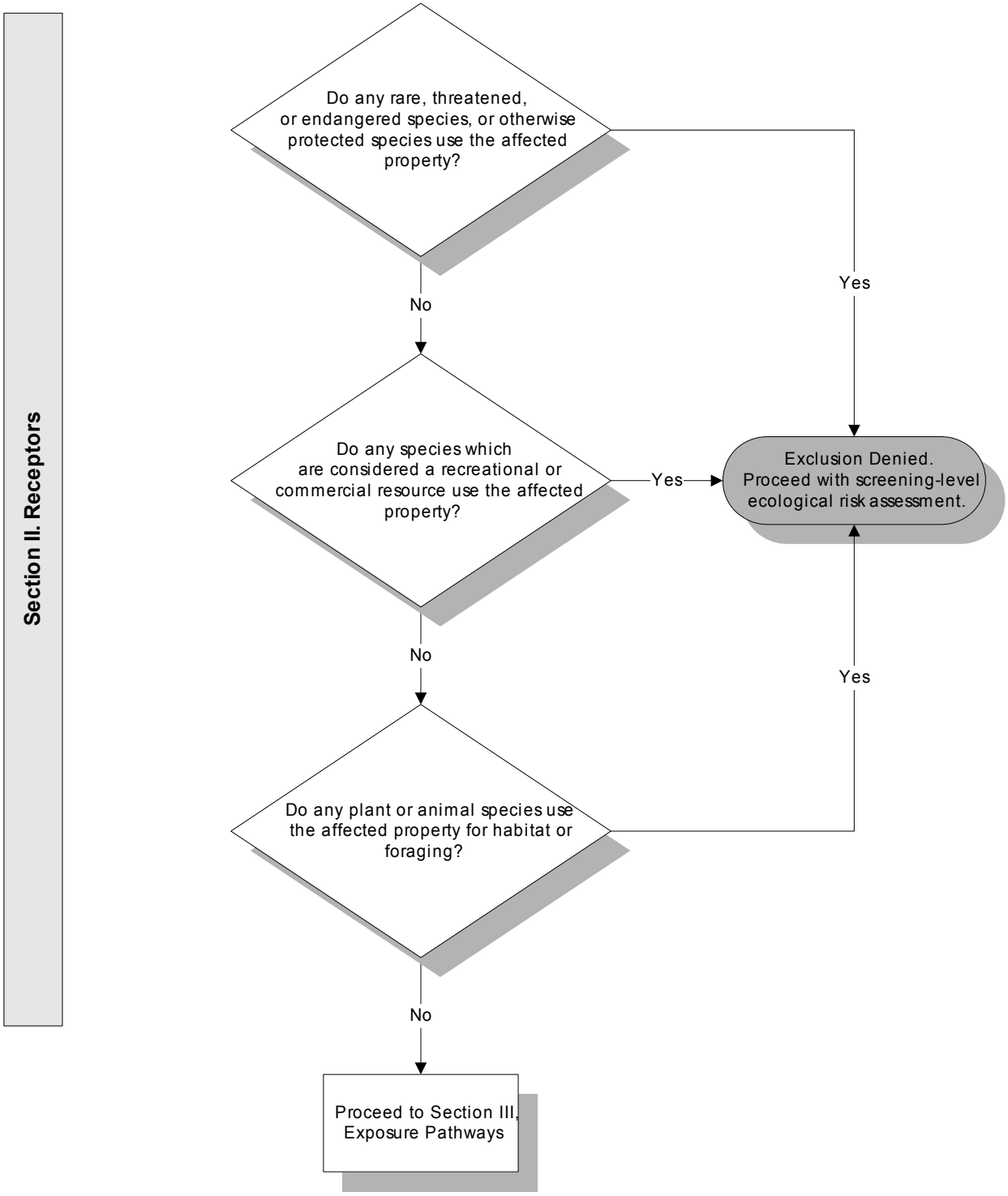
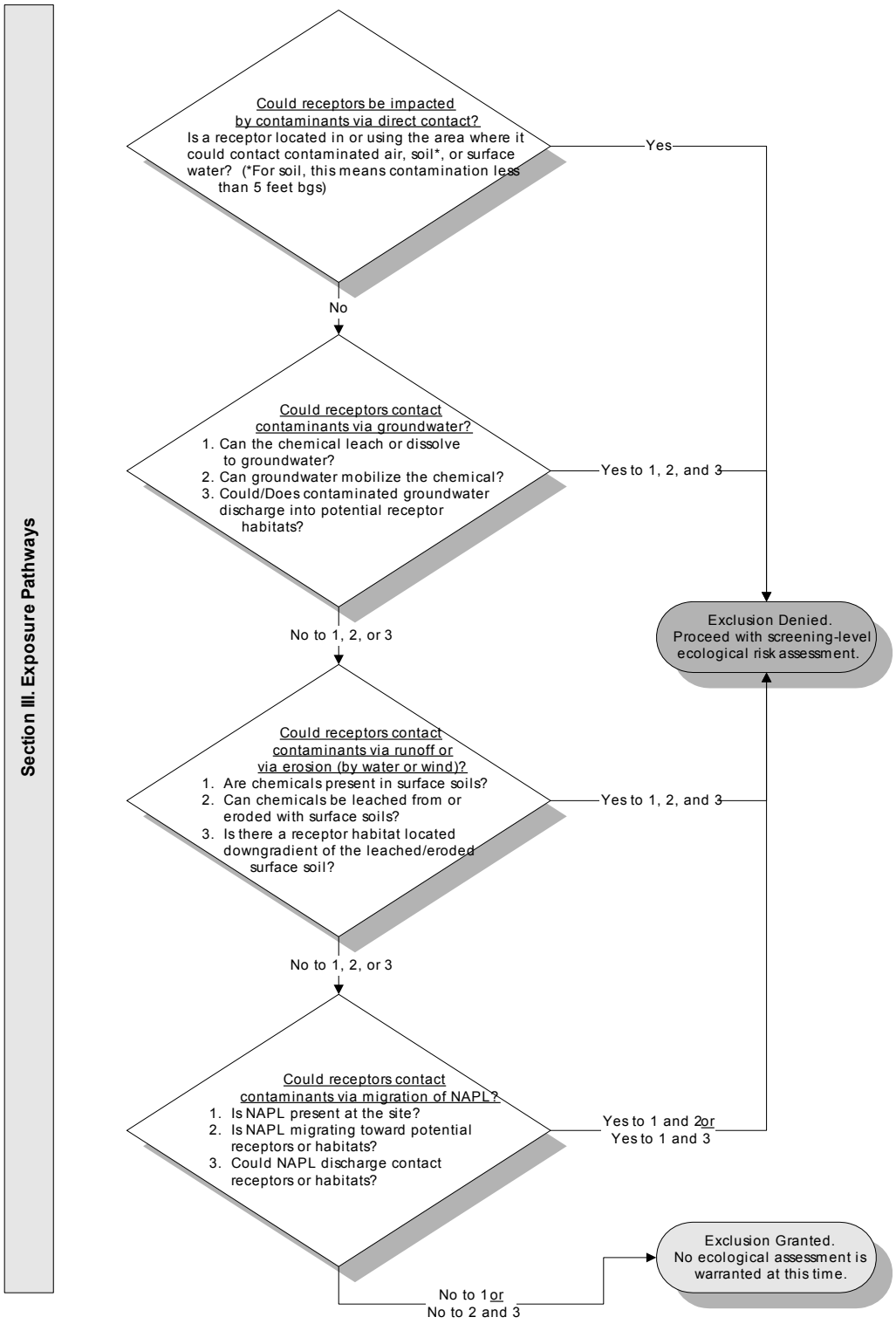


Figure 1 - Exclusion Criteria Decision Tree (continued)


Section III. Exposure Pathways
Could receptors be impacted by contaminants via direct contact?
Is a receptor located in or using the area where it could contact contaminated air, soil*, or surface water? (*For soil, this means contamination less than 5 feet bgs)
Yes
No
Could receptors contact contaminants via groundwater?
1. Can the chemical leach or dissolve to groundwater?
2. Can groundwater mobilize the chemical?
3. Could/Does contaminated groundwater discharge into potential receptor habitats?
Yes to 1, 2, and 3
No to 1, 2, or 3
Exclusion Denied. Proceed with screening-level ecological risk assessment.
Could receptors contact contaminants via runoff or via erosion (by water or wind)?
1. Are chemicals present in surface soils?
2. Can chemicals be leached from or eroded with surface soils?
3. Is there a receptor habitat located downgradient of the leached/eroded surface soil?
Yes to 1, 2, and 3
No to 1, 2, or 3
Could receptors contact contaminants via migration of NAPL?
1. Is NAPL present at the site?
2. Is NAPL migrating toward potential receptors or habitats?
3. Could NAPL discharge contact receptors or habitats?
Yes to 1 and 2or
Yes to 1 and 3
Exclusion Granted. No ecological assessment is warranted at this time.
No to 1or
No to 2 and 3

ATTACHMENT C
TIER 1 TOXICITY REFERENCE VALUES (TRVs) AND ECOLOGICAL SCREENING LEVELS (ESLs) AND TIER 2 TRVs

TABLE C-1: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE DEER MOUSE							
	Tier 1				Tier 2		
Constituent	TRV NOAEL (mg/kg/day)	Type[a]	Source	Screening Level (mg/kg)	TRV LOAEL (mg/kg/day)	Type[a]	Source
VOCs							
Acetone	1.00E+01	chronic cs	EcoRisk 3.2[b]	9.09E+01	5.00E+01	chronic cs	EcoRisk 3.2
Benzene	2.64E+01	chronic cs	EcoRisk 3.2	2.40E+02	2.64E+02	chronic cs	EcoRisk 3.2
2-Butanone (MEK)	1.77E+03	chronic cs	EcoRisk 3.2	1.61E+04	4.57E+03	chronic cs	EcoRisk 3.2
Carbon disulfide	2.50E-01	chronic cs	EcoRisk 3.2	2.27E+00	2.50E+00	chronic cs	EcoRisk 3.2
Chlorobenzene	6.00E+01	chronic cs	EcoRisk 3.2	5.45E+02	6.00E+02	chronic cs	EcoRisk 3.2
Chloroform	1.50E+01	chronic cs	EcoRisk 3.2	1.36E+02	4.10E+01	chronic cs	EcoRisk 3.2
1,2-Dichlorobenzene	2.50E+00	chronic cs	EcoRisk 3.2	2.27E+01	2.50E+01	chronic cs	EcoRisk 3.2
1,3-Dichlorobenzene	2.50E+00	chronic cs	EcoRisk 3.2	2.27E+01	2.50E+01	chronic cs	EcoRisk 3.2
1,4-Dichlorobenzene	2.50E+00	chronic cs	EcoRisk 3.2	2.27E+01	1.00E+01	chronic cs	EcoRisk 3.2
1,1-Dichloroethane	3.82E+02	chronic cs	EcoRisk 3.2	3.47E+03	3.82E+03	chronic cs	EcoRisk 3.2
1,2-Dichloroethane	4.97E+01	chronic cs	EcoRisk 3.2	4.52E+02	4.97E+02	chronic cs	EcoRisk 3.2
1,1-Dichloroethene	3.00E+01	chronic cs	EcoRisk 3.2	2.73E+02	3.00E+02	chronic cs	EcoRisk 3.2
cis-1,2-Dichloroethene	4.52E+01	chronic cs	EcoRisk 3.2	4.11E+02	4.52E+02	chronic cs	EcoRisk 3.2
trans-1,2-Dichloroethene	4.52E+01	chronic cs	EcoRisk 3.2	4.11E+02	4.52E+02	chronic cs	EcoRisk 3.2
2-Hexanone	8.27E+00	chronic GMM	EcoRisk 3.2	7.52E+01	3.15E+01	chronic GMM	EcoRisk 3.2
Methylene chloride	5.85E+00	chronic cs	EcoRisk 3.2	5.32E+01	5.00E+01	chronic cs	EcoRisk 3.2
4-Methyl-2-pentanone (MIBK)	2.50E+01	chronic cs	EcoRisk 3.2	2.27E+02	2.50E+02	chronic cs	EcoRisk 3.2
1,1,2,2-Tetrachloroethane	4.43E+01	chronic	ATSDR 1996	4.03E+02			
Tetrachloroethene	2.00E+00	chronic cs	EcoRisk 3.2	1.82E+01	1.00E+01	chronic cs	EcoRisk 3.2
Toluene	2.60E+01	chronic cs	EcoRisk 3.2	2.36E+02	2.60E+02	chronic cs	EcoRisk 3.2
1,2,4-Trichlorobenzene	1.48E+00	chronic cs	EcoRisk 3.2	1.35E+01	1.48E+01	chronic cs	EcoRisk 3.2
1,1,1-Trichloroethane	9.99E+02	chronic cs	EcoRisk 3.2	9.08E+03	9.99E+03	chronic cs	EcoRisk 3.2
1,1,2-Trichloroethane	3.90E+00	chronic	IRIS	3.55E+01			
Trichloroethene	1.00E+02	chronic cs	EcoRisk 3.2	9.09E+02	1.00E+03	chronic cs	EcoRisk 3.2
Trichlorofluoromethane	2.12E+02	chronic GMM	EcoRisk 3.2	1.93E+03	1.42E+03	chronic GMM	EcoRisk 3.2

TABLE C-1: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE DEER MOUSE							
	Tier 1				Tier 2		
Constituent	TRV NOAEL (mg/kg/day)	Type[a]	Source	Screening Level (mg/kg)	TRV LOAEL (mg/kg/day)	Type[a]	Source
Vinyl chloride	1.70E-01	chronic cs	EcoRisk 3.2	1.55E+00	1.70E+00	chronic cs	EcoRisk 3.2
Xylene (total)	2.10E+00	chronic cs	EcoRisk 3.2	1.91E+01	2.60E+00	chronic cs	EcoRisk 3.2
SVOCs							
Benzyl alcohol	1.43E+02	chronic cs	EcoRisk 3.2	1.30E+03	1.43E+03	chronic cs	EcoRisk 3.2
Bis(2-ethylhexyl) phthalate	1.83E+01	chronic cs	EcoRisk 3.2	1.66E+02	1.83E+02	chronic cs	EcoRisk 3.2
Butyl benzyl phthalate	1.59E+02	chronic cs	EcoRisk 3.2	1.45E+03	1.59E+03	chronic cs	EcoRisk 3.2
Carbazole	2.28E+01	chronic cs	EcoRisk 3.2	2.07E+02	2.28E+02	chronic cs	EcoRisk 3.2
2-Chlorophenol	5.00E-01	chronic cs	EcoRisk 3.2	4.55E+00	5.00E+00	chronic cs	EcoRisk 3.2
Di-n-butyl phthalate	1.34E+03	chronic GMM	EcoRisk 3.2	1.22E+04	3.18E+03	chronic GMM	EcoRisk 3.2
Diethyl phthalate	4.60E+03	chronic cs	EcoRisk 3.2	4.18E+04	4.60E+04	chronic cs	EcoRisk 3.2
Dimethyl phthalate	6.80E+01	chronic cs	EcoRisk 3.2	6.18E+02	6.80E+02	chronic cs	EcoRisk 3.2
Di-n-octyl phthalate	6.51E+01	chronic cs	EcoRisk 3.2	5.92E+02	6.51E+02	chronic cs	EcoRisk 3.2
Hexachlorobenzene	7.10E+00	chronic cs	EcoRisk 3.2	6.45E+01	7.10E+01	chronic cs	EcoRisk 3.2
2-Methylphenol	2.20E+02	chronic cs	EcoRisk 3.2	2.00E+03	2.20E+03	chronic cs	EcoRisk 3.2
2-Nitroaniline	3.00E+00	chronic cs	EcoRisk 3.2	2.73E+01	6.00E+00	chronic cs	EcoRisk 3.2
Nitrobenzene	5.90E+00	chronic cs	EcoRisk 3.2	5.36E+01	5.90E+01	chronic cs	EcoRisk 3.2
Pentachlorophenol	8.42E+00	chronic GMM	EcoRisk 3.2	7.65E+01	8.42E+01	chronic GMM	EcoRisk 3.2
Phenol	6.00E+01	chronic cs	EcoRisk 3.2	5.45E+02	6.00E+02	chronic cs	EcoRisk 3.2
Pestcides/Herbicides							
4,4'-DDD	5.83E+00	chronic GMM	EcoRisk 3.2	5.30E+01	1.17E+01	chronic GMM	EcoRisk 3.2
4,4'-DDE	9.02E+00	chronic GMM	EcoRisk 3.2	8.20E+01	2.27E+01	chronic GMM	EcoRisk 3.2
4,4'-DDT	1.39E-01	chronic cs	EcoRisk 3.2	1.26E+00	6.94E-01	chronic cs	EcoRisk 3.2
Aldrin	2.00E-01	chronic cs	EcoRisk 3.2	1.82E+00	1.00E+00	chronic cs	EcoRisk 3.2
alpha-BHC	8.70E+01	chronic cs	EcoRisk 3.2	7.91E+02	8.70E+02	chronic cs	EcoRisk 3.2
alpha-Chlordane	1.18E+00	chronic cs	EcoRisk 3.2	1.07E+01	1.18E+01	chronic cs	EcoRisk 3.2
beta-BHC	4.00E-01	chronic cs	EcoRisk 3.2	3.64E+00	2.00E+00	chronic cs	EcoRisk 3.2

TABLE C-1: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE DEER MOUSE							
	Tier 1				Tier 2		
Constituent	TRV NOAEL (mg/kg/day)	Type[a]	Source	Screening Level (mg/kg)	TRV LOAEL (mg/kg/day)	Type[a]	Source
delta-BHC	1.40E-02	chronic cs	EcoRisk 3.2	1.27E-01	1.40E-01	chronic cs	EcoRisk 3.2
Dieldrin	1.50E-02	chronic cs	EcoRisk 3.2	1.36E-01	3.00E-02	chronic cs	EcoRisk 3.2
Endosulfan I	1.50E-01	chronic cs	EcoRisk 3.2	1.36E+00	1.50E+00	chronic cs	EcoRisk 3.2
Endosulfan II	1.50E-01	chronic cs	EcoRisk 3.2	1.36E+00	1.50E+00	chronic cs	EcoRisk 3.2
Endrin	9.20E-02	chronic cs	EcoRisk 3.2	8.36E-01	9.20E-01	chronic cs	EcoRisk 3.2
gamma-BHC (Lindane)	1.40E-02	chronic cs	EcoRisk 3.2	1.27E-01	1.40E-01	chronic cs	EcoRisk 3.2
gamma-Chlordane	1.18E+00	chronic cs	EcoRisk 3.2	1.07E+01	1.18E+01	chronic cs	EcoRisk 3.2
Heptachlor	1.00E-01	chronic cs	EcoRisk 3.2	9.09E-01	1.00E+00	chronic cs	EcoRisk 3.2
Methoxychlor	4.00E+00	chronic cs	EcoRisk 3.2	3.64E+01	8.00E+00	chronic cs	EcoRisk 3.2
Aroclors							
Aroclor 1016	1.49E+00	chronic GMM	EcoRisk 3.2	1.35E+01	4.26E+00	chronic GMM	EcoRisk 3.2
Aroclor 1260	1.38E+01	chronic GMM	EcoRisk 3.2	1.25E+02	3.33E+01	chronic GMM	EcoRisk 3.2
Aroclor 1254	6.11E-01	chronic GMM	EcoRisk 3.2	5.55E+00	3.37E+00	chronic GMM	EcoRisk 3.2
PAHs							
Acenaphthene	7.00E+01	chronic cs	EcoRisk 3.2	6.36E+02	7.00E+02	chronic cs	EcoRisk 3.2
Acenaphthylene	7.00E+01	chronic cs	EcoRisk 3.2	6.36E+02	7.00E+02	chronic cs	EcoRisk 3.2
Anthracene	1.00E+02	chronic cs	EcoRisk 3.2	9.09E+02	1.00E+03	chronic cs	EcoRisk 3.2
Benzo(a)anthracene	1.70E-01	chronic cs	EcoRisk 3.2	1.55E+00	1.70E+00	chronic cs	EcoRisk 3.2
Benzo(a)pyrene	5.58E+00	chronic GMM	EcoRisk 3.2	5.07E+01	1.77E+01	chronic GMM	EcoRisk 3.2
Benzo(b)fluoranthene	4.00E+00	chronic cs	EcoRisk 3.2	3.64E+01	4.00E+01	chronic cs	EcoRisk 3.2
Benzo(ghi)perylene	7.20E+00	chronic cs	EcoRisk 3.2	6.54E+01	7.20E+01	chronic cs	EcoRisk 3.2
Benzo(k)fluoranthene	7.20E+00	chronic cs	EcoRisk 3.2	6.54E+01	7.20E+01	chronic cs	EcoRisk 3.2
Chrysene	1.70E-01	chronic cs	EcoRisk 3.2	1.55E+00	1.70E+01	chronic cs	EcoRisk 3.2
Dibenzo(a,h)anthracene	1.33E+00	chronic cs	EcoRisk 3.2	1.21E+01	1.33E+01	chronic cs	EcoRisk 3.2
Fluoranthene	1.25E+01	chronic cs	EcoRisk 3.2	1.14E+02	1.25E+02	chronic cs	EcoRisk 3.2
Fluorene	1.25E+02	chronic cs	EcoRisk 3.2	1.14E+03	2.50E+02	chronic cs	EcoRisk 3.2

TABLE C-1: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE DEER MOUSE							
	Tier 1				Tier 2		
Constituent	TRV NOAEL (mg/kg/day)	Type[a]	Source	Screening Level (mg/kg)	TRV LOAEL (mg/kg/day)	Type[a]	Source
Indeno(1,2,3-cd)pyrene	7.20E+00	chronic cs	EcoRisk 3.2	6.54E+01	7.20E+01	chronic cs	EcoRisk 3.2
Naphthalene	1.43E+01	chronic GMM	EcoRisk 3.2	1.30E+02	4.02E+01	chronic GMM	EcoRisk 3.2
Phenanthrene	5.14E+00	chronic cs	EcoRisk 3.2	4.67E+01	5.14E+01	chronic cs	EcoRisk 3.2
Pyrene	7.50E+00	chronic cs	EcoRisk 3.2	6.82E+01	7.50E+01	chronic cs	EcoRisk 3.2
Dioxin/Furans							
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	5.62E-07	chronic GMM	EcoRisk 3.2	5.11E-06	3.76E-06	chronic GMM	EcoRisk 3.2
Metals							
Aluminum (note: pH dependent)	6.20E+01	chronic	ATSDR 1999	5.64E+02	1.30E+02	chronic	ATSDR 1999
Antimony	5.90E-02	chronic cs	EcoRisk 3.2	5.36E-01	5.90E-01	chronic cs	EcoRisk 3.2
Arsenic	1.04E+00	chronic cs	EcoRisk 3.2	9.45E+00	1.66E+00	chronic cs	EcoRisk 3.2
Barium	5.18E+01	chronic GMM	EcoRisk 3.2	4.71E+02	5.18E+02	chronic GMM	EcoRisk 3.2
Beryllium	5.32E-01	chronic cs	EcoRisk 3.2	4.84E+00	5.32E+00	chronic cs	EcoRisk 3.2
Boron	2.80E+01	chromic cs	EcoRisk 3.2	2.55E+02	2.80E+02	chronic cs	EcoRisk 3.2
Cadmium	7.70E-01	chronic cs	EcoRisk 3.2	7.00E+00	7.70E+00	chronic cs	EcoRisk 3.2
Chromium (total)	2.40E+00	chronic GMM	EcoRisk 3.2	2.18E+01	2.40E+01	chronic GMM	EcoRisk 3.2
Chromium (hexavalent)	9.24E+00	chronic GMM	EcoRisk 3.2	8.40E+01	9.24E+01	chronic GMM	EcoRisk 3.2
Cobalt	7.33E+00	chronic GMM	EcoRisk 3.2	6.66E+01	7.33E+01	chronic GMM	EcoRisk 3.2
Copper	5.60E+00	chronic cs	EcoRisk 3.2	5.09E+01	9.34E+00	chronic cs	EcoRisk 3.2
Lead	4.70E+00	chronic cs	EcoRisk 3.2	4.27E+01	8.90E+00	chronic cs	EcoRisk 3.2
Manganese	5.15E+01	chronic GMM	EcoRisk 3.2	4.68E+02	5.15E+02	chronic GMM	EcoRisk 3.2
Mercury (inorganic)	1.41E+00	chronic cs	EcoRisk 3.2	1.28E+01	1.41E+01	chronic cs	EcoRisk 3.2
Nickel	1.70E+00	chronic cs	EcoRisk 3.2	1.55E+01	3.40E+00	chronic cs	EcoRisk 3.2
Selenium	1.43E-01	chronic cs	EcoRisk 3.2	1.30E+00	2.15E-01	chronic cs	EcoRisk 3.2
Silver	6.02E+00	chronic cs	EcoRisk 3.2	5.47E+01	6.02E+01	chronic cs	EcoRisk 3.2
Thallium	7.10E-03	chronic cs	EcoRisk 3.2	6.45E-02	7.10E-02	chronic cs	EcoRisk 3.2
Vanadium	4.16E+00	chronic cs	EcoRisk 3.2	3.78E+01	8.31E+00	chronic cs	EcoRisk 3.2

TABLE C-1: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE DEER MOUSE							
	Tier 1				Tier 2		
Constituent	TRV NOAEL (mg/kg/day)	Type[a]	Source	Screening Level (mg/kg)	TRV LOAEL (mg/kg/day)	Type[a]	Source
Zinc	7.54E+01	chronic GMM	EcoRisk 3.2	6.85E+02	7.54E+02	chronic GMM	EcoRisk 3.2
Miscellaneous							
Cyanide (CN-)	6.87E+01	chronic cs	EcoRisk 3.2	6.24E+02	6.87E+02	chronic cs	EcoRisk 3.2
Nitrite	5.07E+02	chonic cs	Sample 1996	4.61E+03			
Explosives							
Dinitrobenzene, 1,3-	1.13E-01	chronic cs	EcoRisk 3.2	1.03E+00	2.64E-01	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2,4-	2.68E+00	chronic cs	EcoRisk 3.2	2.44E+01	2.68E+01	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2,6-	1.77E+00	chronic cs	EcoRisk 3.2	1.61E+01	1.77E+01	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2-Amino-4,6-	1.39E+01	chronic cs	EcoRisk 3.2	1.26E+02	1.39E+02	chronic cs	EcoRisk 3.2
Dinitrotoluene, 4-Amino-2,6-	9.59E+00	chronic cs	EcoRisk 3.2	8.72E+01	9.59E+01	chronic cs	EcoRisk 3.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	8.94E+00	chronic GMM	EcoRisk 3.2	8.13E+01	2.83E+01	chronic GMM	EcoRisk 3.2
Nitroglycerin	9.64E+01	chronic cs	EcoRisk 3.2	8.76E+02	1.02E+03	chronic cs	EcoRisk 3.2
Nitrotoluene, m-	1.07E+01	chronic cs	EcoRisk 3.2	9.73E+01	1.07E+02	chronic cs	EcoRisk 3.2
Nitrotoluene, o-	8.91E+00	chronic cs	EcoRisk 3.2	8.10E+01	8.91E+01	chronic cs	EcoRisk 3.2
Nitrotoluene, p-	1.96E+01	chronic cs	EcoRisk 3.2	1.78E+02	1.96E+02	chronic cs	EcoRisk 3.2
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	7.50E+01	chronic cs	EcoRisk 3.2	6.82E+02	2.00E+02	chronic cs	EcoRisk 3.2
PETN	7.00E+01	chronic cs	EcoRisk 3.2	6.36E+02	7.00E+02	chronic cs	EcoRisk 3.2
Tetryl (Trinitrophenylmethylnitramine)	1.30E+00	chronic cs	EcoRisk 3.2	1.18E+01	6.20E+00	chronic cs	EcoRisk 3.2
Trinitrobenzene, 1,3,5-	1.34E+01	chronic cs	EcoRisk 3.2	1.22E+02	1.34E+02	chronic cs	EcoRisk 3.2
Trinitrotoluene, 2,4,6-	3.47E+01	chronic cs	EcoRisk 3.2	3.15E+02	1.60E+02	chronic cs	EcoRisk 3.2
Agent Breakdown Products							
DIMP	3.00E+02	chronic	ATSDR 1988	2.73E+03	3.75E+02	chronic	IRIS
IMPA	2.79E+02	chronic	IRIS	2.54E+03	1.16E+02	chronic	IRIS
MPA	2.79E+02	chronic	IRIS	2.54E+03	1.16E+02	chronic	IRIS
Thiodiglycol	5.00E+02	chronic	USACHPPM 1999	4.55E+03			

[a]chronic cs - TRV based on a critical study (two or less data), chronic GMM - TRV based on geometric mean (three or more relevent data), [b] EcoRisk 3.2 - includes uncertainty factors for extrapolation to chronic NOAEL and LOAEL (see Uncertanty Factor's tab

TABLE C-2: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE HORNED LARK							
Surrogate: American Robin (Avian Omnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
VOCs							
Acetone	2.01E+02	chronic	EcoRisk 3.2	9.51E+02	2.01E+03	chronic	EcoRisk 3.2
Chlorobenzene	6.00E+01	chronic	EcoRisk 3.2	2.84E+02	6.00E+02	chronic	EcoRisk 3.2
1,2-Dichloroethane	4.60E+00	chronic cs	EcoRisk 3.2	2.18E+01	9.10E+00	chronic cs	EcoRisk 3.2
Hexachlorobenzene	5.00E+00	chronic cs	EcoRisk 3.2	2.37E+01	5.00E+01	chronic cs	EcoRisk 3.2
2-Hexanone	1.00E+00	chronic cs	EcoRisk 3.2	4.73E+00	1.00E+01	chronic cs	EcoRisk 3.2
Xylene (total)	1.07E+02	chronic cs	EcoRisk 3.2	5.06E+02	1.07E+03	chronic cs	EcoRisk 3.2
SVOCs							
Bis(2-ethylhexyl) phthalate	1.10E+00	chronic cs	EcoRisk 3.2	5.20E+00	1.10E+01	chronic cs	EcoRisk 3.2
2-Chlorophenol	1.13E+00	chronic cs	EcoRisk 3.2	5.34E+00	1.13E+01	chronic cs	EcoRisk 3.2
Di-n-butyl phthalate	1.40E-01	chronic cs	EcoRisk 3.2	6.62E-01	1.40E+00	chronic cs	EcoRisk 3.2
Pentachlorophenol	6.73E+00	chronic cs	EcoRisk 3.2	3.18E+01	6.73E+01	chronic cs	EcoRisk 3.2
Pestcides/Herbicides							
4,4'-DDD	1.60E-02	chronic GMM	EcoRisk 3.2	7.57E-02	8.30E-02	chronic GMM	EcoRisk 3.2
4,4'-DDE	4.80E-01	chronic GMM	EcoRisk 3.2	2.27E+00	2.40E+00	chronic GMM	EcoRisk 3.2
4,4'-DDT	2.01E+00	chronic GMM	EcoRisk 3.2	9.51E+00	5.96E+00	chronic GMM	EcoRisk 3.2
alpha-Chlordane	2.14E+00	chronic cs	EcoRisk 3.2	1.01E+01	1.07E+01	chronic cs	EcoRisk 3.2
beta-BHC	3.83E+01	chronic cs	EcoRisk 3.2	1.81E+02	3.83E+02	chronic cs	EcoRisk 3.2
Dieldrin	7.09E-02	chronic cs	EcoRisk 3.2	3.35E-01	3.78E+00	chronic cs	EcoRisk 3.2
Endosulfan I	1.00E+01	chronic cs	EcoRisk 3.2	4.73E+01	1.00E+02	chronic cs	EcoRisk 3.2
Endosulfan II	1.00E+01	chronic cs	EcoRisk 3.2	4.73E+01	1.00E+02	chronic cs	EcoRisk 3.2
Endrin	1.00E-02	chronic cs	EcoRisk 3.2	4.73E-02	1.00E-01	chronic cs	EcoRisk 3.2
gamma-BHC (Lindane)	5.60E-01	chronic cs	EcoRisk 3.2	2.65E+00	2.25E+00	chronic cs	EcoRisk 3.2
gamma-Chlordane	2.14E+00	chronic cs	EcoRisk 3.2	1.01E+01	1.07E+01	chronic cs	EcoRisk 3.2
Heptachlor	9.20E-01	chronic cs	EcoRisk 3.2	4.35E+00	9.20E+00	chronic cs	EcoRisk 3.2
Methoxychlor	2.58E+01	chronic cs	EcoRisk 3.2	1.22E+02	2.58E+02	chronic cs	EcoRisk 3.2

TABLE C-2: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE HORNED LARK							
Surrogate: American Robin (Avian Omnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Aroclors							
Aroclor 1260	2.15E+00	chronic GMM	EcoRisk 3.2	1.02E+01	3.04E+00	chronic GMM	EcoRisk 3.2
Aroclor 1254	1.00E-01	chronic cs	EcoRisk 3.2	4.73E-01	1.00E+00	chronic cs	EcoRisk 3.2
PAHs							
Benzo(a)anthracene	1.07E-01	chronic cs	EcoRisk 3.2	5.06E-01	1.07E+00	chronic cs	EcoRisk 3.2
Naphthalene	1.50E+01	chronic cs	EcoRisk 3.2	7.10E+01	1.50E+02	chronic cs	EcoRisk 3.2
Pyrene	2.05E+01	chronic cs	EcoRisk 3.2	9.70E+01	2.05E+02	chronic cs	EcoRisk 3.2
Metals							
Aluminum (Note: pH dependent)	1.10E+02	chronic	Sample 1996	5.20E+02			
Arsenic	2.24E+00	chronic GMM	EcoRisk 3.2	1.06E+01	2.24E+01	chronic GMM	EcoRisk 3.2
Barium	7.35E+01	chronic GMM	EcoRisk 3.2	3.48E+02	1.31E+02	chronic GMM	EcoRisk 3.2
Boron	2.92E+00	chronic GMM	EcoRisk 3.2		1.45E+01	chronic GMM	EcoRisk 3.2
Cadmium	1.47E+00	chronic GMM	EcoRisk 3.2	6.95E+00	1.47E+01	chronic GMM	EcoRisk 3.2
Chromium (total)	2.66E+00	chronic GMM	EcoRisk 3.2	1.26E+01	2.66E+01	chronic GMM	EcoRisk 3.2
Chromium (hexavalent)	1.10E+01	chronic cs	EcoRisk 3.2	5.20E+01	1.10E+02	chronic cs	EcoRisk 3.2
Cobalt	7.61E+00	chronic GMM	EcoRisk 3.2	3.60E+01	7.61E+01	chronic GMM	EcoRisk 3.2
Copper	4.05E+00	chronic cs	EcoRisk 3.2	1.92E+01	1.21E+01	chronic cs	EcoRisk 3.2
Lead	1.63E+00	chronic cs	EcoRisk 3.2	7.71E+00	3.26E+00	chronic cs	EcoRisk 3.2
Manganese	1.79E+02	chronic GMM	EcoRisk 3.2	8.47E+02	1.79E+03	chronic GMM	EcoRisk 3.2
Mercury (inorganic)	1.90E-02	chronic cs	EcoRisk 3.2	8.99E-02	1.90E-01	chronic cs	EcoRisk 3.2
Molybdenum	3.50E+00	chronic cs	EcoRisk 3.2	1.66E+01	3.50E+01	chronic cs	EcoRisk 3.2
Nickel	6.71E+00	chronic cs	EcoRisk 3.2	3.17E+01	6.71E+01	chronic cs	EcoRisk 3.2
Selenium	2.90E-01	chronic cs	EcoRisk 3.2	1.37E+00	5.79E-01	chronic cs	EcoRisk 3.2
Silver	2.20E+00	chronic cs	EcoRisk 3.2	1.04E+01	2.02E+01	chronic cs	EcoRisk 3.2
Thallium	3.50E-01	chronic cs	EcoRisk 3.2	1.66E+00	3.50E+00	chronic cs	EcoRisk 3.2
Vanadium	3.44E-01	chronic cs	EcoRisk 3.2	1.63E+00	6.88E-01	chronic cs	EcoRisk 3.2
Zinc	6.61E+01	chronic	EcoRisk	3.13E+02	6.61E+02	chronic	EcoRisk

TABLE C-2: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE HORNED LARK							
Surrogate: American Robin (Avian Omnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
		GMM	3.2			GMM	3.2
Miscellaneous							
Cyanide (CN-)	4.00E-02	chronic cs	EcoRisk 3.2	1.89E-01	4.00E-01	chronic cs	EcoRisk 3.2
Explosives							
Dinitrobenzene, 1,3-	4.22E-01	chronic cs	EcoRisk 3.2	2.00E+00	4.22E+00	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2,6-	6.00E+01	chronic cs	EcoRisk 3.2	2.84E+02	6.00E+02	chronic cs	EcoRisk 3.2
Trinitrotoluene, 2,4,6-	9.75E+00	chronic cs	EcoRisk 3.2	4.61E+01	1.78E+01	chronic cs	EcoRisk 3.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	2.36E+00	chronic GMM	EcoRisk 3.2	1.12E+01	4.49E+00	chronic GMM	EcoRisk 3.2

[a]chronic cs - TRV based on a critical study (two or less data), chronic GMM - TRV based on geometric mean (three or more relevent data)
[b] EcoRisk 3.2 - includes uncertainty factors for extrapolation to chronic NOAEL and LOAEL (see Uncertanty Factor's tab)

TABLE C-3: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE KIT FOX							
Surrogate: Red Fox (Mammalian to Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
VOCs							
Acetone	1.00E+01	chronic cs	EcoRisk 3.2	4.04E+02	5.00E+01	chronic cs	EcoRisk 3.2
Benzene	2.64E+01	chronic cs	EcoRisk 3.2	1.07E+03	2.64E+02	chronic cs	EcoRisk 3.2
2-Butanone (MEK)	1.77E+03	chronic cs	EcoRisk 3.2	7.15E+04	4.57E+03	chronic cs	EcoRisk 3.2
Carbon disulfide	2.50E-01	chronic cs	EcoRisk 3.2	1.01E+01	2.50E+00	chronic cs	EcoRisk 3.2
Chlorobenzene	6.00E+01	chronic cs	EcoRisk 3.2	2.42E+03	6.00E+02	chronic cs	EcoRisk 3.2
Chloroform	1.50E+01	chronic cs	EcoRisk 3.2	6.06E+02	4.10E+01	chronic cs	EcoRisk 3.2
1,2-Dichlorobenzene	2.50E+00	chronic cs	EcoRisk 3.2	1.01E+02	2.50E+01	chronic cs	EcoRisk 3.2
1,3-Dichlorobenzene	2.50E+00	chronic cs	EcoRisk 3.2	1.01E+02	2.50E+01	chronic cs	EcoRisk 3.2
1,4-Dichlorobenzene	2.50E+00	chronic cs	EcoRisk 3.2	1.01E+02	1.00E+01	chronic cs	EcoRisk 3.2
1,1-Dichloroethane	3.82E+02	chronic cs	EcoRisk 3.2	1.54E+04	3.82E+03	chronic cs	EcoRisk 3.2
1,2-Dichloroethane	4.97E+01	chronic cs	EcoRisk 3.2	2.01E+03	4.97E+02	chronic cs	EcoRisk 3.2
1,1-Dichloroethene	3.00E+01	chronic cs	EcoRisk 3.2	1.21E+03	3.00E+02	chronic cs	EcoRisk 3.2
cis-1,2-Dichloroethene	4.52E+01	chronic cs	EcoRisk 3.2	1.83E+03	4.52E+02	chronic cs	EcoRisk 3.2
trans-1,2-Dichloroethene	4.52E+01	chronic cs	EcoRisk 3.2	1.83E+03	4.52E+02	chronic cs	EcoRisk 3.2
2-Hexanone	8.27E+00	chronic GMM	EcoRisk 3.2	3.34E+02	3.15E+01	chronic GMM	EcoRisk 3.2
Hexachlorobenzene	7.10E+00	chronic cs	EcoRisk 3.2	2.87E+02	7.10E+01	chronic cs	EcoRisk 3.2
Methylene chloride	5.85E+00	chronic cs	EcoRisk 3.2	2.36E+02	5.00E+01	chronic cs	EcoRisk 3.2
4-Methyl-2-pentanone (MIBK)	2.50E+01	chronic cs	EcoRisk 3.2	1.01E+03	2.50E+02	chronic cs	EcoRisk 3.2
Tetrachloroethene	2.00E+00	chronic cs	EcoRisk 3.2	8.08E+01	1.00E+01	chronic cs	EcoRisk 3.2
Toluene	2.60E+01	chronic cs	EcoRisk 3.2	1.05E+03	2.60E+02	chronic cs	EcoRisk 3.2
1,2,4-Trichlorobenzene	1.48E+00	chronic cs	EcoRisk 3.2	5.98E+01	1.48E+01	chronic cs	EcoRisk 3.2
1,1,1-Trichloroethane	9.99E+02	chronic cs	EcoRisk 3.2	4.04E+04	9.99E+03	chronic cs	EcoRisk 3.2
Trichloroethene	1.00E+02	chronic cs	EcoRisk 3.2	4.04E+03	1.00E+03	chronic cs	EcoRisk 3.2
Trichlorofluoromethane	2.12E+02	chronic GMM	EcoRisk 3.2	8.56E+03	1.42E+03	chronic GMM	EcoRisk 3.2
Vinyl chloride	1.70E-01	chronic cs	EcoRisk 3.2	6.87E+00	1.70E+00	chronic cs	EcoRisk 3.2

TABLE C-3: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE KIT FOX							
Surrogate: Red Fox (Mammalian to Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Xylene (total)	2.10E+00	chronic cs	EcoRisk 3.2	8.48E+01	2.60E+00	chronic cs	EcoRisk 3.2
SVOCs							
Benzyl alcohol	1.43E+02	chronic cs	EcoRisk 3.2	5.78E+03	1.43E+03	chronic cs	EcoRisk 3.2
Bis(2-ethylhexyl) phthalate	1.83E+01	chronic cs	EcoRisk 3.2	7.39E+02	1.83E+02	chronic cs	EcoRisk 3.2
Butyl benzyl phthalate	1.59E+02	chronic cs	EcoRisk 3.2	6.42E+03	1.59E+03	chronic cs	EcoRisk 3.2
Carbazole	2.28E+01	chronic cs	EcoRisk 3.2	9.21E+02	2.28E+02	chronic cs	EcoRisk 3.2
2-Chlorophenol	5.00E-01	chronic cs	EcoRisk 3.2	2.02E+01	5.00E+00	chronic cs	EcoRisk 3.2
Di-n-butyl phthalate	1.34E+03	chronic GMM	EcoRisk 3.2	5.41E+04	3.18E+03	chronic GMM	EcoRisk 3.2
Diethyl phthalate	4.60E+03	chronic cs	EcoRisk 3.2	1.86E+05	4.60E+04	chronic cs	EcoRisk 3.2
Dimethyl phthalate	6.80E+01	chronic cs	EcoRisk 3.2	2.75E+03	6.80E+02	chronic cs	EcoRisk 3.2
Di-n-octyl phthalate	6.51E+01	chronic cs	EcoRisk 3.2	2.63E+03	6.51E+02	chronic cs	EcoRisk 3.2
Hexachlorobenzene	7.10E+00	chronic cs	EcoRisk 3.2	2.87E+02	7.10E+01	chronic cs	EcoRisk 3.2
2-Methylphenol	2.20E+02	chronic cs	EcoRisk 3.2	8.89E+03	2.20E+03	chronic cs	EcoRisk 3.2
2-Nitroaniline	3.00E+00	chronic cs	EcoRisk 3.2	1.21E+02	6.00E+00	chronic cs	EcoRisk 3.2
Nitrobenzene	5.90E+00	chronic cs	EcoRisk 3.2	2.38E+02	5.90E+01	chronic cs	EcoRisk 3.2
Pentachlorophenol	8.42E+00	chronic GMM	EcoRisk 3.2	3.40E+02	8.42E+01	chronic GMM	EcoRisk 3.2
Phenol	6.00E+01	chronic cs	EcoRisk 3.2	2.42E+03	6.00E+02	chronic cs	EcoRisk 3.2
Pestcides/Herbicides							
4,4'-DDD	5.83E+00	chronic GMM	EcoRisk 3.2	2.36E+02	1.17E+01	chronic GMM	EcoRisk 3.2
4,4'-DDE	9.02E+00	chronic GMM	EcoRisk 3.2	3.64E+02	2.27E+01	chronic GMM	EcoRisk 3.2
4,4'-DDT	1.39E-01	chronic cs	EcoRisk 3.2	5.62E+00	6.94E-01	chronic cs	EcoRisk 3.2
Aldrin	2.00E-01	chronic cs	EcoRisk 3.2	8.08E+00	1.00E+00	chronic cs	EcoRisk 3.2
alpha-BHC	8.70E+01	chronic cs	EcoRisk 3.2	3.51E+03	8.70E+02	chronic cs	EcoRisk 3.2
alpha-Chlordane	1.18E+00	chronic cs	EcoRisk 3.2	4.77E+01	1.18E+01	chronic cs	EcoRisk 3.2
beta-BHC	4.00E-01	chronic cs	EcoRisk 3.2	1.62E+01	2.00E+00	chronic cs	EcoRisk 3.2
delta-BHC	1.40E-02	chronic cs	EcoRisk 3.2	5.66E-01	1.40E-01	chronic cs	EcoRisk 3.2

TABLE C-3: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE KIT FOX							
Surrogate: Red Fox (Mammalian to Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Dieldrin	1.50E-02	chronic cs	EcoRisk 3.2	6.06E-01	3.00E-02	chronic cs	EcoRisk 3.2
Endosulfan I	1.50E-01	chronic cs	EcoRisk 3.2	6.06E+00	1.50E+00	chronic cs	EcoRisk 3.2
Endosulfan II	1.50E-01	chronic cs	EcoRisk 3.2	6.06E+00	1.50E+00	chronic cs	EcoRisk 3.2
Endrin	9.20E-02	chronic cs	EcoRisk 3.2	3.72E+00	9.20E-01	chronic cs	EcoRisk 3.2
gamma-BHC (Lindane)	1.40E-02	chronic cs	EcoRisk 3.2	5.66E-01	1.40E-01	chronic cs	EcoRisk 3.2
gamma-Chlordane	1.18E+00	chronic cs	EcoRisk 3.2	4.77E+01	1.18E+01	chronic cs	EcoRisk 3.2
Heptachlor	1.00E-01	chronic cs	EcoRisk 3.2	4.04E+00	1.00E+00	chronic cs	EcoRisk 3.2
Methoxychlor	4.00E+00	chronic cs	EcoRisk 3.2	1.62E+02	8.00E+00	chronic cs	EcoRisk 3.2
Aroclors							
Aroclor 1016	1.49E+00	chronic GMM	EcoRisk 3.2	6.02E+01	4.26E+00	chronic GMM	EcoRisk 3.2
Aroclor 1260	3.10E-02	chronic cs	EcoRisk 3.2	1.25E+00	3.10E-01	chronic cs	EcoRisk 3.2
Aroclor 1254	6.11E-01	chronic GMM	EcoRisk 3.2	2.47E+01	3.37E+00	chronic GMM	EcoRisk 3.2
PAHs							
Acenaphthene	7.00E+01	chronic cs	EcoRisk 3.2	2.83E+03	7.00E+02	chronic cs	EcoRisk 3.2
Acenaphthylene	7.00E+01	chronic cs	EcoRisk 3.2	2.83E+03	7.00E+02	chronic cs	EcoRisk 3.2
Anthracene	1.00E+02	chronic cs	EcoRisk 3.2	4.04E+03	1.00E+03	chronic cs	EcoRisk 3.2
Benzo(a)anthracene	1.70E-01	chronic cs	EcoRisk 3.2	6.87E+00	1.70E+00	chronic cs	EcoRisk 3.2
Benzo(a)pyrene	5.58E+00	chronic GMM	EcoRisk 3.2	2.25E+02	1.77E+01	chronic GMM	EcoRisk 3.2
Benzo(b)fluoranthene	4.00E+00	chronic cs	EcoRisk 3.2	1.62E+02	4.00E+01	chronic cs	EcoRisk 3.2
Benzo(ghi)perylene	7.20E+00	chronic cs	EcoRisk 3.2	2.91E+02	7.20E+01	chronic cs	EcoRisk 3.2
Benzo(k)fluoranthene	7.20E+00	chronic cs	EcoRisk 3.2	2.91E+02	7.20E+01	chronic cs	EcoRisk 3.2
Chrysene	1.70E-01	chronic cs	EcoRisk 3.2	6.87E+00	1.70E+01	chronic cs	EcoRisk 3.2
Dibenzo(a,h)anthracene	1.33E+00	chronic cs	EcoRisk 3.2	5.37E+01	1.33E+01	chronic cs	EcoRisk 3.2
Fluoranthene	1.25E+01	chronic cs	EcoRisk 3.2	5.05E+02	1.25E+02	chronic cs	EcoRisk 3.2
Fluorene	1.25E+02	chronic cs	EcoRisk 3.2	5.05E+03	2.50E+02	chronic cs	EcoRisk 3.2
Indeno(1,2,3-cd)pyrene	7.20E+00	chronic cs	EcoRisk 3.2	2.91E+02	7.20E+01	chronic cs	EcoRisk 3.2

TABLE C-3: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE KIT FOX							
Surrogate: Red Fox (Mammalian to Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Naphthalene	1.43E+01	chronic GMM	EcoRisk 3.2	5.78E+02	4.02E+01	chronic GMM	EcoRisk 3.2
Phenanthrene	5.14E+00	chronic cs	EcoRisk 3.2	2.08E+02	5.14E+01	chronic cs	EcoRisk 3.2
Pyrene	7.50E+00	chronic cs	EcoRisk 3.2	3.03E+02	7.50E+01	chronic cs	EcoRisk 3.2
Dioxin/Furans							
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	5.62E-07	chronic GMM	EcoRisk 3.2	2.27E-05	3.76E-06	chronic GMM	EcoRisk 3.2
Metals							
Aluminum (note: pH dependent)	6.20E+01	chronic	ATSDR 1999	2.50E+03	1.30E+02	chronic	ATSDR 1999
Antimony	5.90E-02	chronic cs	EcoRisk 3.2	2.38E+00	5.90E-01	chronic cs	EcoRisk 3.2
Arsenic	1.04E+00	chronic cs	EcoRisk 3.2	4.20E+01	1.66E+00	chronic cs	EcoRisk 3.2
Barium	5.18E+01	chronic GMM	EcoRisk 3.2	2.09E+03	5.18E+02	chronic GMM	EcoRisk 3.2
Beryllium	5.32E-01	chronic cs	EcoRisk 3.2	2.15E+01	5.32E+00	chronic cs	EcoRisk 3.2
Boron	2.80E+01	chronic cs	EcoRisk 3.2	1.13E+03	2.80E+02	chronic cs	EcoRisk 3.2
Cadmium	7.70E-01	chronic cs	EcoRisk 3.2	3.11E+01	7.70E+00	chronic cs	EcoRisk 3.2
Chromium (total)	2.40E+00	chronic GMM	EcoRisk 3.2	9.70E+01	2.40E+01	chronic GMM	EcoRisk 3.2
Chromium (hexavalent)	9.24E+00	chronic GMM	EcoRisk 3.2	3.73E+02	9.24E+01	chronic GMM	EcoRisk 3.2
Cobalt	7.33E+00	chronic GMM	EcoRisk 3.2	2.96E+02	7.33E+01	chronic GMM	EcoRisk 3.2
Copper	5.60E+00	chronic cs	EcoRisk 3.2	2.26E+02	9.34E+00	chronic cs	EcoRisk 3.2
Lead	4.70E+00	chronic cs	EcoRisk 3.2	1.90E+02	8.90E+00	chronic cs	EcoRisk 3.2
Manganese	5.15E+01	chronic GMM	EcoRisk 3.2	2.08E+03	5.15E+02	chronic GMM	EcoRisk 3.2
Mercury (inorganic)	1.41E+00	chronic cs	EcoRisk 3.2	5.70E+01	1.41E+01	chronic cs	EcoRisk 3.2
Nickel	1.70E+00	chronic cs	EcoRisk 3.2	6.87E+01	3.40E+00	chronic cs	EcoRisk 3.2
Selenium	1.43E-01	chronic cs	EcoRisk 3.2	5.78E+00	2.15E-01	chronic cs	EcoRisk 3.2
Silver	6.02E+00	chronic cs	EcoRisk 3.2	2.43E+02	6.02E+01	chronic cs	EcoRisk 3.2
Thallium	7.10E-03	chronic cs	EcoRisk 3.2	2.87E-01	7.10E-02	chronic cs	EcoRisk 3.2
Vanadium	4.16E+00	chronic cs	EcoRisk 3.2	1.68E+02	8.31E+00	chronic cs	EcoRisk 3.2
Zinc	7.54E+01	chronic GMM	EcoRisk 3.2	3.05E+03	7.54E+02	chronic GMM	EcoRisk 3.2

TABLE C-3: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE KIT FOX							
Surrogate: Red Fox (Mammalian to Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Miscellaneous							
Nitrite	5.07E+02	chonic cs	Sample 1996	2.05E+04			
Cyanide (CN-)	6.87E+01	chronic cs	EcoRisk 3.2	2.78E+03	6.87E+02	chronic cs	EcoRisk 3.2
Explosives							
Trinitrobenzene, 1,3,5-	1.34E+01	chronic cs	EcoRisk 3.2	5.41E+02	1.34E+02	chronic cs	EcoRisk 3.2
Dinitrobenzene, 1,3-	1.13E-01	chronic cs	EcoRisk 3.2	4.57E+00	2.64E-01	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2,4-	2.68E+00	chronic cs	EcoRisk 3.2	1.08E+02	2.68E+01	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2,6-	1.77E+00	chronic cs	EcoRisk 3.2	7.15E+01	1.77E+01	chronic cs	EcoRisk 3.2
Trinitrotoluene, 2,4,6-	3.47E+01	chronic cs	EcoRisk 3.2	1.40E+03	1.60E+02	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2-Amino-4,6-	1.39E+01	chronic cs	EcoRisk 3.2	5.62E+02	1.39E+02	chronic cs	EcoRisk 3.2
Nitrotoluene, o-	8.91E+00	chronic cs	EcoRisk 3.2	3.60E+02	8.91E+01	chronic cs	EcoRisk 3.2
Nitrotoluene, m-	1.07E+01	chronic cs	EcoRisk 3.2	4.32E+02	1.07E+02	chronic cs	EcoRisk 3.2
Dinitrotoluene, 4-Amino-2,6-	9.59E+00	chronic cs	EcoRisk 3.2	3.87E+02	9.59E+01	chronic cs	EcoRisk 3.2
Nitrotoluene, p-	1.96E+01	chronic cs	EcoRisk 3.2	7.92E+02	1.96E+02	chronic cs	EcoRisk 3.2
PETN	7.00E+01	chronic cs	EcoRisk 3.2	2.83E+03	7.00E+02	chronic cs	EcoRisk 3.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	8.94E+00	chronic GMM	EcoRisk 3.2	3.61E+02	2.83E+01	chronic GMM	EcoRisk 3.2
Tetryl (Trinitrophenylmethylnitramine)	1.30E+00	chronic cs	EcoRisk 3.2	5.25E+01	6.20E+00	chronic cs	EcoRisk 3.2
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	7.50E+01	chronic cs	EcoRisk 3.2	3.03E+03	2.00E+02	chronic cs	EcoRisk 3.2
Nitroglycerin	9.64E+01	chronic cs	EcoRisk 3.2	3.89E+03	1.02E+03	chronic cs	EcoRisk 3.2

[a]chronic cs - TRV based on a critical study (two or less data), chronic GMM - TRV based on geometric mean (three or more relevent data)
[b] EcoRisk 3.2 - includes uncertainty factors for extrapolation to chronic NOAEL and
LOAEL (see Uncertanty Factor's tab)

TABLE C-4: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE RED-TAILED HAWK							
Surrogate: American Kestral (Avian Top Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
VOCs							
Acetone	2.01E+02	chronic cs	EcoRisk 3.2	7.32E+03	2.01E+03	chronic cs	EcoRisk 3.2
1,2-Dichloroethane	4.60E+00	chronic cs	EcoRisk 3.2	1.67E+02	9.10E+00	chronic cs	EcoRisk 3.2
Hexachlorobenzene	5.00E+00	chronic cs	EcoRisk 3.2	1.82E+02	5.00E+01	chronic cs	EcoRisk 3.2
2-Hexanone	1.00E+00	chronic cs	EcoRisk 3.2	3.64E+01	1.00E+01	chronic cs	EcoRisk 3.2
Xylene (total)	1.07E+02	chronic cs	EcoRisk 3.2	3.89E+03	1.07E+03	chronic cs	EcoRisk 3.2
SVOCs							
Bis(2-ethylhexyl) phthalate	1.10E+00	chronic cs	EcoRisk 3.2	4.00E+01	1.10E+01	chronic cs	EcoRisk 3.2
2-Chlorophenol	1.13E+00	chronic cs	EcoRisk 3.2	4.11E+01	1.13E+01	chronic cs	EcoRisk 3.2
Di-n-butyl phthalate	1.40E-01	chronic cs	EcoRisk 3.2	5.10E+00	1.40E+00	chronic cs	EcoRisk 3.2
Pentachlorophenol	6.73E+00	chronic cs	EcoRisk 3.2	2.45E+02	6.73E+01	chronic cs	EcoRisk 3.2
Pestcides/Herbicides							
4,4'-DDD	1.60E-02	chronic GMM	EcoRisk 3.2	5.82E-01	8.30E-02	chronic GMM	EcoRisk 3.2
4,4'-DDE	4.80E-01	chronic GMM	EcoRisk 3.2	1.75E+01	2.40E+00	chronic GMM	EcoRisk 3.2
4,4'-DDT	2.01E+00	chronic GMM	EcoRisk 3.2	7.32E+01	5.96E+00	chronic GMM	EcoRisk 3.2
alpha-Chlordane	2.14E+00	chronic cs	EcoRisk 3.2	7.79E+01	1.07E+01	chronic cs	EcoRisk 3.2
beta-BHC	3.83E+01	chronic cs	EcoRisk 3.2	1.39E+03	3.83E+02	chronic cs	EcoRisk 3.2
Dieldrin	7.09E-02	chronic cs	EcoRisk 3.2	2.58E+00	3.78E+00	chronic cs	EcoRisk 3.2
Endosulfan I	1.00E+01	chronic cs	EcoRisk 3.2	3.64E+02	1.00E+02	chronic cs	EcoRisk 3.2
Endosulfan II	1.00E+01	chronic cs	EcoRisk 3.2	3.64E+02	1.00E+02	chronic cs	EcoRisk 3.2
Endrin	1.00E-02	chronic cs	EcoRisk 3.2	3.64E-01	1.00E-01	chronic cs	EcoRisk 3.2
gamma-BHC (Lindane)	5.60E-01	chronic cs	EcoRisk 3.2	2.04E+01	2.25E+00	chronic cs	EcoRisk 3.2
gamma-Chlordane	2.14E+00	chronic cs	EcoRisk 3.2	7.79E+01	1.07E+01	chronic cs	EcoRisk 3.2
Heptachlor	9.20E-01	chronic cs	EcoRisk 3.2	3.35E+01	9.20E+00	chronic cs	EcoRisk 3.2
Methoxychlor	2.58E+01	chronic cs	EcoRisk 3.2	9.39E+02	2.58E+02	chronic cs	EcoRisk 3.2
Aroclors							
Aroclor 1260	2.15E+00	chronic GMM	EcoRisk 3.2	7.83E+01	3.04E+00	chronic cs	EcoRisk 3.2

TABLE C-4: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE RED-TAILED HAWK							
Surrogate: American Kestral (Avian Top Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
Aroclor 1254	1.00E-01	chronic cs	EcoRisk 3.2	3.64E+00	1.00E+00	chronic cs	EcoRisk 3.2
PAHs							
Benzo(a)anthracene	1.07E-01	chronic cs	EcoRisk 3.2	3.89E+00	1.07E+00	chronic cs	EcoRisk 3.2
Naphthalene	1.50E+01	chronic cs	EcoRisk 3.2	5.46E+02	1.50E+02	chronic cs	EcoRisk 3.2
Pyrene	2.05E+01	chronic cs	EcoRisk 3.2	7.46E+02	2.05E+02	chronic cs	EcoRisk 3.2
Metals							
Aluminum (Note: pH dependent)	1.10E+02	chronic	Sample 1996	4.00E+03			
Arsenic	2.24E+00	chronic GMM	EcoRisk 3.2	8.15E+01	2.24E+01	chronic GMM	EcoRisk 3.2
Barium	7.35E+01	chronic GMM	EcoRisk 3.2	2.68E+03	1.31E+02	chronic GMM	EcoRisk 3.2
Boron	2.92E+00	chronic GMM	EcoRisk 3.2	1.06E+02	1.45E+01	chronic GMM	EcoRisk 3.2
Cadmium	1.47E+00	chronic GMM	EcoRisk 3.2	5.35E+01	1.47E+01	chronic GMM	EcoRisk 3.2
Chromium (total)	2.66E+00	chronic GMM	EcoRisk 3.2	9.68E+01	2.66E+01	chronic GMM	EcoRisk 3.2
Chromium (hexavalent)	1.10E+01	chronic cs	EcoRisk 3.2	4.00E+02	1.10E+02	chronic cs	EcoRisk 3.2
Cobalt	7.61E+00	chronic GMM	EcoRisk 3.2	2.77E+02	7.61E+01	chronic GMM	EcoRisk 3.2
Copper	4.05E+00	chronic cs	EcoRisk 3.2	1.47E+02	1.21E+01	chronic cs	EcoRisk 3.2
Lead	1.63E+00	chronic cs	EcoRisk 3.2	5.93E+01	3.26E+00	chronic cs	EcoRisk 3.2
Manganese	1.79E+02	chronic GMM	EcoRisk 3.2	6.52E+03	1.79E+03	chronic GMM	EcoRisk 3.2
Mercury (inorganic)	1.90E-02	chronic cs	EcoRisk 3.2	6.92E-01	1.90E-01	chronic cs	EcoRisk 3.2
Molybdenum	3.50E+00	chronic cs	EcoRisk 3.2	1.27E+02	3.50E+01	chronic cs	EcoRisk 3.2
Nickel	6.71E+00	chronic cs	EcoRisk 3.2	2.44E+02	6.71E+01	chronic cs	EcoRisk 3.2
Selenium	2.90E-01	chronic cs	EcoRisk 3.2	1.06E+01	5.79E-01	chronic cs	EcoRisk 3.2
Silver	2.02E+00	chronic cs	EcoRisk 3.2	7.35E+01	2.02E+01	chronic cs	EcoRisk 3.2
Thallium	3.50E-01	chronic cs	EcoRisk 3.2	1.27E+01	3.50E+00	chronic cs	EcoRisk 3.2
Vanadium	3.44E-01	chronic cs	EcoRisk 3.2	1.25E+01	6.88E-01	chronic cs	EcoRisk 3.2
Zinc	6.61E+01	chronic GMM	EcoRisk 3.2	2.41E+03	6.61E+02	chronic GMM	EcoRisk 3.2
Miscellaneous							
Cyanide (CN-)	4.00E-02	chronic cs	EcoRisk	1.46E+00	4.00E-01	chronic cs	EcoRisk

TABLE C-4: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE RED-TAILED HAWK							
Surrogate: American Kestral (Avian Top Carnivore)	**Tier 1**				**Tier 2**		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type[a]**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type[a]**	**Source**
			3.2				3.2
Explosives							
Dinitrobenzene, 1,3-	4.22E-01	chronic cs	EcoRisk 3.2	1.54E+01	4.22E+00	chronic cs	EcoRisk 3.2
Dinitrotoluene, 2,6-	6.00E+01	chronic cs	EcoRisk 3.2	2.18E+03	6.00E+02	chronic cs	EcoRisk 3.2
Trinitrotoluene, 2,4,6-	9.75E+00	chronic cs	EcoRisk 3.2	3.55E+02	1.78E+01	chronic cs	EcoRisk 3.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	2.36E+00	chronic GMM	EcoRisk 3.2	8.59E+01	4.49E+00	chronic GMM	EcoRisk 3.2

[a]chronic cs - TRV based on a critical study (two or less data), chronic GMM - TRV based on geometric mean (three or more relevent data)

[b] EcoRisk 3.2 - includes uncertainty factors for extrapolation to chronic NOAEL and LOAEL (see Uncertanty Factor's tab)

TABLE C-5: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR THE PRONGHORN ANTELOPE							
	Tier 1				Tier 2		
Constituent	**TRV NOAEL (mg/kg/day)**	**Type**	**Source**	**Screening Level (mg/kg)**	**TRV LOAEL (mg/kg/day)**	**Type**	**Source**
Metals							
Arsenic	1.25E-01	subchronic	NAS, 1972	3.61E+01	1.56E-01	subchronic	NAS, 1972
Cobalt	2.00E-01	chronic	NAS, 1980	5.77E+01	2.50E-01	chronic	NAS, 1980
Lead	6.00E-01	chronic	NAS, 1980	1.73E+02	7.50E-01	chronic	NAS, 1980
Manganese	2.00E+01	chronic	NAS, 1980	5.77E+03	2.50E+01	chronic	NAS, 1980
Molybdenum	4.00E+00	chronic	NAS, 1972	1.15E+03	5.00E+00	chronic	NAS, 1972
Nickel	1.00E+00	chronic	NAS, 1980	2.89E+02	1.25E+00	chronic	NAS, 1980
Silver	1.00E-02	acute	Gough, 1979	2.89E+00			
Vanadium	1.00E+00	chronic	NAS, 1980	2.89E+02	1.25E+00	chronic	NAS, 1980
Zinc	1.00E+01	chronic	NAS, 1980	2.89E+03	1.25E+01	chronic	NAS, 1980

TABLE C-6: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR PLANTS						
	Tier 1			Tier 2		
Constituent	Effect Concentration NOAEL (mg/kg)	Type[a]	Source	Effect Concentration LOAEL (mg/kg)	Type[a]	Source
VOCs						
Hexachlorobenzene	1.00E+01	chronic cs	EcoRisk 3.2	1.00E+02	chronic cs	EcoRisk 3.2
Methylene chloride	1.67E+03	chronic cs	EcoRisk 3.2	1.67E+04	chronic cs	EcoRisk 3.2
Styrene	3.20E+00	chronic cs	EcoRisk 3.2	3.20E+01	chronic cs	EcoRisk 3.2
Tetrachloroethene	1.00E+01	chronic cs	EcoRisk 3.2	1.00E+02	chronic cs	EcoRisk 3.2
Toluene	2.00E+02	chronic cs	EcoRisk 3.2	2.00E+03	chronic cs	EcoRisk 3.2
Xylene (total)	1.00E+02	chronic cs	EcoRisk 3.2	1.00E+03	chronic cs	EcoRisk 3.2
SVOCs						
Dibenzofuran	6.17E+00	chronic cs	EcoRisk 3.2	6.17E+01	chronic cs	EcoRisk 3.2
Di-n-butyl phthalate	1.67E+02	chronic GMM	EcoRisk 3.2	6.01E+02	chronic GMM	EcoRisk 3.2
Diethyl phthalate	1.00E+02	chronic cs	EcoRisk 3.2	1.00E+03	chronic cs	EcoRisk 3.2
Hexachlorobenzene	1.00E+01	chronic cs	EcoRisk 3.2	1.00E+02	chronic cs	EcoRisk 3.2
2-Methylphenol	6.70E-01	chronic cs	EcoRisk 3.2	6.70E+00	chronic cs	EcoRisk 3.2
3-Methylphenol	6.90E-01	chronic cs	EcoRisk 3.2	6.90E+00	chronic cs	EcoRisk 3.2
Pentachlorophenol	5.00E+00	chronic GMM	EcoRisk 3.2	5.00E+01	chronic GMM	EcoRisk 3.2
Phenol	7.90E-01	chronic cs	EcoRisk 3.2	7.90E+00	chronic cs	EcoRisk 3.2
Pestcides/Herbicides						
gamma-BHC (Lindane)	1.00E-01	chronic cs	EcoRisk 3.2	1.00E+00	chronic cs	EcoRisk 3.2
alpha-Chlordane	2.24E+00	chronic cs	EcoRisk 3.2	2.24E+01	chronic cs	EcoRisk 3.2
gamma-Chlordane	2.24E+00	chronic cs	EcoRisk 3.2	2.24E+01	chronic cs	EcoRisk 3.2
4,4'-DDT	4.10E+00	chronic GMM	EcoRisk 3.2	6.10E+00	chronic GMM	EcoRisk 3.2
Dieldrin	1.00E+01	chronic cs	EcoRisk 3.2	1.00E+02	chronic cs	EcoRisk 3.2
Endrin	3.40E-03	chronic cs	EcoRisk 3.2	3.40E-02	chronic cs	EcoRisk 3.2
Heptachlor	4.08E-01	chronic cs	EcoRisk 3.2	4.08E+00	chronic cs	EcoRisk 3.2
Aroclors						
Aroclor 1254	1.63E+02	chronic GMM	EcoRisk 3.2	6.20E+02	chronic GMM	EcoRisk 3.2
PAHs						
Acenaphthene	2.50E-01	chronic cs	EcoRisk 3.2	2.50E+00	chronic cs	EcoRisk 3.2
Anthracene	6.88E+00	chronic GMM	EcoRisk 3.2	8.95E+00	chronic GMM	EcoRisk 3.2
Benzo(a)anthracene	1.80E+01	chronic cs	EcoRisk 3.2	1.80E+02	chronic cs	EcoRisk 3.2
Benzo(b)fluoranthene	1.80E+01	chronic cs	EcoRisk 3.2	1.80E+02	chronic cs	EcoRisk 3.2
Naphthalene	1.00E+00	chronic cs	EcoRisk 3.2	1.00E+01	chronic cs	EcoRisk 3.2
Metals						

TABLE C-6: TIER 1 TRVS AND ESLS AND TIER 2 TRVS FOR PLANTS						
	Tier 1			Tier 2		
Constituent	Effect Concentration NOAEL (mg/kg)	Type[a]	Source	Effect Concentration LOAEL (mg/kg)	Type[a]	Source
Antimony	1.14E+01	chronic GMM	EcoRisk 3.2	5.80E+01	chronic GMM	EcoRisk 3.2
Arsenic	1.80E+01	chronic GMM	EcoRisk 3.2	9.10E+01	chronic GMM	EcoRisk 3.2
Barium	1.18E+02	chronic GMM	EcoRisk 3.2	2.61E+02	chronic GMM	EcoRisk 3.2
Beryllium	2.50E+00	chronic cs	EcoRisk 3.2	2.50E+01	chronic cs	EcoRisk 3.2
Boron	3.68E+01	chronic GMM	EcoRisk 3.2	8.66E+01	chronic GMM	EcoRisk 3.2
Cadmium	3.20E+01	chronic GMM	EcoRisk 3.2	1.60E+02	chronic GMM	EcoRisk 3.2
Chromium (hexavalent)	3.50E-01	chronic cs	EcoRisk 3.2	3.50E+00	chronic cs	EcoRisk 3.2
Cobalt	1.30E+01	chronic GMM	EcoRisk 3.2	1.34E+02	chronic GMM	EcoRisk 3.2
Copper	7.00E+01	chronic GMM	EcoRisk 3.2	4.97E+02	chronic GMM	EcoRisk 3.2
Lead	1.20E+02	chronic GMM	EcoRisk 3.2	5.76E+02	chronic GMM	EcoRisk 3.2
Manganese	2.20E+02	chronic GMM	EcoRisk 3.2	1.10E+03	chronic GMM	EcoRisk 3.2
Mercury (inorganic)	3.49E+01	chronic cs	EcoRisk 3.2	6.40E+01	chronic cs	EcoRisk 3.2
Nickel	3.80E+01	chronic GMM	EcoRisk 3.2	2.76E+02	chronic GMM	EcoRisk 3.2
Selenium	5.20E-01	chronic GMM	EcoRisk 3.2	3.40E+00	chronic GMM	EcoRisk 3.2
Silver	5.60E+02	chronic GMM	EcoRisk 3.2	2.81E+03	chronic GMM	EcoRisk 3.2
Thallium	5.00E-02	chronic cs	EcoRisk 3.2	5.00E-01	chronic cs	EcoRisk 3.2
Vanadium	6.00E+01	chronic cs	EcoRisk 3.2	8.00E+01	chronic cs	EcoRisk 3.2
Zinc	1.60E+02	chronic GMM	EcoRisk 3.2	8.12E+02	chronic GMM	EcoRisk 3.2
Explosives						
Dinitrotoluene, 2,4-	6.00E+00	EPA Eco SSL	EcoRisk 3.2	6.00E+01	EPA Eco SSL	EcoRisk 3.2
Trinitrotoluene, 2,4,6-	6.21E+01	chronic GMM	EcoRisk 3.2	1.26E+02	chronic GMM	EcoRisk 3.2
Dinitrotoluene, 2-Amino-4,6-	1.40E+01	EPA Eco SSL	EcoRisk 3.2	1.40E+02	EPA Eco SSL	EcoRisk 3.2
Dinitrotoluene, 4-Amino-2,6-	3.30E+01	EPA Eco SSL	EcoRisk 3.2	3.30E+02	EPA Eco SSL	EcoRisk 3.2
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2.74E+03	chronic GMM	EcoRisk 3.2	3.56E+03	chronic GMM	EcoRisk 3.2
Nitroglycerin	2.10E+01	EPA Eco SSL	EcoRisk 3.2	2.10E+02	EPA Eco SSL	EcoRisk 3.2

[a]chronic cs - TRV based on a critical study (two or less data), chronic GMM - TRV based on geometric mean (three or more relevent data)

[b] EcoRisk 3.2 - includes uncertainty factors for extrapolation to chronic NOAEL and LOAEL (see Uncertanty Factor's tab)

Appendix B

Field Methods

Groundwater Sampling

Groundwater Elevation

All water/product levels are determined to an accuracy of 0.01 foot using a Geotech Interface Meter. The technician records separate phase hydrocarbon, depth to water, and total well depth using this probe.

Water Quality/Groundwater Sampling

Water quality parameters are measured using an YSI Professional Plus instrument. Electrical conductance, oxidation-reduction potential (ORP), pH, temperature, and dissolved oxygen are monitored during purging.

Well Purging Technique

At least three well volumes are purged from the well. Purge volumes are determined using the following equation:

(Well depth) – (Casing height) – (Depth to Liquid) x (Conversion Factor) x 3

The conversion factor is determined by the diameter of the well casing.

Casing	Conversion Factor
6”	1.50 gal/ft
5”	1.02 gal/ft
4”	0.74 gal/ft
3”	0.367 gal/ft
2”	0.163 gal/ft

Well Sampling and Sample Handling Procedure

Equipment and supplies needed for collecting representative groundwater samples include:

- Interface Probe
- YSI Professional Plus
- Distilled Water
- Disposable Nitrile Gloves
- Disposable Bailers

- String/Twine
- Cooler with Ice
- Bottle kits with Preservatives (provided by the contract laboratory)
- Sharpie Permanent Marker
- Field Paperwork/Log sheet
- Two 5-gallon buckets
- Trash container (plastic garbage bag)
- Ziploc Bags
- Paper towels

Typically disposable bailers are used for purging and sampling. Each bailer holds one liter of liquid. Three well volumes can be calculated by counting the number of times a well is bailed. All purged water is poured into a 55-gallon drum designated for sampling events.

After sufficient purging, samples are collected with the bailer and poured into the appropriate sample containers. Two people are usually utilized for sampling. Sampling takes place over a bucket to insure that spills are contained

Samples are labeled immediately with location, date, time, analysis, preservative, and sampler. Then they are put in a Ziploc bag and placed in a cooler holding sufficient ice to keep them cool. The field log sheet is reviewed to verify all entries.

Purge and Decontamination Water Disposal

The YSI Professional Plus and the interface probe are rinsed with distilled water after every well. The rinse procedure takes place over a bucket to insure that spills are contained. All rinse and purge water is contained and then disposed of through the refinery wastewater system.

Instrument Calibration

Calibration of the YSI Professional Plus occurs at the beginning of each day of sampling. The probe is powered on and allowed to stabilize, which usually takes 15 minutes. The calibration menu is selected. The LCD screen runs through a list of selections to specify units, calibration solutions, etc. The calibrations procedures outlined in the YSI Professional Plus instruction manual are followed.

Appendix C

Hall Environmental Analysis Laboratory

QUALITY ASSURANCE PLAN

Effective Date: March 11th, 2016

Revision 10.1

www.hallenvironmental.com

Control Number: 00000177

Approved By:

Andy Freeman — Date: 3/9/16
Laboratory Manager

Approved By:

Ian Cameron — Date: 3/9/16
Quality Assurance/Quality Control Officer

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John Caldwell 3-9-16
John Caldwell Date
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3/9/16
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Rene Aguilera Date
Volatiles Technical Director

3/9/16
Tiffany Shaw Date
Metals Technical Director

Stacey McCoy 3/9/16
Stacey McCoy Date
Wet Chemistry Technical Director

Stacey McCoy Stacey McCoy 3/9/16 (acting)
Stephanie Shaffers Date
Microbiology Technical Director

Table of Contents

3.0 Introduction

Purpose of Document

The purpose of this Quality Assurance Plan is to formally document the quality assurance policies and procedures of Hall Environmental Analysis Laboratory, Inc. (HEAL), for the benefit of its employees, clients, and accrediting organizations. HEAL continually implements all aspects of this plan as an essential and integral part of laboratory operations in order to ensure that high quality data is produced in an efficient and effective manner.

Objectives

The objective of HEAL is to achieve and maintain excellence in environmental testing. This is accomplished by developing, incorporating and documenting the procedures and policies specified by each of our accrediting authorities and outlined in this plan. These activities are carried out by a laboratory staff that is analytically competent, well-qualified, and highly trained. An experienced management team, knowledgeable in their area of expertise, monitors them. Finally, a comprehensive quality assurance program governs laboratory practices and ensures that the analytical results are valid, defensible, reproducible, reconstructable and of the highest quality.

HEAL establishes and thoroughly documents its activities to ensure that all data generated and processed will be scientifically valid and of known and documented quality. Routine laboratory activities are detailed in method specific standard operating procedures (SOP). All data reported meets the applicable requirements for the specific method or methods that are referenced, ORELAP, TCEQ, EPA, client specific requirements and/or State Bureaus. In the event that these requirements are ever in contention with each other, it is HEAL's policy to always follow the most prudent requirement available. For specific method requirements refer to HEAL's Standard Operating Procedures (SOP's), EPA methods, Standard Methods 20th edition, ASTM methods or state specific methods.

HEAL management ensures that this document is correct in terms of required accuracy and data reproducibility, and that the procedures contain proper quality control measures. HEAL management additionally ensures that all equipment is reliable, well-maintained and appropriately calibrated. The procedures and practices of the laboratory are geared towards not only strictly following our regulatory requirements but also allowing the flexibility to conform to client specific specifications. Meticulous records are maintained for all samples and their respective analyses so that results are well-documented and defensible in a court of law.

The HEAL Quality Assurance/Quality Control Officer (QA/QCO) and upper management are responsible for supervising and administering this quality assurance program, and

ensuring each individual is responsible for its proper implementation. All HEAL management remains committed to the encouragement of excellence in analytical testing and will continue to provide the necessary resources and environment conducive to its achievement.

Policies

Understanding that quality cannot be mandated, it is the policy of this laboratory to provide an environment that encourages all staff members to take pride in the quality of their work. In addition to furnishing proper equipment and supplies, HEAL stresses the importance of continued training and professional development. Further, HEAL recognizes the time required for data interpretation. Therefore, no analyst should feel pressure to sacrifice data quality for data quantity. Each staff member must perform with the highest level of integrity and professional competence, always being alert to problems that could compromise the quality of their technical work.

Management and senior personnel supervise analysts closely in all operations. Under no circumstance is the willful act or fraudulent manipulation of analytical data condoned. Such acts must be reported immediately to HEAL management. Reported acts will be assessed on an individual basis and resulting actions could result in dismissal. The laboratory staff is encouraged to speak with lab managers or senior management if they feel that there are any undo commercial, financial, or other pressures, which might adversely affect the quality of their work; or in the event that they suspect that data quality has been compromised in any way. HEAL's Quality Assurance/Quality Control Officer is available if any analyst and/or manager wishes to anonymously report any suspected or known breaches in data integrity.

Understanding the importance of meeting customer requirements in addition to the requirements set forth in statutory and regulatory requirements, HEAL shall periodically seek feedback from customers and evaluate the feedback in order to initiate improvements.

All proprietary rights and client information at HEAL (including national security concerns) are considered confidential. No information will be given out without the express verbal or written permission of the client. All reports generated will be held in the strictest of confidence.

HEAL shall continually improve the effectiveness of its management system through the use of the policies and procedures outlined in this Quality Assurance Plan. Quality control results, internal and external audit findings, management reviews, new and continual training and corrective and preventive actions are continually evaluated to identify possible improvements and to ensure that appropriate communication processes are taking place regarding the effectiveness of the management system. HEAL shall ensure that the

integrity of the quality system is maintained when changes to the system are planned and implemented.

This is a controlled document. Each copy is assigned a unique tracking number and when released to a client or accrediting agency the QA/QCO keeps the tracking number on file. This document is reviewed on an annual basis to ensure that it is valid and representative of current practices at HEAL.

HEAL employs the use of the 24-hour clock (or military time) when a time stamp is required to be noted. This includes, but is not limited to, time stamps on chains-of-custody, temperature logs, and bench sheets.

4.0 Organization and Responsibility

Company

HEAL is accredited in accordance with the 2009 TNI standard (see NELAC accredited analysis list in the QA Department or on the company website), through ORELAP and TCEQ and by the Arizona Department of Health Services. Additionally, HEAL is qualified as defined under the State of New Mexico Water Quality Control Commission regulations and the New Mexico State Drinking Water Bureau. HEAL is a locally owned small business that was established in 1991. HEAL is a full service environmental analysis laboratory with analytical capabilities that include both organic and inorganic methodologies and has performed analyses of soil, water, and air as well as various other matrices for many sites in the region. HEAL's client base includes local, state and federal agencies, private consultants, commercial industries as well as individual homeowners. HEAL has performed as a subcontractor to the state of New Mexico and to the New Mexico Department of Transportation. HEAL has been acclaimed by its customers as producing quality results and as being adaptive to client-specific needs.

The laboratory is divided into an organic section, an inorganic section and a microbiology section. Each section has a designated manager/technical director. The technical directors report directly to the laboratory manager, who oversees all operations.

Certifications

ORELAP – NELAC Oregon Primary accrediting authority.

TCEQ – NELAC Texas Secondary accrediting authority.

The Arizona Department of Health Services

The New Mexico Drinking Water Bureau

See our website at www.hallenvironmental.com or the QA Office for copies of current licenses and licensed parameters.

In the event of a certification being revoked or suspended, HEAL will notify, in writing, those clients that require the affected certification.

Personnel

HEAL management ensures the competence of all who operate equipment, perform environmental tests, evaluate results, and sign test reports. Personnel performing specific tasks shall be qualified on the basis of appropriate education, training, experience and /or demonstrated skills.

HEAL ensures that all personnel are aware of the relevance and importance of their activities and how each employee contributes to the achievement of the objectives defined throughout this document.

All personnel shall be responsible for complying with HEAL's quality assurance/quality control requirements that pertain to their technical function. Each technical staff member must have a combination of experience and education to adequately demonstrate specific knowledge of their particular function and a general knowledge of laboratory operations, test methods, quality assurance/quality control procedures, and records management.

All employees' training certificates and diplomas are kept on file with demonstrations of capability for each method they perform. An Organizational Chart can be found at the end of this section and a personnel list is available in the current Controlled Document Logbook.

Laboratory Director

The Laboratory Director is responsible for overall technical direction and business leadership of HEAL. The Laboratory Manager, the Project Manager and Quality Assurance/Quality Control Officer report directly to the Laboratory Director. Someone with a minimum of 7 years of directly related experience and a bachelor's degree in a scientific or engineering discipline should fill this position.

Laboratory Manager/Lead Technical Director

The Laboratory Manager shall exercise day–to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results. The Laboratory Manager shall be experienced in the fields of accreditation for which the laboratory is approved or seeking accreditation. The Laboratory Manager shall certify that personnel with appropriate educational and/or technical background perform all tests for which HEAL is accredited. Such certification shall be documented.

The Laboratory Manager shall monitor standards of performance in quality control and quality assurance and monitor the validity of the analyses performed and data generated at HEAL to assure reliable data.

The Laboratory Manager is responsible for the daily operations of the laboratory. The Laboratory Manager is the lead technical director of the laboratory and, in conjunction with the section technical directors, is responsible for coordinating activities within the laboratory with the overall goal of efficiently producing high quality data within a reasonable time frame.

In events where employee scheduling or current workload is such that new work cannot be incorporated, without missing hold times, the Laboratory Manager has authority to modify employee scheduling, re-schedule projects or, when appropriate, allocate the work to approved subcontracting laboratories.

Additionally, the laboratory manager reviews and approves new analytical procedures and methods, and performs a final review of most analytical results. The Laboratory Manager provides technical support to both customers and HEAL staff.

The Laboratory Manager also observes the performance of supervisors to ensure that good laboratory practices and proper techniques are being taught and utilized, and to assist in overall quality control implementation and strategic planning for the future of the company. Other duties include assisting in establishing laboratory policies that lead to the fulfillment of requirements for various certification programs, assuring that all Quality Assurance and Quality Control documents are reviewed and approved, and assisting in conducting Quality Assurance Audits.

The laboratory manager addresses questions or complaints that cannot be answered by the section managers.

The Laboratory Manager shall have a bachelor's degree in a chemical, environmental, biological sciences, physical sciences or engineering field, and at least five years of experience in the environmental analysis of representative inorganic and organic analytes for which the laboratory seeks or maintains accreditation.

Assistant Laboratory Manager

The Assistant Laboratory Manager shall aid the Laboratory Manager in exercising day–to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results. The Assistant Laboratory Manager shall be experienced in the fields of accreditation for which the laboratory is approved or seeking accreditation.

The Assistant Laboratory Manager is responsible for helping the Laboratory Manager in the daily operations of the laboratory. In conjunction with the section Technical Directors, the Assistant Laboratory Manager is responsible for coordinating activities within the laboratory with the overall goal of efficiently producing high quality data within a reasonable time frame.

The Assistant Laboratory Manager shall have at least ten years of experience in environmental analysis of representative inorganic and/or organic analytes for which the laboratory seeks or maintains accreditation.

Quality Assurance Quality Control Officer

The Quality Assurance/Quality Control Officer (QA/QCO) serves as the focal point for QA/QC and shall be responsible for the oversight and/or review of quality control data. The QA/QCO functions independently from laboratory operations and shall be empowered to halt unsatisfactory work and/or prevent the reporting of results generated from an out-of-control measurement system. The QA/QCO shall objectively evaluate data and perform assessments without any outside/managerial influence. The QA/QCO shall have direct access to the highest level of management at which decisions are made on laboratory policy and/or resources. The QA/QCO shall notify laboratory management of deficiencies in the quality system in periodic, independent reports.

The QA/QCO shall have general knowledge of the analytical test methods for which data review is performed and have documented training and/or experience in QA/QC procedures and in the laboratory's quality system. The QA/QCO will have a minimum of a BS in a scientific or related field and a minimum of three years of related experience.

The QA/QCO shall schedule and conduct internal audits as per the Internal Audit SOP at least annually, monitor and trend Corrective Action Reports as per the Data Validation SOP, periodically review control charts for out of control conditions, and initiate any appropriate corrective actions.

The QA/QCO shall oversee the analysis of proficiency testing in accordance with our standards and monitor any corrective actions issued as a result of this testing.

The QA/QCO reviews all standard operating procedures and statements of work in order to assure their accuracy and compliance to method and regulatory requirements.

The QA/QCO shall be responsible for maintaining and updating this quality manual.

Project Managers

The role of the project manager is to act as a liaison between HEAL and our clients. The Project Manager updates clients on the status of projects in-house, prepares quotations for new work, and is responsible for HEAL's marketing effort.

All new work is assessed by the Project Manager and reviewed with the other managers so as to not exceed the laboratory's capacity. In events where employee scheduling or current workload is such that new work cannot be incorporated without missing hold times, the Project Manager has authority to re-schedule projects.

It is also the duty of the project manager to work with the Laboratory Manager and QA/QCO to insure that before new work is undertaken, the resources required and accreditations requested are available to meet the client's specific needs.

Additionally, the Project Manager can initiate the review of the need for new analytical procedures and methods, and perform a final review of some analytical results. The Project Manager provides technical support to customers. Someone with a minimum of 2 years of directly related experience and a bachelor's degree in a scientific or engineering discipline should fill this position.

Technical Directors

Technical Directors are full-time members of the staff at HEAL who exercise day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results for their department within HEAL. A Technical Director's duties shall include, but not be limited to, monitoring standards of performance in quality control and quality assurance, monitoring the validity of the analyses performed and the data generated in their sections to ensure reliable data, overseeing training and supervising departmental staff, scheduling incoming work for their sections, and monitoring laboratory personnel to ensure that proper procedures and techniques are being utilized. They supervise and implement new Quality Control procedures as directed by the QA/QCO, update and maintain quality control records including, but not limited to, training forms, IDOCs, ADOCPs, and MDLs, and evaluate laboratory personnel in their Quality Control activities. In addition, technical directors are responsible for upholding the spirit and intent of HEAL's data integrity procedures.

As Technical Directors of their associated section, they review analytical data to acknowledge that data meets all criteria set forth for good Quality Assurance practices. Someone with a minimum of 2 years of experience in the environmental analysis of representative analytes for which HEAL seeks or maintains accreditation and a bachelor's degree in a scientific or related discipline should fill this position.

The education requirements for a Technical Director may be waived at the discretion of HEAL's accrediting agencies.

Health and Safety / Chemical Hygiene Officer

Refer to the most recent version of the Health and Safety and Chemical Hygiene Plans for the roles, responsibilities, and basic requirements of the Health and Safety Officer (H&SO) and the Chemical Hygiene Officer (CHO). These jobs can be executed by the same employee.

Analyst I, II and III

Analysts are responsible for the analysis of various sample matrices including, but not limited to, solid, aqueous, and air, as well as the generation of high quality data in accordance with the HEAL SOPs and QA/QC guidelines in a reasonable time as prescribed by standard turnaround schedules or as directed by the Section Manager or Laboratory Manager.

Analysts are responsible for making sure all data generated is entered in the database in the correct manner and the raw data is reviewed, signed and delivered to the appropriate peer for review. An analyst reports daily to the section manager and will inform them as to material needs of the section specifically pertaining to the analyses performed by the analyst. Additional duties may include preparation of samples for analysis, maintenance of lab instruments or equipment, and cleaning and providing technical assistance to lower level laboratory staff.

The senior analyst in the section may be asked to perform supervisory duties as related to operational aspects of the section. The analyst may perform all duties of a lab technician.

The position of Analyst is a full or part time hourly position and is divided into three levels, Analyst I, II, and III. All employees hired into an Analyst position at HEAL must begin as an Analyst I and remain there at a minimum of three months regardless of their education and experience. Analyst I must have a minimum of an AA in a related field or equivalent experience (equivalent experience means years of related experience can be substituted for the education requirement). An Analyst I is responsible for analysis, instrument operation, including calibration and data reduction. Analyst II must have a minimum of an AA in a related field or equivalent experience and must have documented and demonstrated aptitude to perform all functions of an Analyst II. An Analyst II is responsible for the full analysis of their test methods, routine instrument maintenance, purchase of consumables as dictated by their Technical Director, advanced data reduction, and basic data review. Analyst II may also assist Analyst III in method development and, as dictated by their Technical Director, may be responsible for the review and/or revision of their method specific SOPs. Analyst III must have Bachelor's degree or equivalent experience and must have documented and demonstrated aptitude to perform all functions of an Analyst III. An Analyst III is responsible for all tasks completed by an Analyst I and II as well as advanced data review, non-routine instrument maintenance, assisting their technical director in basic supervisory duties and method development.

Laboratory Technician

A laboratory technician is responsible for providing support to analysts in the organics, inorganics and disposal departments. Laboratory Technicians can assist analysts in basic sample preparation, general laboratory maintenance, glassware washing, chemical inventories, sample disposal and sample kit preparation. This position can be filled by someone without the education and experience necessary to obtain a position as an analyst.

Sample Control Manager

The sample control manager is responsible for receiving samples and reviewing the sample login information after it has been entered into the computer. The sample control manager also checks the samples against the chain-of-custody for any sample and/or labeling discrepancies prior to distribution.

The sample control manager is responsible for sending out samples to the sub-contractors along with the review and shipping of field sampling bottle kits. The sample control manager acts as a liaison between the laboratory and field sampling crew to ensure that the appropriate analytical test is assigned. If a discrepancy is noted, the sample control manager or sample custodian will contact the customer to resolve any questions or problems. The sample control manager is an integral part of the customer service team.

This position should be filled by someone with a high school diploma and a minimum of 2 years of related experience and can also be filled by a senior manager.

Sample Custodians

Sample Custodians work directly under the Sample Control Manager. They are responsible for sample intake into the laboratory and into the LIMS. Sample Custodians take orders from our clients and prepare appropriate bottle kits to meet the clients' needs. Sample Custodians work directly with the clients in properly labeling and identifying samples as well as properly filling out legal COCs. When necessary, Sample Custodians contact clients to resolve any questions or problems associated with their samples. Sample Custodians are responsible for distributing samples throughout the laboratory and are responsible for notifying analysts of special circumstances such as short holding times or improper sample preservation upon receipt.

Sample Disposal Custodian

The sample disposal custodian is responsible for characterizing and disposing of samples in accordance to the most recent version of the sample disposal SOP. The sample disposal custodian collects waste from the laboratory and transports it to the disposal warehouse for storage and eventual disposal. The sample disposal custodian is responsible for maintaining the disposal warehouse and following the requirements for documentation, integrity, chemical hygiene and health and safety as set forth in the various HEAL administrative SOPs. The sample disposal custodian is responsible for overseeing any laboratory technicians employed at the disposal warehouse.

This position should be filled by someone with a high school diploma and a minimum of 1 year of related experience.

Bookkeeper

The Bookkeeper is responsible for the preparation of quarterly financials and quarterly payroll reports. The bookkeeper monitors payables, receivables, deposits, pays all bills and maintains an inventory of administrative supplies. The Bookkeeper completes final data package assembly and oversees the consignment of final reports. The Bookkeeper assists in the project management of drinking water compliance samples for NMED and NMEFC and any other tasks as assigned by the Laboratory Manager. This position should be filled by someone with a degree in accounting or a minimum of a high school diploma and at least 4 years of directly related experience.

Administrative Assistant

The Administrative Assistant is responsible for aiding administrative staff in tasks that include but are not limited to: the processing and consignment of final reports, and the generation of client specific spreadsheets. This position should be filled by someone with a minimum of a high school diploma.

IT Specialist

The IT Specialist is responsible for the induction and maintenance of all hard and software technology not maintained through a service agreement. The IT Specialist follows the requirements of this document, all regulatory documents and the EPAs Good Automated Laboratory Practices. This position should be filled by someone with a degree in a computer related field, or at least two years of directly related experience.

Delegations in the Absence of Key Personnel

Planned absences shall be preceded by notification to the Laboratory Manager. The appropriate staff members shall be informed of the absence. In the case of unplanned absences, the superior shall either assume the responsibilities and duties or delegate the responsibilities and duties to another appropriately qualified employee.

In the event that the Laboratory Manager is absent for a period of time exceeding fifteen consecutive calendar days, another full-time staff member meeting the basic qualifications and competent to temporarily perform this function will be designated. If this absence exceeds thirty-five consecutive calendar days, HEAL will notify ORELAP in writing of the absence and the pertinent qualifications of the temporary laboratory manager.

Laboratory Personnel Qualification and Training

All personnel joining HEAL shall undergo orientation and training. During this period the new personnel shall be introduced to the organization and their responsibilities, as well as the policies and procedures of the company. They shall also undergo on-the-job training and shall work with trained staff. They will be shown required tasks and be observed while performing them.

When utilizing staff undergoing training, appropriate supervision shall be dictated and overseen by the appropriate section technical director. Prior to analyzing client samples, a new employee, or an employee new to a procedure, must meet the following basic requirements. The SOP and Method(s) for the analysis must be read and signed by the employee indicating that they read, understand, and intend to comply with the requirements of the documents. The employee must undergo documented training. Training is conducted by a senior analyst familiar with the procedure and overseen by the section Technical Director. This training is documented by any means deemed appropriate by the trainer and section Technical Director, and kept on file in the employees file located in the QA/QCO's office. The employee must perform a successful Initial Demonstration of Capability (IDOC). See the current Document Control Logbook for the training documents and checklists utilized at HEAL to ensure that all of these requirements are met. Once all of the above requirements are met it is incumbent upon the section Technical Director to determine at which point the employee can begin to perform the test unsupervised. A Certification to Complete Work Unsupervised (see the current Document Control Logbook) is then filled out by the employee and technical director.

IDOCs are required for all new analysts and methods prior to sample analysis. IDOCs are also required any time there is a change in the instrument, analyte list or method. If more than twelve months have passed since an analyst performed an IDOC and they

have not performed the method and/or have not met the continuing DOC requirements, the analyst must perform an IDOC prior to resuming the test.

All IDOCs shall be documented through the use of the certification form which can be found in the current Document Control Logbook. IDOCs are performed by analyzing four Laboratory Control Spikes (LCSs). Using the results of the LCSs the mean recovery is calculated in the appropriate reporting units and the standard deviations of the population sample (n-1) (in the same units) as well as the relative percent difference for each parameter of interest. When it is not possible or pertinent to determine mean and standard deviations HEAL assesses performance against establish and documented criteria dictated in the method SOP. The mean and standard deviation are compared to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory-generated acceptance criteria. In the event that the HEAL SOP or test method(s) fail to establish the pass/fail criteria the default limits of +/- 20% for calculated recovery and <20% relative percent difference based on the standard deviation will be utilized. If all parameters meet the acceptance criteria, the IDOC is successfully completed. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter and the analyst must either locate and correct the source of the problem and repeat the test for all parameters of interest or repeat the test for all parameters that failed to meet criteria. Repeat failure, however, confirms a general problem with the measurement system. If this occurs the source of the problem must be identified and the test repeated for all parameters of interest.

New employees that do not have prior analysis experience will not be allowed to perform analysis until they have demonstrated attention to detail with minimal errors in the assigned tasks. To ensure a sustained level of quality performance among staff members, continuing demonstration of capability shall be performed at least once a year. These are as an Annual Documentation of Continued Proficiency (ADOCP).

At least once per year an ADOCP must be completed. This is achieved by the acceptable performance of a blind sample (typically by using a PT sample, but can be a single blind (to the analyst) sample), by performing another IDOC, or by summarizing the data of four consecutive laboratory control samples with acceptable levels of precision and accuracy (these limits are those currently listed in the LIMS for an LCS using the indicated test method(s).) ADOCPs are documented using a standard form and are kept on file in each analyst's employee folder. ADOCPs may be demonstrated as an analyst group utilizing LIMS control charting, so long as all listed analysts participated, the results are consecutive and pass the requirements for precision and accuracy.

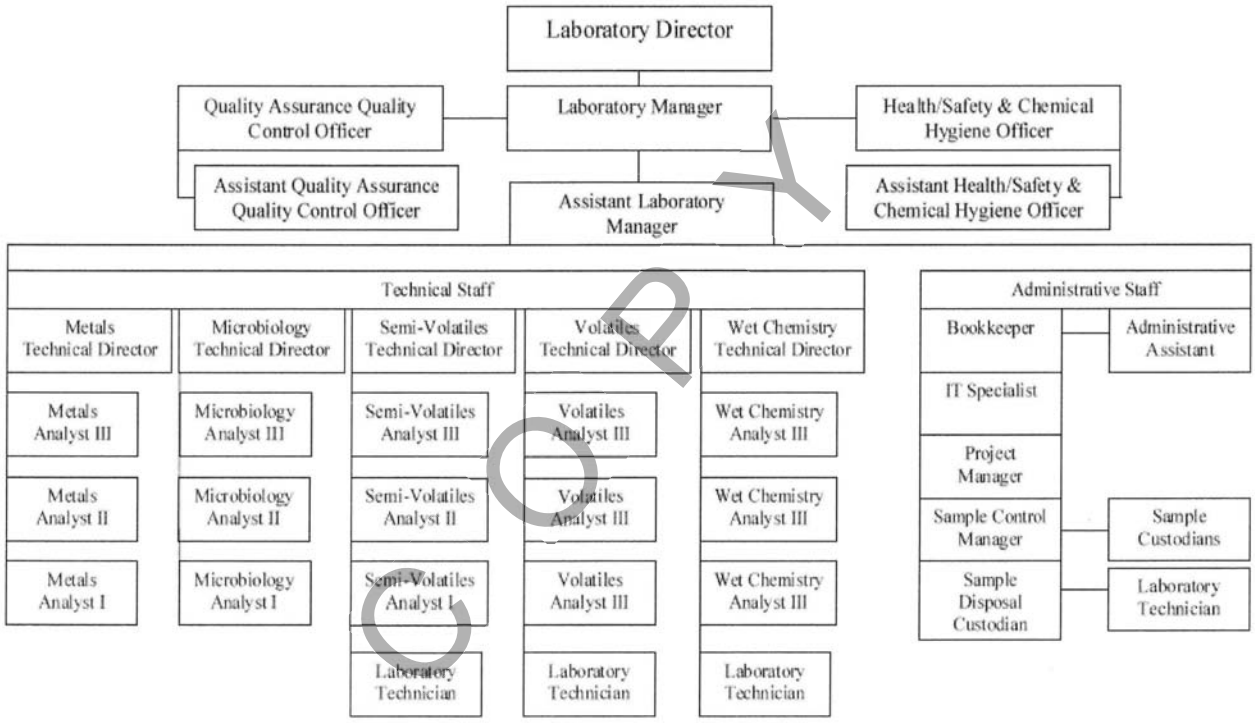
Each new employee shall be provided with data integrity training as a formal part of their new employee orientation. Each new employee will sign an ethics and data integrity agreement to ensure that they understand that data quality is our main objective. Every HEAL employee recognizes that although turnaround time is

important, quality is put above any pressure to complete the task expediently. Analysts are not compensated for passing QC parameters nor are incentives given for the quantity of work produced. Data Integrity and Ethics training are performed on an annual basis in order to remind all employees of HEAL's policy on data quality. Employees are required to understand that any infractions of the laboratory data integrity procedures will result in a detailed investigation that could lead to very serious consequences including immediate termination, debarment, or civil/criminal prosecution.

Training for each member of HEAL's technical staff is further established and maintained through documentation that each employee has read, understood, and is using the latest version of this Quality Assurance Manual. Training courses or workshops on specific equipment, analytical techniques, or laboratory procedures are documented through attendance sheets, certificates of attendance, training forms, or quizzes. This training documentation is located in analyst specific employee folders in the QA/QCO Office. On the front of all methods, SOPs, and procedures for HEAL, there is a signoff sheet that is signed by all pertinent employees, indicating that they have read, understand, and agree to perform the most recent version of the document.

The effectiveness of training will be evaluated during routine data review, annual employee reviews, and internal and external audits. Repetitive errors, complaints and audit findings serve as indicators that training has been ineffective. When training is deemed to have been ineffective a brief review of the training process will be completed and a re-training conducted as soon as possible.

HEAL Personnel Chart



5.0 Receipt and Handling of Samples

Reviewing Requests, Tenders and Contracts

All contracts and written requests by clients are closely reviewed to ensure that the client's data quality objectives can be met to their specifications. This review includes making sure that HEAL has the resources necessary to perform the tests to the clients specifications.

When HEAL is unable to meet the clients specifications their samples will be subcontracted to an approved laboratory capable of meeting the client's data quality objectives.

Sampling

Procedures

HEAL does not provide field sampling for any projects. Sample kits are prepared and provided for clients upon request. The sample kits contain the appropriate sampling containers (with a preservative when necessary), labels, blue ice (The use of "blue ice" by anyone except HEAL personnel is discouraged because it generally does not maintain the appropriate temperature of the sample. If blue ice is used, it should be completely frozen at the time of use, the sample should be chilled before packing, and special notice taken at sample receipt to be certain the required temperature has been maintained.), a cooler, chain-of-custody forms, plastic bags, bubble wrap, and any special sampling instructions. Sample kits are reviewed prior to shipment for accuracy and completeness.

Containers

Containers which are sent out for sampling are purchased by HEAL from a commercial source. Glass containers are certified "EPA Cleaned" QA level 1. Plastic containers are certified clean when required. These containers are received with a Certificate of Analysis verifying that the containers have been cleaned according to the EPA wash procedure. Containers are used once and discarded. If the samples are collected and stored in inappropriate containers the laboratory may not be able to accurately quantify the amount of the desired components. In this case, re-sampling may be required.

Preservation

If sampling for analyte(s) requires preservation, the sample custodians fortify the containers prior to shipment to the field, or provide the preservative for the sampler to add in the field. The required preservative is introduced into the vials in uniform amounts

and done so rapidly to minimize the risk of contamination. Vials that contain a preservative are labeled appropriately. If the samples are stored with inappropriate preservatives, the laboratory may not be able to accurately quantify the amount of the desired components. In this case re-sampling may be required.

Refer to the current Login SOP and/or the current price book for detailed sample receipt and handling procedures, appropriate preservation and holding time requirements.

Sample Custody

Chain-of-Custody Form

A Chain-of-Custody (COC) form is used to provide a record of sample chronology from the field to receipt at the laboratory. HEAL's COC contains the client's name, address, phone and fax numbers, the project name and number, the project manager's name, and the field sampler's name. It also identifies the date and time of sample collection, sample matrix, field sample ID number, number/volume of sample containers, sample temperature upon receipt, and any sample preservative information.

There is also a space to record the HEAL ID number assigned to samples after they are received. Next to the sample information is a space for the client to indicate the desired analyses to be performed. There is a section for the client to indicate the data package level as well as any accreditation requirements. Finally, there is a section to track the actual custody of the samples. The custody section contains lines for signatures, dates and times when samples are relinquished and received. The COC form also includes a space to record special sample related instructions, sampling anomalies, time constraints, and any sample disposal considerations.

It is paramount that all COCs arrive at HEAL complete and accurate so that the samples can be processed and allocated for testing in a timely and efficient manner. A sample chain-of-custody form can be found in the current Document Control Logbook or on line at www.hallenvironmental.com.

Should a specific project or client require the use of an internal COC, advanced notification and approval must be obtained. The use of internal COCs are not part of our standard operating procedure.

Receiving Samples

Samples are received by authorized HEAL personnel. Upon arrival, the COC is compared to the respective samples. After the samples and COC have been determined to be complete and accurate, the sampler signs over the COC. The HEAL staff member in turn signs the chain-of-custody, also noting the current date, time, and sample temperature. This relinquishes custody of the samples from the sampler and

delegates sample custody to HEAL. The first (white) copy of the COC form is filed in the appropriate sample folder. The second (yellow) copy of the COC form is filed in the COC file in the sample control manager's office. The third (pink) copy of the COC form is given to the person who has relinquished custody of the samples.

Logging in Samples and Storage

Standard Operating Procedures have been established for the receiving and tracking of all samples (refer to the current HEAL Login SOP). These procedures ensure that samples are received and properly logged into the laboratory and that all associated documentation, including chain of custody forms, is complete and consistent with the samples received. Each sample set is given a unique HEAL tracking ID number. Individual sample locations within a defined sample set are given a unique sample ID suffix-number. Labels with the HEAL numbers, and tests requested, are generated and placed on their respective containers. The pH of preserved, non-volatile samples is checked and noted if out of compliance. Due to the nature of the samples, the pHs of volatiles samples are checked after analysis. Samples are reviewed prior to being distributed for analysis.

All samples received that are requested for compliance, whether on the COC or by contract, will be identified as compliance samples in the LIMS so as to properly notify the analytical staff that they are to be analyzed in accordance with the test method(s) as well as the compliance requirements.

Samples are distributed for analysis based upon the requested tests. In the event that sample volume is limited and different departments at HEAL are required to share the sample, volatile work takes precedence and will always be analyzed first before the sample is sent to any other department for analysis.

Care will be taken to store samples isolated from laboratory contaminants, standards and highly contaminated samples.

All samples that require thermal preservation shall be acceptably stored at a temperature range just above freezing to 6 °C unless specified at another range by the SOP and Method.

Each project (sample set) is entered into the Laboratory Information Management System (LIMS) with a unique ID that will be identified on every container. The ID tag includes the Lab ID, Client ID, date and time of collection, and the analysis/analyses to be performed. The LIMS continually updates throughout the lab. Therefore, at any time, an analyst or manager may inquire about a project and/or samples status. For more information about the login procedures, refer to the Sample Login SOP.