APPENDIX H

FATE AND TRANSPORT MODELING RESULTS

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Table H-1. Physical and Chemical Properties of Metal SRCs at RQL

Analyte	K_d (L/kg)	Reference	H' (atm-m^3/mol)	Reference	C_w (mg/L)	C_w Reference	Generic SSL (DAF = 1)	Reference
Aluminum	1.50E+03	b	NA		3.65E+01	PRG9	5.48E+04	
Antimony	4.50E+01	a	NA		6.00E-03	MCL	3.00E-01	a
Arsenic	2.90E+01	a	NA		1.00E-02	MCL	2.90E-01	a
Barium	4.10E+01	a	NA		2.00E+00	MCL	8.20E+01	a
Beryllium	7.90E+02	a	NA		4.00E-03	MCL	3.00E+00	a
Cadmium	7.50E+01	a	NA		5.00E-03	MCL	4.00E-01	a
Chromium	1.90E+01	a	NA		1.00E-01	MCL	2.00E+00	a
Cobalt	1.30E+03	c	NA		7.30E-01	PRG9	9.49E+02	
Copper	3.50E+01	b	NA		1.30E+00	MCL	4.58E+01	
Cyanide	9.90E+00	a	NA		7.30E-01	PRG9	2.00E+00	a
Lead	1.60E+04	c	NA		1.50E-02	MCL	2.40E+02	
Manganese	7.50E+02	c	NA		8.76E-01	PRG9	6.57E+02	
Mercury	5.20E+01	a	NA		2.00E-03	MCL	1.00E-01	a
Nickel	6.50E+01	a	NA		7.30E-01	PRG9	7.00E+00	a
Selenium	5.00E+00	a	NA		5.00E-02	MCL	3.00E-01	a
Silver	8.30E+00	a	NA		1.83E-01	PRG9	2.00E+00	a
Thallium	7.10E+01	a	NA		2.00E-03	MCL	4.00E-02	a
Vanadium	1.00E+03	a	NA		2.56E-01	PRG9	3.00E+02	a
Zinc	6.20E+01	a	NA		1.10E+01	PRG9	6.20E+02	a

Cw = Target groundwater concentration (either MCL or PRG9).
DAF = Dilution attenuation factor.
H' = Henry's Law Constant.
Kd = Distribution coefficient.
MCL = Clean Water Act Drinking Water maximum contaminant level.
NA = Not applicable.
PRG9 = U. S. Environmental Protection Agency Region 9 preliminary remedial goals.
RQL = Ramsdell Quarry Landfill.
SRC = Site-related contaminant.
References:
a. EPA Soil Screening Guidance: Technical Background Document, May 1996.
b. Baes and Sharp 1983.
c. Sheppard and Thibault 1990.
d. RREL = Risk Reduction Engineering Laboratory (EPA 1994).

Table H-2. Physical and Chemical Properties of Organic SRCs at RQL

Analyte	K_{oc} (L/kg)	Reference	H' (atm-m^3/mol)	Reference	C_w (mg/L)	Reference
Explosives						
1,3-Dinitrobenzene	1.95E+01	d	2.30E-07	d	3.65E-03	PRG9
2,4,6-Trinitrotoluene	2.13E+05	d	2.00E-07	d	2.24E-03	PRG9
2,4-Dinitrotoluene	9.55E+01	a	9.26E-08	a	7.30E-02	PRG9
2,6-Dinitrotoluene	6.92E+01	a	7.47E-07	a	3.60E-02	PRG9
2-Amino-4,6-Dinitrotoluene	NF		NF		NF	
2-Nitrotoluene	2.17E+02	m	1.25E-05	o	6.10E-02	PRG9
3-Nitrotoluene	2.59E+02	n	9.30E-06	o	6.10E-02	PRG9
4-Amino-2,6-Dinitrotoluene	NF		NF		NF	
HMX	4.20E+00	o	8.67E-10	o	1.80E+00	PRG9
Nitrocellulose	NF		NF		NF	
Nitroglycerin	1.54E+02	k	4.33E-08	p	4.80E-03	PRG9
RDX	4.67E+00	g	NF		6.10E-04	PRG9
Organics-Semivolatile						
2-Methylnaphthalene	7.50E+03	e	5.18E-04	e	1.22E-01	PRG3
Acenaphthene	4.90E+03	a	1.55E-04	a	3.70E-01	PRG9
Acenaphthylene	7.40E+03	d	1.14E-04	d	3.70E-01	PRG9
Anthracene	2.35E+04	a	6.50E-05	a	1.80E+00	PRG9
Benz(*a*)anthracene	3.58E+05	a	3.35E-06	a	9.20E-05	PRG9
Benzo(*a*)pyrene	9.69E+05	a	1.13E-06	a	2.00E-04	MCL
Benzo(*b*)fluoranthene	1.23E+06	a	1.11E-04	a	9.20E-05	PRG9
Benzo(*g,h,i*)perylene	1.07E+07	d	1.40E-07	d	NF	
Benzo(*k*)fluoranthene	1.23E+06	a	8.29E-07	a	9.20E-04	PRG9
Bis(2-ethylhexyl)phthalate	1.11E+05	a	1.02E-07	a	6.00E-03	MCL
Carbazole	3.39E+03	a	1.53E-08	a	3.36E-03	PRG9
Chrysene	3.98E+05	a	9.46E-05		9.20E-03	PRG9
Dibenz(*a,h*)anthracene	1.79E+06	a	1.47E-08		9.20E-06	PRG9
Dibenzofuran	8.31E+03	d	1.26E-05	e	2.43E-02	PRG9
Fluoranthene	4.91E+04	a	1.61E-05	a	1.50E+00	PRG9
Fluorene	7.71E+03	a	6.36E-05	a	2.40E-01	PRG9
Indeno(1,2,3-*cd*)pyrene	3.47E+06	a	1.60E-06	a	9.20E-05	PRG9
Naphthalene	1.19E+03	a	4.83E-04	a	6.20E-03	PRG9
Phenanthrene	1.82E+04	d	3.93E-05	d	NF	
Pyrene	6.80E+04	a	1.10E-05	a	1.80E-01	PRG9
Organics-Volatile						
2-Butanone	1.15E+00	d	6.61E-07	d	1.90E+00	PRG9
Acetone	5.75E-01	a	3.88E-05	a	6.08E-01	PRG9
Carbon Disulfide	4.57E+01	a	3.03E-02	a	1.04E+00	PRG9
Methylene Chloride	1.00E+01	a	2.19E-03	a	5.00E-03	MCL

Cw = Target groundwater concentration (either MCL or PRG9).
H' = Henry's Law Constant.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
Kd = Distribution coefficient.
Koc = Octanol-water coefficient.
MCL = Clean Water Act Drinking Water maximum contaminant level.
NF = Not found.
PRG9 = EPA Region 9 preliminary remedial goals.

Table H-2. Physical and Chemical Properties of Organic SRCs at RQL (continued)

RDX = Octahydro-1,3,5-trinitro-1,3,5-triazine.
RQL = Ramsdell Quarry Landfill.
SRC = Site-related contaminant.
References:
a. EPA Soil Screening Guidance: Technical Background Document, May 1996.
b. Baes and Sharp 1983.
c. Sheppard and Thibault 1990.
d. RREL = Risk Reduction Engineering Laboratory (EPA 1994).
e. RBCA = Risk-based corrective action manual and protocol (SAIC 1999).
f. Calculated from EPA Superfund Office of Emergency and Remedial Response Soil Screening Guidance http://risk.lsd.ornl.gov.
l. Estimated Koc for Tetryl.
- log Kow = 1.64, Koc = 0.63 Kow where Sw = Solubility in water (umol/L).
- Obtained Sw =1800 mg/L from EPA Risk Reduction Engineering Laboratory Treatability Data Base (EPA 1994).
- Noted MW = 227.10 g/mol implying Sw = 7926 umol/L.

m. Estimated Koc for 2-Nitrotoluene.
- Obtained Sw =650 mg/L from Syracuse Research Corporation (2004).
- Obtained Sw =650 mg/L from Syracuse Research Corporation (2004).
SRC = Site-related contaminant.
n. Estimated Koc for 3-Nitrotoluene.
- log Kow = 2.61, Koc = 0.63 Kow where Sw = Solubility in water (umol/L)
- Obtained Sw =500 mg/L from Syracuse Research Corporation (2004).
- Noted MW = 137.14 g/mol implying Sw = 3645 umol/L
o. Syracuse Research Corporation, 2004. http://www.syrres.com/esc/physdemo.htm, August 03.
p. Estimated Kh for Nitroglucerine.
- Kh = (Vp/760)/(Sw/Mw)
- Obtained Vp =2.6E-4 tor, Sw =1.8E+3 mg/L, and MW = 227.10 g/mol from RREL.

Table H-3. Climatic Data from SESOIL for RQL
(Station: Youngstown WSO AP, Ohio)[a]

Month	Air Temp (°C)	Cloud Cover	Humidity	ALBEDO	Evapotranspiration[b] (cm/d)	Precipitation (cm)	Duration (days)	Storms per Month	Model Days in Month
October	12	0.60	0.70	0.17	0	6.46	0.42	5.33	30.4
November	5.22	0.70	0.75	0.24	0	7.4	0.53	6.67	30.4
December	-1.06	0.80	0.75	0.31	0	7.06	0.57	6.14	30.4
January	-2.94	0.80	0.80	0.3	0	7.06	0.61	5.69	30.4
February	-2.33	0.70	0.75	0.32	0	5.76	0.53	5.09	30.4
March	2.33	0.70	0.70	0.29	0	8.26	0.55	7.14	30.4
April	9.11	0.70	0.70	0.19	0	8.83	0.48	7.4	30.4
May	14.61	0.60	0.70	0.16	0	8.46	0.45	7.15	30.4
June	19.89	0.60	0.70	0.16	0	9.07	0.36	6.57	30.4
July	21.89	0.50	0.70	0.16	0	9.8	0.3	6.06	30.4
August	21.11	0.55	0.70	0.16	0	8.14	0.3	6.06	30.4
September	17.67	0.55	0.70	0.16	0	7.85	0.4	5.44	30.4

[a]1996 data from Youngstown, Ohio, Weather Service Office - Airport Station.
[b]Data calculated in SESOIL model. 0.00 indicates evapotranspiration is calculated from other climatic data.
RQL = Ramsdell Quarry Landfill.
SESOIL = Seasonal Soil Compartment (model).

Table H-4. Initial CMCOPCs Based on Comparison of the SRCs Exposure Concentration with its GSSL with DAF = 3

Analyte	Units	Exposure Concentration	GSSL*DAF	Initial CMCOPC (DAF = 3?)
Explosives				
1,3-Dinitrobenzene	mg/kg	4.43E-01	2.88E-03	Yes
2,4,6-Trinitrotoluene	mg/kg	4.47E-01	1.71E-03	Yes
2,4-Dinitrotoluene	mg/kg	6.40E-02	1.20E-04	Yes
2,6-Dinitrotoluene	mg/kg	8.43E-01	1.26E-04	Yes
2-Amino-4,6-Dinitrotoluene	mg/kg	1.65E+00		
2-Nitrotoluene	mg/kg	7.00E-02	1.16E-01	
3-Nitrotoluene	mg/kg	1.15E-01	1.31E-01	
4-Amino-2,6-Dinitrotoluene	mg/kg	2.84E-01		
HMX	mg/kg	2.15E-01	1.08E+00	
Nitrocellulose	mg/kg	1.77E+00		
Nitroglycerin	mg/kg	2.41E+01	7.32E-03	Yes
RDX	mg/kg	2.07E-01	3.83E-04	Yes
Metals				
Aluminum	mg/kg	1.28E+04	1.64E+05	
Antimony	mg/kg	2.53E+00	9.00E-01	Yes
Arsenic	mg/kg	1.60E+01	8.70E-01	Yes
Barium	mg/kg	1.18E+02	2.46E+02	
Beryllium	mg/kg	6.12E-01	9.00E+00	
Cadmium	mg/kg	1.80E+00	1.20E+00	Yes
Chromium	mg/kg	3.72E+01	6.00E+00	Yes
Cobalt	mg/kg	1.26E+01	2.85E+03	
Copper	mg/kg	8.17E+01	1.37E+02	
Cyanide	mg/kg	5.34E-01	6.00E+00	
Lead	mg/kg	4.01E+02	7.20E+02	
Manganese	mg/kg	8.68E+02	1.97E+03	
Mercury	mg/kg	3.38E-01	3.00E-01	Yes
Nickel	mg/kg	3.78E+01	2.10E+01	Yes
Selenium	mg/kg	8.26E-01	9.00E-01	
Silver	mg/kg	7.97E-01	6.00E+00	
Thallium	mg/kg	6.05E-01	1.20E-01	Yes
Vanadium	mg/kg	2.40E+01	9.00E+02	
Zinc	mg/kg	3.59E+02	1.86E+03	
Organics-Semivolatile				
2-Methylnaphthalene	mg/kg	6.34E+00	5.55E+00	Yes
Acenaphthene	mg/kg	3.40E+01	8.70E+01	
Acenaphthylene	mg/kg	1.08E+00	1.67E+01	
Anthracene	mg/kg	9.38E+01	1.77E+03	
Benz(*a*)anthracene	mg/kg	1.32E+02	2.40E-01	Yes
Benzo(*a*)pyrene	mg/kg	9.03E+01	1.23E+00	Yes
Benzo(*b*)fluoranthene	mg/kg	1.13E+02	6.00E-01	Yes

Table H-4. Initial CMCOPCs Based on Comparison of the SRCs Exposure Concentration with its GSSL with DAF = 3 (continued)

Analyte	Units	Exposure Concentration	GSSL*DAF	Initial CMCOPC (DAF = 3?)
Benzo(*g,h,i*)perylene	mg/kg	6.11E+01		
Benzo(*k*)fluoranthene	mg/kg	5.46E+01	6.00E+00	Yes
Bis(2-ethylhexyl)phthalate	mg/kg	2.10E-01	5.40E+02	
Carbazole	mg/kg	4.33E+01	9.00E-02	Yes
Chrysene	mg/kg	9.41E+01	2.40E+01	Yes
Dibenz(*a,h*)anthracene	mg/kg	1.74E+01	2.40E-01	Yes
Dibenzofuran	mg/kg	2.56E+01	1.23E+00	Yes
Fluoranthene	mg/kg	2.91E+02	6.30E+02	
Fluorene	mg/kg	4.24E+01	8.40E+01	
Indeno(1,2,3-*cd*)pyrene	mg/kg	5.92E+01	2.10E+00	Yes
Naphthalene	mg/kg	9.94E+00	1.20E+01	
Phenanthrene	mg/kg	3.00E+02		
Pyrene	mg/kg	2.81E+02	6.90E+02	
Organics-Volatile				
2-Butanone	mg/kg	1.74E-02	1.32E+01	
Acetone	mg/kg	3.97E-02	2.40E+00	
Carbon Disulfide	mg/kg	3.40E-03	6.00E+00	
Methylene Chloride	mg/kg	1.20E-03	3.00E-03	

CMCPOC = Contaminant migration contaminant of potential concern.
GSSL * DAF = Generic soil screening level multiplied by a dilution attenuation factor of 3.
HMX = Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
SRC = Site-related contaminant.

Table H-5. Initial CMCOPCs (Extracted from Table H-4)

Analyte	Units	Exposure Concentration	GSSL*DAF	Initial CMCOPC (DAF = 3?)
Explosives				
1,3-Dinitrobenzene	mg/kg	4.43E-01	2.88E-03	Yes
2,4,6-Trinitrotoluene	mg/kg	4.47E-01	1.71E-03	Yes
2,4-Dinitrotoluene	mg/kg	6.40E-02	1.20E-04	Yes
2,6-Dinitrotoluene	mg/kg	8.43E-01	1.26E-04	Yes
Nitroglycerin	mg/kg	2.41E+01	7.32E-03	Yes
RDX	mg/kg	2.07E-01	3.83E-04	Yes
Metals				
Antimony	mg/kg	2.53E+00	9.00E-01	Yes
Arsenic	mg/kg	1.60E+01	8.70E-01	Yes
Cadmium	mg/kg	1.80E+00	1.20E+00	Yes
Chromium	mg/kg	3.72E+01	6.00E+00	Yes
Mercury	mg/kg	3.38E-01	3.00E-01	Yes
Nickel	mg/kg	3.78E+01	2.10E+01	Yes
Thallium	mg/kg	6.05E-01	1.20E-01	Yes
Organics-Semivolatile				
2-Methylnaphthalene	mg/kg	6.34E+00	5.55E+00	Yes
Benz(*a*)anthracene	mg/kg	1.32E+02	2.40E-01	Yes
Benzo(*a*)pyrene	mg/kg	9.03E+01	1.23E+00	Yes
Benzo(*b*)fluoranthene	mg/kg	1.13E+02	6.00E-01	Yes
Benzo(*k*)fluoranthene	mg/kg	5.46E+01	6.00E+00	Yes
Carbazole	mg/kg	4.33E+01	9.00E-02	Yes
Chrysene	mg/kg	9.41E+01	2.40E+01	Yes
Dibenz(a,h)anthracene	mg/kg	1.74E+01	2.40E-01	Yes
Dibenzofuran	mg/kg	2.56E+01	1.23E+00	Yes
Indeno(1,2,3-*cd*)pyrene	mg/kg	5.92E+01	2.10E+00	Yes

CMCOPC = Contaminant migration contaminant of potential concern.
GSSL * DAF = Generic soil screening level multiplied by a dilution attenuation factor of 3.
RDX = Hexahdyro-1,3,5-trinitro-1,3,5-triazine.

Table H-6. Initial CMCOPCs Reaching the Groundwater Table (based on Arrival Time <= 1,500 years)

$$R = 1 + \frac{\rho_b K_d}{\theta_w} \qquad T = L_z \theta_w R / q$$

Parameter	Symbol	Value		Units		Notes		
Percolation rate	q	0.3100		ft/year		0.1 * (SESOIL Recharge)		
Soil-water distribution coefficient	K_d	constituent-specific		L/kg		Literature		
Organic carbon distribution coefficient	K_{oc}	constituent-specific		L/kg		Literature		
Fraction organic carbon	f_{oc}	0.0026		unitless				
Water filled soil porosity	q_w	0.2230		unitless		Site-specific (Moisture Content by Weight=11.8%)		
Bulk density (dry)	r_b	1.8000		gm/cm^3		Site-specific		
Leaching zone	Lz	3.0000		ft		Calculated		
Retardation factor	R	constituent-specific		unitless		Calculated		
Arrival time	T	constituent-specific		year				
Analyte		**K_{oc} (L/kg)**	**Reference**	**K_d (L/kg)**	**Reference**	**R**	**T (yr)**	**T < 1,500?**
Metals and Inorganic Compounds								
Antimony				4.50E+01	a	3.64E+02	7.86E+02	Yes
Arsenic				2.90E+01	a	2.35E+02	5.07E+02	Yes
Cadmium				7.50E+01	a	6.06E+02	1.31E+03	Yes
Chromium (total)				1.90E+01	a	1.54E+02	3.33E+02	Yes
Mercury				5.20E+01	a	4.21E+02	9.08E+02	Yes
Nickel				6.50E+01	a	5.26E+02	1.13E+03	Yes
Thallium				7.10E+01	a	5.74E+02	1.24E+03	Yes
Semivolatile Organic Compounds								
2-Methylnaphthalene		7.50E+03	e	1.95E+01		1.58E+02	3.42E+02	Yes
Benzo(*a*)anthracene		3.58E+05	a	9.31E+02		7.51E+03	1.62E+04	
Benzo(*a*)pyrene		9.69E+05	a	2.52E+03		2.03E+04	4.39E+04	
Benzo(*b*)fluoranthene		1.23E+06	a	3.20E+03		2.58E+04	5.57E+04	
Benzo(*k*)fluoranthene		1.23E+06	a	3.20E+03		2.58E+04	5.57E+04	
Chrysene		3.98E+05	a	1.03E+03		8.35E+03	1.80E+04	
Dibenz(*a,h*)anthracene		1.79E+06	a	4.65E+03		3.76E+04	8.11E+04	
Dibenzofuran		8.31E+03	d	2.16E+01		1.75E+02	3.79E+02	Yes
Indeno(1,2,3-*cd*)pyrene		3.47E+06	a	9.02E+03		7.28E+04	1.57E+05	
Carbazole		3.39E+03	a	8.81E+00		7.21E+01	1.56E+02	Yes
Explosives								
RDX		4.67E+00	g	1.21E-02		1.10E+00	2.37E+00	Yes
1,3-Dinitrobenzene		1.95E+01	h	5.07E-02		1.41E+00	3.04E+00	Yes

Table H-6. Initial CMCOPCs Reaching the Groundwater Table (based on Arrival Time <= 1,500 years) (continued)

Analyte		K_{oc} (L/kg)	Reference	K_d (L/kg)	Reference	R	T (yr)	T < 1,500?
2,4,6-Trinitrotoluene		2.13E+05	h	5.54E+02		4.47E+03	9.65E+03	
2,4-Dinitrotoluene		9.55E+01	a	2.48E-01		3.00E+00	6.48E+00	Yes
2,6-Dinitrotoluene		6.92E+01	a	1.80E-01		2.45E+00	5.29E+00	Yes
Nitroglycerine		1.54E+02	k	4.00E-01		4.23E+00	9.13E+00	Yes

CMCOPC = Contaminant migration contaminant of potential concern.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
References:
a. EPA Soil Screening Guidance: Technical Background Document, May 1996.
b. Baes and Sharp 1983.
c. Sheppard and Thibault 1990.
d. RREL.
e. RBCA.
f. LL1 GSSL.xls.
g. LL1 GSSL Update.xls.
h. From Load Line 1.
j. EPA Manual Ground-Water and Leachate Treatment Systems, January 1995.
k. Estimated Koc for Nitroglycerine using EPA, 1985.
-. log Kow = 5 - 0.67 Log Sw, Koc = 0.63 Kow where Sw = Solubility in water (umol/L)
-. Obtained Sw =1800 mg/L from EPA Risk Reduction Engineering Laboratory Treatability Data Base (EPA 1994).
-. Noted MW = 227.10 g/mol implying Sw = 7926 umol/L
l. Estimated Koc for Tetryl.
-. log Kow = 1.64, Koc = 0.63 Kow where Sw = Solubility in water (umol/L)
-. Obtained Sw =1800 mg/L from EPA Risk Reduction Engineering Laboratory Treatability Data Base (EPA 1994).
-. Noted MW = 227.10 g/mol implying Sw = 7926 umol/L
m. Estimated Koc for 2-Nitrotoluene.
-. log Kow = 2.53, Koc = 0.63 Kow where Sw = Solubility in water (umol/L)
-. Obtained Sw =650 mg/L from Syracuse Research Corporation (2004).
-. Noted MW = 137.14 g/mol implying Sw = 4740 umol/L
n. Estimated Koc for 3-Nitrotoluene.
-. log Kow = 2.61, Koc = 0.63 Kow where Sw = Solubility in water (umol/L)
-. Obtained Sw =500 mg/L from Syracuse Research Corporation (2004).
-. Noted MW = 137.14 g/mol implying Sw = 3645 umol/L
o. Syracuse Research Corporation, 2004. http://www.syrres.com/esc/physdemo.htm, August 03.

Table H-7. Initial CMCOPCs for Leachate Modeling (based on Table H-6)

Analyte	Leachate Modeling?
Explosives	
1,3-Dinitrobenzene	Yes
2,4-Dinitrotoluene	Yes
2,6-Dinitrotoluene	Yes
Nitroglycerin	Yes
RDX	Yes
Metals	
Antimony	Yes
Arsenic	Yes
Cadmium	Yes
Chromium	Yes
Mercury	Yes
Nickel	Yes
Thallium	Yes
Organics-Semivolatile	
2-Methylnaphthalene	Yes
Carbazole	Yes
Dibenzofuran	Yes

CMCOPC = Contaminant migration contaminant of potential concern.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

Table H-8. Physical and Chemical Properties of Initial CMCOPCs Selected for Leachate Modeling

Initial CMCOPC	Molecular Weight	Solubility (mg/L)	Kd or Koc (L/kg)	Diffusion Coefficient in Air (cm^2/s)	Biodegradation Rate (1/day)
Explosives					
1,3-Dinitrobenzene	168.0	4.69E-01	1.95E+01	2.80E-01	1.90E-03
2,4-Dinitrotoluene	182.0	2.70E-01	9.55E+01	2.00E-01	1.90E-03
2,6-Dinitrotoluene	182.0	1.82E-01	6.92E+01	2.00E-01	1.90E-03
Nitroglycerin	227.0	1.80E+00	1.54E+02	NF	NF
RDX	222.0	6.00E-02	4.67E+00	NF	NF
Metals					
Antimony	122.0	1.00E+03	4.50E+01	NA	NA
Arsenic	74.9	1.00E+02	2.90E+01	NA	NA
Cadmium	112.0	1.00E+02	7.50E+01	NA	NA
Chromium	52.0	1.00E+02	1.90E+01	NA	NA
Mercury	201.0	6.00E-05	5.20E+01	3.07E-02	NA
Organics-Semivolatile					
2-Methylnaphthalene	142.0	2.60E-02	7.50E+03	5.60E-02	NF
Carbazole	167.0	7.48E-03	3.39E+03	3.90E-02	NF
Dibenzofuran	168.0	1.00E-02	8.31E+03	6.80E-02	6.19E-03

CMCOPC = Contaminant migration contaminant of potential concern.
Kd = Distribution coefficient.
Koc = Organic-carbon partition coefficient.
NA = Not applicable.
NF = Not found.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

Table H-9. Layers Used in Leachate Model

Transect	Layer Number	Layer Thickness	Number of Sublayers	Purpose
Ramsdell Quarry Landfill	1	0.3 m (1 ft)	1	Contaminant Loading
	2	0.6 m (2 ft)	2	Leaching
	3	0.3 m (1 ft)	2	Leaching

Table H-10. Load Application Data for Leachate Model

Analyte	No. of Layers	Layer No.	Thickness of Layer (ft)	No. of Sublayers	Sublayer No.	Concentration (mg/kg)
1,3-Dinitrobenzene	3	1	1	1	1	4.43E-01
		2	2	2	1	0
					2	0
		3	1	2	1	0
					2	0
2,4-Dinitrotoluene	3	1	1	1	1	6.40E-02
		2	2	2	1	0
					2	0
		3	1	2	1	0
					2	0
2,6-Dinitrotoluene	3	1	1	1	1	8.43E-01
		2	2	2	1	0
					2	0
		3	1	2	1	0
					2	0
Nitroglycerin	3	1	1	1	1	2.41E+01
		2	2	2	1	0
					2	0
		3	1	2	1	0
					2	0
RDX	3	1	1	1	1	2.07E-01
		2	2	2	1	0
					2	0
		3	1	2	1	0
					2	0

Table H-11. Summary of Leachate Modeling Results for RQL

Initial CMCOPC	RME 0 to 1 ft (mg/kg)	Predicted $C_{leachate,max}$ Beneath the Source (mg/L)	Predicted Tmax (years)	Predicted $C_{gw,max}$ At the Source[a] (mg/L)	Observed $C_{gw,max}$ Downgradient of Source (mg/L)	MCL/RBC (mg/L)	Final CMCOPC[b]
Explosives							
1,3-Dinitrobenzene	4.43E-01	4.14E-01	2	1.38E-01	NF	3.65E-03	Yes
2,4-Dinitrotoluene	6.40E-02	9.35E-03	4	3.12E-03	NF	7.30E-02	
2,6-Dinitrotoluene	8.43E-01	1.77E-01	3	5.88E-02	NF	3.60E-02	Yes
Nitroglycerin	2.41E+01	3.09E+01	6	1.03E+01	NF	4.80E-03	Yes
RDX	2.07E-01	8.19E-01	2	2.73E-01	NF	6.10E-04	Yes
Metals							
Antimony	2.53E+00	3.59E-02	437	1.20E-02	5.80E-04	6.00E-03	Yes
Arsenic	1.60E+01	3.55E-01	284	1.18E-01	6.80E-03	1.00E-02	Yes
Cadmium	1.80E+00	1.47E-02	719	4.89E-03	7.00E-04	5.00E-03	
Chromium	3.72E+01	1.26E+00	187	4.20E-01	NF	1.00E-01	Yes
Mercury	3.38E-01	3.01E-04	445	1.00E-04	NF	2.00E-03	
Nickel	3.78E+01	3.68E-01	629	1.23E-01	3.06E-01	7.30E-01	
Thallium	6.05E-01	5.44E-03	689	1.81E-03	NF	2.00E-03	
Organics-Semivolatile							
2-Methylnaphthalene	6.34E+00	1.55E-01	179	5.18E-02	NF	1.22E-01	
Carbazole	4.33E+01	3.17E+00	88	1.06E+00	NF	3.36E-03	Yes
Dibenzofuran	2.56E+01	1.00E-11	146	3.33E-12	NF	2.43E-02	

[a]The concentration was calculated using a dilution attenuation factor = 3.
[b]The final CMCOPC was identified comparing predicted/observed concentration in groundwater to the MCL/RBC. A constituent is a final CMCOPC if its predicted/observed concentration in groundwater exceeds its MCL/RBC with 1,000 years.
CMCOPC = Contaminant migration contaminant of potential concern.
MCL = Maximum contaminant level.
NF = Not found.
RBC = Risk-based concentration.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RME = Reasonable maximum exposure.

Table H-12. Development of Additional Final CMCOPCs Based on Comparison of Observed Maximum Groundwater Concentration with its Target Groundwater Concentration

Analyte	Units	Maximum Concentration	MCL/RBC	Final CMCOPC?
Metals				
Aluminum	mg/L	6.13E+00	3.65E+01	
Antimony	mg/L	5.80E-04	6.00E-03	
Arsenic	mg/L	6.80E-03	1.00E-02	
Beryllium	mg/L	5.70E-04	4.00E-03	
Cadmium	mg/L	7.00E-04	5.00E-03	
Cobalt	mg/L	7.00E-02	7.30E-01	
Copper	mg/L	3.40E-03	1.30E+00	
Lead	mg/L	1.30E-03	1.50E-02	
Manganese	mg/L	6.17E+00	8.76E-01	Yes
Nickel	mg/L	3.06E-01	7.30E-01	
Vanadium	mg/L	1.60E-03	2.56E-01	
Zinc	mg/L	3.12E-01	1.10E+01	
Organics-Volatile				
Carbon Disulfide	mg/L	7.90E-03	1.04E+00	

CMCOPC = Contaminant migration contaminant of potential concern.
MCL = Maximum contaminant level.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

Table H-13. Final CMCOPCs in Groundwater based on Leachate Modeling and Observed Groundwater Concentration

Initial CMCOPC	RME 0 to 1 ft (mg/kg)	Predicted $C_{leachate,max}$ Beneath the Source (mg/L)	Predicted Tmax (years)	Predicted $C_{gw,max}$ At the Source[a] (mg/L)	Observed $C_{gw,max}$ Downgradient of Source (mg/L)	MCL/RBC (mg/L)	Final CMCOPC[b]
Explosives							
1,3-Dinitrobenzene	4.43E-01	4.14E-01	2	1.38E-01	NF	3.65E-03	Yes
2,6-Dinitrotoluene	8.43E-01	1.77E-01	3	5.88E-02	NF	3.60E-02	Yes
Nitroglycerin	2.41E+01	3.09E+01	6	1.03E+01	NF	4.80E-03	Yes
RDX	2.07E-01	8.19E-01	2	2.73E-01	NF	6.10E-04	Yes
Metals							
Antimony	2.53E+00	3.59E-02	437	1.20E-02	5.80E-04	6.00E-03	Yes
Arsenic	1.60E+01	3.55E-01	284	1.18E-01	6.80E-03	1.00E-02	Yes
Chromium	3.72E+01	1.26E+00	187	4.20E-01	NF	1.00E-01	Yes
Manganese	NF	NA	NA	NA	6.17E+00	8.76E-01	Yes
Organics-Semivolatile							
Carbazole	4.33E+01	3.17E+00	88	1.06E+00	NF	3.36E-03	Yes

[a]The concentration was calculated using a dilution attenuation factor = 3.
[b]The final CMCOPC was identified comparing predicted/observed concentration in groundwater to the MCL/RBC. A constituent is a final CMCOPC if its predicted/observed concentration in groundwater exceeds its MCL/RBC with 1,000 years.
CMCOPC = Contaminant migration contaminant of potential concern.
MCL = Maximum contaminant level.
NA = Not applicable.
NF = Not found.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RME = Reasonable maximum exposure.

Table H-14. Final CMCOPCs Reaching the Nearest Receptor (based on Arrival Time <= 1,500 years)

$$R = 1 + \frac{\rho_b K_d}{\theta_w} \qquad T = L_z \theta_{we} R / q$$

Parameter	Symbol	Value		Units		Notes		
Darcy flux	q	13.6600		ft/year		Site-specific		
Soil-water distribution coefficient	K_d	constituent-specific		L/kg		Literature		
Organic carbon distribution coefficient	K_{oc}	constituent-specific		L/kg		Literature		
Fraction organic carbon	f_{oc}	0.0026		unitless				
Effective porosity	q_{we}	0.2000		unitless		Site-specific		
Bulk density (dry)	r_b	1.8000		gm/cm^3		Site-specific		
Porosity	q_w	0.3200		unitless		Site-specific		
Distance to nearest receptor	Lz	1200.0000		ft				
Retardation factor	R	constituent-specific		unitless		Calculated		
Arrival time	T	constituent-specific		year		Calculated		
Analyte		**K_{oc} (L/kg)**	**Reference**	**K_d (L/kg)**	**Reference**	**R**	**T (year)**	**T < 1,500?**
Metals and Inorganic Compounds								
Antimony				4.50E+01	a	2.54E+02	4.46E+03	
Arsenic				2.90E+01	a	1.64E+02	2.88E+03	
Chromium (total)				1.90E+01	a	1.08E+02	1.90E+03	
Manganese				7.50E+02	c	4.22E+03	7.41E+04	
Semivolatile Organic Compounds								
Carbazole		3.39E+03	a	8.81E+00		5.06E+01	8.89E+02	Yes
Explosives								
RDX		4.67E+00	g	1.21E-02		1.07E+00	1.88E+01	Yes
1,3-Dinitrobenzene		1.95E+01	h	5.07E-02		1.29E+00	2.26E+01	Yes
2,6-Dinitrotoluene		6.92E+01	a	1.80E-01		2.01E+00	3.54E+01	Yes
Nitroglycerine		1.54E+02	k	4.00E-01		3.25E+00	5.71E+01	Yes

CMCOPC = Contaminant migration contaminant of potential concern.
REX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
References:
a. EPA Soil Screening Guidance: Technical Background Document, May 1996.
c. Sheppard and Thibault 1990.
g. LL1 GSSL Update.xls.
h. From Load Line 1.
k. Estimated Koc for Nitroglycerine using EPA, 1985.
- log Kow = 5 - 0.67 Log Sw, Koc = 0.63 Kow where Sw = Solubility in water (umol/L)
- Obtained Sw =1800 mg/L from EPA Risk Reduction Engineering Laboratory Treatability Data Base (EPA 1994).
- Noted MW = 227.10 g/mol implying Sw = 7926 umol/L

Table H-15. Physical and Chemical Properties of Final CMCOPCs Selected for AT123D Modeling

Analyte	Distribution Coefficient, Kd (L/kg)	Retardation factor, Rd[a]	Diffusion Coefficient in Water (cm^2/s)	Biodegradation Rate (1/day)
Explosives				
1,3-Dinitrobenzene	5.07E-02	1.29E+00	7.36E-06	1.90E-03
2,6-Dinitrotoluene	1.80E-01	2.01E+00	7.28E-06	1.90E-03
Nitroglycerine	4.00E-01	3.25E+00	1.00E-06	NF
RDX	1.21E-02	1.07E+00	1.00E-06	NF
Organics-Semivolatile				
Carbazole	8.81E+00	5.06E+01	7.03E-06	NF

[a]Calculated value.
AT123D = Analytical Transient 1-, 2-, 3-Dimensional (model).
CMCOPC = Contaminant migration contaminant of potential concern.
NF = Not found.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.

Table H-16. Summary of Groundwater Modeling Results for RQL

Final CMCOPC	Source Concentration (mg/L)	Reference	Receptor Concentration Sand Creek (mg/L)	Reference	Observed $C_{gw,max}$ (mg/L)	MCL/RBC (mg/L)	CMCOC[b]
Explosives							
1,3-Dinitrobenzene	9.70E-03	b	1.48E-06	b	NF	3.65E-03	
2,6-Dinitrotoluene	4.23E-03	b	1.57E-08	b	NF	3.60E-02	
Nitroglycerin	2.10E+00	b	4.23E-01	b	NF	4.80E-03	Yes
RDX	4.46E-02	b	1.72E-02	b	NF	6.10E-04	Yes
Metals							
Antimony	1.20E-02	a	0.00E+00	d	5.80E-04	6.00E-03	
Arsenic	1.18E-01	a	0.00E+00	d	6.80E-03	1.00E-02	
Chromium	4.20E-01	a	0.00E+00	d	NF	1.00E-01	
Manganese	6.17E+00	c	0.00E+00	d	6.17E+00	8.76E-01	
Organics-Semivolatile							
Carbazole	2.19E-01	b	3.21E-02	b	NF	3.36E-03	Yes

[a]The concentration was calculated using a dilution attenuation factor = 3.
[b]The concentration was re-calculated using SESOIL and AT123D models.
[c]The concentration was observed in groundwater.
[d]The concentration was set to 0 considering a travel time exceeding 1,500 years.
CMCOC = Contaminant migration contaminant of concern.
CMCOPC = Contaminant migration contaminant of potential concern.
MCL = Maximum contaminant level.
NF = Not found.
RBC = Risk-based concentration.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
RQL = Ramsdell Quarry Landfill.

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