

*Richardson Flat Tailings Site
Screening Ecological Risk Assessment*

APPENDIX D

**DERIVATION OF WILDLIFE
TOXICITY REFERENCE VALUES (TRVs)**

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TRV CALCULATION WORKSHEET FOOTNOTES:

1 If no study is available to establish a LOAEL TRV, the LOAEL is set to equal 3 x NOAEL

2 $TRV(\text{food}) = TRV(\text{water}) / 0.50$

3 Test species uncertainty factor equals 1 since both Old World and New World mice are physiologically similar;
and laboratory rodents are often more sensitive than wild species due to genetic heterogeneity of natural populations.

4 $TRV(\text{water or capsule}) = TRV(\text{food}) * 0.50$

5 $TRV = \text{Study Dose} / UF$

SMF = Study Modifying Factor

NA = Not Available

UF = Uncertainty Factor

NOAEL = No observed adverse effect level

LOAEL = Lowest observed adverse effect level

BW = body weight

TRV = Toxicity Reference Value

NOAEL & LOAEL TRVs - ANTIMONY

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) ¹	Uncertainty Factors (UF)				Other	Total UF ⁵		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)			
					Source	Inter-species	Duration	Endpoint			NOAEL			LOAEL											
								NOAEL							LOAEL										
Deer Mice (water)	Schroeder et al., 1968	Antimony potassium tartarate	Oral Water	Mouse	Chronic; > 1 yr		1 dose of 5 ppm	Lifespan; Longevity		5.00	0.0075 EPA 1988	NA	0.04	1	1	1	1	1	1	1	1	1	1.3E-02	3.8E-02	
Deer Mice (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV ²																						2.5E-02	7.5E-02	
Mink (water)	Schroeder et al., 1968	Antimony potassium tartarate	Oral Water	Mouse	Chronic; > 1 yr		1 dose of 5 ppm	Lifespan; Longevity		5.00	0.0075 EPA 1988	NA	0.04	4	1	1	1	1	1	4	4	4	3.1E-03	9.4E-03	
Mink (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV ²																						6.3E-03	1.9E-02	
Masked Shrew (water)	Schroeder et al., 1968	Antimony potassium tartarate	Oral Water	Mouse	Chronic; > 1 yr		1 dose of 5 ppm	Lifespan; Longevity		5.00	0.0075 EPA 1988	NA	0.04	4	1	1	1	1	1	4	4	4	3.1E-03	9.4E-03	
Masked Shrew (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV ²																						6.3E-03	1.9E-02	
Red Fox (water)	Schroeder et al., 1968	Antimony potassium tartarate	Oral Water	Mouse	Chronic; > 1 yr		1 dose of 5 ppm	Lifespan; Longevity		5.00	0.0075 EPA 1988	NA	0.04	1	1	1	1	1	1	1	1	1	1	1.3E-02	3.8E-02
Red Fox (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV ²																							2.5E-02	7.5E-02
American Robin (water)	No Reliable TRV Establishing Studies Found																							NA	NA
American Robin (diet)	No Reliable TRV Establishing Studies Found																							NA	NA
American Kestrel (water)	No Reliable TRV Establishing Studies Found																							NA	NA
American Kestrel (diet)	No Reliable TRV Establishing Studies Found																							NA	NA
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found																							NA	NA
Belted Kingfisher (diet)	No Reliable TRV Establishing Studies Found																							NA	NA
Mallard Duck (water)	No Reliable TRV Establishing Studies Found																							NA	NA
Mallard Duck (diet)	No Reliable TRV Establishing Studies Found																							NA	NA
Greater-Sage Grouse (water)	No Reliable TRV Establishing Studies Found																							NA	NA
Greater-Sage Grouse (diet)	No Reliable TRV Establishing Studies Found																							NA	NA

NOAEL & LOAEL TRVs - ARSENIC

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) ¹	Uncertainty Factors (UF)					Other	Total UF ⁵	NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)				
					Duration	N	Doses	Endpoint						Inter-species	Duration	Endpoint		NOAEL					LOAEL			
																NOAEL	LOAEL									
Deer Mice (water)	Schroeder & Mitchener, 1971	Arsenite salt	Oral Water	Charles River CD Mice ³	Chronic; 3 generations	10 animals in each generation	1 dose of 5.06 ppm (5 ppm water + 0.06 ppm diet)	Reproduction, Growth, Longevity	5.06		0.25	1.27	NA	1	1	1	1	1	1	1	1	1	1	1.3E+00	3.8E+00	
Deer Mice (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV ²																							2.5E+00	7.6E+00	
Mink (water)	Schroeder & Mitchener, 1971	Arsenite salt	Oral Water	Charles River CD Mice ³	Chronic; 3 generations	10 animals in each generation	1 dose of 5.06 ppm (5 ppm water + 0.06 ppm diet)	Reproduction, Growth, Longevity	5.06		0.25	1.27	NA	5	1	1	1	1	1	5	5			2.5E-01	7.6E-01	
Mink (diet)	Byron et al., 1967	Sodium arsenite	Oral Diet	Beagle	2 years	6 animals per dose group	4 doses each of arsenate or arsenite 5, 25, 50, 125 ppm	Growth, Mortality	50		0.024	1.2	NA	4	1	1	1	2 Unknown Effect Level	8	8			1.5E-01	4.5E-01		
Masked Shrew (water)	Schroeder & Mitchener, 1971	Arsenite salt	Oral Water	Charles River CD Mice ³	Chronic; 3 generations	10 animals in each generation	1 dose of 5.06 ppm (5 ppm water + 0.06 ppm diet)	Reproduction, Growth, Longevity	5.06		0.25	1.27	NA	5	1	1	1	1	5	5			2.5E-01	7.6E-01		
Masked Shrew (diet)	Byron et al., 1967	Sodium arsenite	Oral Diet	Beagle	2 years	6 animals per dose group	4 doses each of arsenate or arsenite 5, 25, 50, 125 ppm	Growth, Mortality	50		0.024	1.2	NA	5	1	1	1	2 Unknown Effect Level	10	10			1.2E-01	3.6E-01		
Red Fox (water)	Schroeder & Mitchener, 1971	Arsenite salt	Oral Water	Charles River CD Mice ³	Chronic; 3 generations	10 animals in each generation	1 dose of 5.06 ppm (5 ppm water + 0.06 ppm diet)	Reproduction, Growth, Longevity	5.06		0.25	1.27	NA	5	1	1	1	1	5	5			2.5E-01	7.6E-01		
Red Fox (diet)	Byron et al., 1967	Sodium arsenite	Oral Diet	Beagle	2 years	6 animals per dose group	4 doses each of arsenate or arsenite 5, 25, 50, 125 ppm	Growth, Mortality	50		0.024	1.2	NA	3	1	1	1	2 Unknown Effect Level	6	6			2.0E-01	6.0E-01		
American Robin (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																							4.1E-01	3.5E+00	
American Robin (diet)	Stanley et al., 1994	Sodium arsenate	Oral Diet	Mallard	Chronic; 8 weeks	12 pairs (24 ducks) per diet	4 doses of 0, 25, 100, 400 ppm (Mean at 100 & 400 = 93 & 403 ppm)	Reproduction, Growth	93	403	0.175 Camardese et al., 1990	16	71	5	1	2	1	2	20	10			SMF		8.1E-01	7.1E+00
American Kestrel (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																							4.1E-01	3.5E+00	
American Kestrel (diet)	Stanley et al., 1994	Sodium arsenate	Oral Diet	Mallard	Chronic; 8 weeks	12 pairs (24 ducks) per diet	4 doses of 0, 25, 100, 400 ppm (Mean at 100 & 400 = 93 & 403 ppm)	Reproduction, Growth	93	403	0.175 Camardese et al., 1990	16	71	5	1	2	1	2	20	10			SMF		8.1E-01	7.1E+00
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																							4.1E-01	3.5E+00	
Belted Kingfisher (diet)	Stanley et al., 1994	Sodium arsenate	Oral Diet	Mallard	Chronic; 8 weeks	12 pairs (24 ducks) per diet	4 doses of 0, 25, 100, 400 ppm (Mean at 100 & 400 = 93 & 403 ppm)	Reproduction, Growth	93	403	0.175 Camardese et al., 1990	16	71	5	1	2	1	2	20	10			SMF		8.1E-01	7.1E+00
Mallard Duck (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																							4.1E-01	3.5E+00	
Mallard Duck (diet)	Stanley et al., 1994	Sodium arsenate	Oral Diet	Mallard	Chronic; 8 weeks	12 pairs (24 ducks) per diet	4 doses of 0, 25, 100, 400 ppm (Mean at 100 & 400 = 93 & 403 ppm)	Reproduction, Growth	93	403	0.175 Camardese et al., 1990	16	71	5	1	2	1	2	20	10			SMF		8.1E-01	7.1E+00
Greater-Sage Grouse (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																							4.1E-01	3.5E+00	
Greater-Sage Grouse (diet)	Stanley et al., 1994	Sodium arsenate	Oral Diet	Mallard	Chronic; 8 weeks	12 pairs (24 ducks) per diet	4 doses of 0, 25, 100, 400 ppm (Mean at 100 & 400 = 93 & 403 ppm)	Reproduction, Growth	93	403	0.175 Camardese et al., 1990	16	71	5	1	2	1	2	20	10			SMF		8.1E-01	7.1E+00

NOAEL & LOAEL TRVs - BARIUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) ¹	Uncertainty Factors (UF)				Other	Total UF ⁵		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
					Source	Inter-species	Duration	Endpoint			NOAEL			LOAEL	NOAEL	LOAEL						
								NOAEL									LOAEL					
Deer Mice (water)	Perry et al 1983	Barium chloride	Oral Water	Rat	16 months		3 exposures 1, 10, 100 ppm	Growth; Hypertension	100.00		0.05 Measured in study	5.06	NA	3	1	1	1	1	3	3	1.7E+00	5.1E+00
Deer Mice (diet)	No Reliable TRV Establishing Study Derive from water TRV																				3.4E+00	1.0E+01
Mink (water)	Perry et al 1983	Barium chloride	Oral Water	Rat	16 months		3 exposures 1, 10, 100 ppm	Growth; Hypertension	100.00		0.05 Measured in study	5.06	NA	5	1	1	1	1	5	5	1.0E+00	3.0E+00
Mink (diet)	No Reliable TRV Establishing Study Derive from water TRV																				2.0E+00	6.1E+00
Masked Shrew (water)	Perry et al 1983	Barium chloride	Oral Water	Rat	16 months		3 exposures 1, 10, 100 ppm	Growth; Hypertension	100.00		0.05 Measured in study	5.06	NA	5	1	1	1	1	5	5	1.0E+00	3.0E+00
Masked Shrew (diet)	No Reliable TRV Establishing Study Derive from water TRV																				2.0E+00	6.1E+00
Red Fox (water)	Perry et al 1983	Barium chloride	Oral Water	Rat	16 months		3 exposures 1, 10, 100 ppm	Growth; Hypertension	100.00		0.05 Measured in study	5.06	NA	5	1	1	1	1	5	5	1.0E+00	3.0E+00
Red Fox (diet)	No Reliable TRV Establishing Study Derive from water TRV																				2.0E+00	6.1E+00
American Robin (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.4E+00	2.8E+00
American Robin (diet)	Johnson et al 1960		Oral Diet	Chicken	4 weeks Subchronic duration		8 exposures 250, 500, 1000, 2000, 4000, 8000, 16,000, 32,000 ppm	Mortality	2,000	4,000	0.104 BW & FCNS - EPA 1988a	208	417	5	5	3	3	1	75	75	2.8E+00	5.6E+00
American Kestrel (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.4E+00	2.8E+00
American Kestrel (diet)	Johnson et al 1960		Oral Diet	Chicken	4 weeks Subchronic duration		8 exposures 250, 500, 1000, 2000, 4000, 8000, 16,000, 32,000 ppm	Mortality	2,000	4,000	0.104 BW & FCNS - EPA 1988a	208	417	5	5	3	3	1	75	75	2.8E+00	5.6E+00
Belted Kingfisher (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.4E+00	2.8E+00
Belted Kingfisher (diet)	Johnson et al 1960		Oral Diet	Chicken	4 weeks Subchronic duration		8 exposures 250, 500, 1000, 2000, 4000, 8000, 16,000, 32,000 ppm	Mortality	2,000	4,000	0.104 BW & FCNS - EPA 1988a	208	417	5	5	3	3	1	75	75	2.8E+00	5.6E+00
Mallard Duck (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.4E+00	2.8E+00
Mallard Duck (diet)	Johnson et al 1960		Oral Diet	Chicken	4 weeks Subchronic duration		8 exposures 250, 500, 1000, 2000, 4000, 8000, 16,000, 32,000 ppm	Mortality	2,000	4,000	0.104 BW & FCNS - EPA 1988a	208	417	5	5	3	3	1	75	75	2.8E+00	5.6E+00
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.4E+00	2.8E+00
Greater-Sage Grouse (diet)	Johnson et al 1960		Oral Diet	Chicken	4 weeks Subchronic duration		8 exposures 250, 500, 1000, 2000, 4000, 8000, 16,000, 32,000 ppm	Mortality	2,000	4,000	0.104 BW & FCNS - EPA 1988a	208	417	5	5	3	3	1	75	75	2.8E+00	5.6E+00

NOAEL & LOAEL TRVs - CADMIUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day)	Uncertainty Factors (UF)				Total UF ⁵		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)		
					Source	Inter-species	Duration	Endpoint			Other			NOAEL	LOAEL								
								NOAEL								LOAEL							
Deer Mice (water)	Schroeder & Mitchener, 1971	Soluble cadmium salts	Oral Water	Charles River CD Mice	Chronic; 3 generations	10 animals per dose group	1 exposure of 10 mg/L (0.1 ppm in diet)	Reproduction	10	0.25 ORNL 1996	NA	2.5	1	1	1	1	1	1	1	0.83	2.5		
Deer Mice (diet)	Wilson et al., 1941	Cadmium chloride	Oral Diet	Albino rats	Chronic; 100 days	4 to 6 animals per dose group	6 exposures (0 control, 31, 62, 125, 250, 500 ppm)	Growth	31	62	0.08 ORNL 1996	2.48	4.96	3	1	1	1	1	3	3	0.83	1.7	
Mink (water)	Schroeder & Mitchener, 1971	Soluble cadmium salts	Oral Water	Charles River CD Mice	Chronic; 3 generations	10 animals per dose group	1 exposure of 10 mg/L (0.1 ppm in diet)	Reproduction	10	0.25 ORNL 1996	NA	2.5	5	1	1	1	1	5	5	0.17	0.5		
Mink (diet)	Wilson et al., 1941	Cadmium chloride	Oral Diet	Albino rats	Chronic; 100 days	4 to 6 animals per dose group	6 exposures (0 control, 31, 62, 125, 250, 500 ppm)	Growth	31	62	0.08 ORNL 1996	2.48	4.96	5	1	1	1	1	5	5	0.50	1.0	
Masked Shrew (water)	Schroeder & Mitchener, 1971	Soluble cadmium salts	Oral Water	Charles River CD Mice	Chronic; 3 generations	10 animals per dose group	1 exposure of 10 mg/L (0.1 ppm in diet)	Reproduction	10	0.25 ORNL 1996	NA	2.5	5	1	1	1	1	5	5	0.17	0.5		
Masked Shrew (diet)	Wilson et al., 1941	Cadmium chloride	Oral Diet	Albino rats	Chronic; 100 days	4 to 6 animals per dose group	6 exposures (0 control, 31, 62, 125, 250, 500 ppm)	Growth	31	62	0.08 ORNL 1996	2.48	4.96	5	1	1	1	1	5	5	0.50	1.0	
Red Fox (water)	Schroeder & Mitchener, 1971	Soluble cadmium salts	Oral Water	Charles River CD Mice	Chronic; 3 generations	10 animals per dose group	1 exposure of 10 mg/L (0.1 ppm in diet)	Reproduction	10	0.25 ORNL 1996	NA	2.5	5	1	1	1	1	5	5	0.17	0.5		
Red Fox (diet)	Wilson et al., 1941	Cadmium chloride	Oral Diet	Albino rats	Chronic; 100 days	4 to 6 animals per dose group	6 exposures (0 control, 31, 62, 125, 250, 500 ppm)	Growth	31	62	0.08 ORNL 1996	2.48	4.96	5	1	1	1	1	5	5	0.50	1.0	
American Robin (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁶																			0.04	1.2		
American Robin (diet)	White & Finley, 1978	Cadmium chloride	Oral Diet	Mallard	Chronic; 90 days	20 animals per dose group	4 exposure groups (0 control, 20, 200, 2000 ppm wet weight)	Reproduction	17.3	239	0.1 Measured in study	1.73	23.9	5	1	2	1	2	SMF	20	10	0.09	2.4
American Kestrel (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁶																				0.04	1.2	
American Kestrel (diet)	White & Finley, 1978	Cadmium chloride	Oral Diet	Mallard	Chronic; 90 days	20 animals per dose group	4 exposure groups (0 control, 20, 200, 2000 ppm wet weight)	Reproduction	17.3	239	0.1 Measured in study	1.73	23.9	5	1	2	1	2	SMF	20	10	0.09	2.4
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁶																				0.04	1.2	
Belted Kingfisher (diet)	White & Finley, 1978	Cadmium chloride	Oral Diet	Mallard	Chronic; 90 days	20 animals per dose group	4 exposure groups (0 control, 20, 200, 2000 ppm wet weight)	Reproduction	17.3	239	0.1 Measured in study	1.73	23.9	5	1	2	1	2	SMF	20	10	0.09	2.4
Mallard Duck (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁶																				0.04	1.2	
Mallard Duck (diet)	White & Finley, 1978	Cadmium chloride	Oral Diet	Mallard	Chronic; 90 days	20 animals per dose group	4 exposure groups (0 control, 20, 200, 2000 ppm wet weight)	Reproduction	17.3	239	0.1 Measured in study	1.73	23.9	5	1	2	1	2	SMF	20	10	0.09	2.4
Greater-Sage Grouse (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁶																				0.04	1.2	
Greater-Sage Grouse (diet)	White & Finley, 1978	Cadmium chloride	Oral Diet	Mallard	Chronic; 90 days	20 animals per dose group	4 exposure groups (0 control, 20, 200, 2000 ppm wet weight)	Reproduction	17.3	239	0.1 Measured in study	1.73	23.9	5	1	2	1	2	SMF	20	10	0.09	2.4

NOAEL & LOAEL TRVs - COBALT

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) ¹	Uncertainty Factors (UF)				Other	Total UF ⁵		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)		
					Duration	N	Doses	Endpoint						Inter-species	Duration	Endpoint			NOAEL	LOAEL				
											NOAEL					LOAEL								
Deer Mice (water)	No Reliable TRV Establishing Study Derive from dietary TRV																					1.1E+00	3.3E+00	
Deer Mice (diet)	Mollenhauer et al 1985	Cobalt chloride	Oral Diet	Rat	98 days			Reproduction Testicular degeneration			1 None required	NA 20	3 1	1 1	1 1	1 1	3 3	3 3	2.2E+00	6.7E+00				
Mink (water)	No Reliable TRV Establishing Study Derive from dietary TRV																					6.7E-01	2.0E+00	
Mink (diet)	Mollenhauer et al 1985	Cobalt chloride	Oral Diet	Rat	98 days			Reproduction Testicular degeneration			1 None required	NA 20	5 1	1 1	1 1	1 1	5 5	5 5	1.3E+00	4.0E+00				
Masked Shrew (water)	No Reliable TRV Establishing Study Derive from dietary TRV																					6.7E-01	2.0E+00	
Masked Shrew (diet)	Mollenhauer et al 1985	Cobalt chloride	Oral Diet	Rat	98 days			Reproduction Testicular degeneration			1 None required	NA 20	5 1	1 1	1 1	1 1	5 5	5 5	1.3E+00	4.0E+00				
Red Fox (water)	No Reliable TRV Establishing Study Derive from dietary TRV																					6.7E-01	2.0E+00	
Red Fox (diet)	Mollenhauer et al 1985	Cobalt chloride	Oral Diet	Rat	98 days			Reproduction Testicular degeneration			1 None required	NA 20	5 1	1 1	1 1	1 1	5 5	5 5	1.3E+00	4.0E+00				
American Robin (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					1.3E-01	2.7E-01	
American Robin (diet)	Hill 1974	Cobalt chloride hexahydrate	Oral Diet	Chicken	2 weeks	10 chicks per dose group	5 exposures + control (0.50/100/200/300/400 mg/kg)	Growth, Mortality	50	100	0.11 From EcoSSL derivation	1.3 *Adjusted to account for 25% Co in CoCl ₂ 6H ₂ O	2.7	5	1	1	1	1	5	5	2.7E-01	5.3E-01		
American Kestrel (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					1.3E-01	2.7E-01	
American Kestrel (diet)	Hill 1974	Cobalt chloride hexahydrate	Oral Diet	Chicken	2 weeks	10 chicks per dose group	5 exposures + control (0.50/100/200/300/400 mg/kg)	Growth, Mortality	50	100	0.11 From EcoSSL derivation	1.3 *Adjusted to account for 25% Co in CoCl ₂ 6H ₂ O	2.7	5	1	1	1	1	5	5	2.7E-01	5.3E-01		
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					1.3E-01	2.7E-01	
Belted Kingfisher (diet)	Hill 1974	Cobalt chloride hexahydrate	Oral Diet	Chicken	2 weeks	10 chicks per dose group	5 exposures + control (0.50/100/200/300/400 mg/kg)	Growth, Mortality	50	100	0.11 From EcoSSL derivation	1.3 *Adjusted to account for 25% Co in CoCl ₂ 6H ₂ O	2.7	5	1	1	1	1	5	5	2.7E-01	5.3E-01		
Mallard Duck (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					1.3E-01	2.7E-01	
Mallard Duck (diet)	Hill 1974	Cobalt chloride hexahydrate	Oral Diet	Chicken	2 weeks	10 chicks per dose group	5 exposures + control (0.50/100/200/300/400 mg/kg)	Growth, Mortality	50	100	0.11 From EcoSSL derivation	1.3 *Adjusted to account for 25% Co in CoCl ₂ 6H ₂ O	2.7	5	1	1	1	1	5	5	2.7E-01	5.3E-01		
Greater-Sage Grouse (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					1.3E-01	2.7E-01	
Greater-Sage Grouse (diet)	Hill 1974	Cobalt chloride hexahydrate	Oral Diet	Chicken	2 weeks	10 chicks per dose group	5 exposures + control (0.50/100/200/300/400 mg/kg)	Growth, Mortality	50	100	0.11 From EcoSSL derivation	1.3 *Adjusted to account for 25% Co in CoCl ₂ 6H ₂ O	2.7	5	1	1	1	1	5	5	2.7E-01	5.3E-01		

NOAEL & LOAEL TRVs - COPPER

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) ¹	Uncertainty Factors (UF)					NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)		
					Duration	N	Doses	Endpoint						Source	Inter-species	Duration	Endpoint				Other	
											NOAEL						LOAEL	Total UF ⁵				
		NOAEL	LOAEL																			
Deer Mice (water)	Hebert et al., 1993	Copper sulfate	Oral Water	B6C3F1 mice	Subchronic; 15 days	5 animals per sex per dose group	5 exposures (0, 300, 1000, 3000, 10000 mg/L)	Growth, Mortality			1 None Required	95	226	1	5	5	5	1	25	25	3.8E+00	9.0E+00
Deer Mice (diet)	Hebert et al., 1993	Copper sulfate	Oral Diet	B6C3F1 mice	Chronic; 92 days	10 animals per sex per dose group	6 exposures (0, 1000, 2000, 4000, 8000, 16000 mg/kg)	Reproduction, Growth			1 None Required	168	362	1	1	1	1	1	1	1	1.7E+02	3.6E+02
Mink (water)	Aulerich et al., 1982	Copper sulfate	Oral Water	Mink	Chronic; 357 days	24 animals per dose group	5 exposures (60.5 control, 25, 50, 100, 200 mg/kg)	Reproduction (Reproductive success)	110.5	160.5	0.16 USEPA, 1993	17.7	25.7	1	1	1	1	1	1	1	1.8E+01	2.6E+01
Mink (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV ²																				8.8E+00	1.3E+01
Masked Shrew (water)	Hebert et al., 1993	Copper sulfate	Oral Water	B6C3F1 mice	Subchronic; 15 days	5 animals per sex per dose group	5 exposures (0, 300, 1000, 3000, 10000 mg/L)	Growth, Mortality			1 None Required	95	226	5	5	5	5	1	125	125	7.6E-01	1.8E+00
Masked Shrew (diet)	Hebert et al., 1993	Copper sulfate	Oral Diet	B6C3F1 mice	Chronic; 92 days	10 animals per sex per dose group	6 exposures (0, 1000, 2000, 4000, 8000, 16000 mg/kg)	Reproduction, Growth			1 None Required	168	362	5	1	1	1	1	5	5	3.4E+01	7.2E+01
Red Fox (water)	Aulerich et al., 1982	Copper sulfate	Oral Water	Mink	Chronic; 357 days	24 animals per dose group	5 exposures (60.5 control, 25, 50, 100, 200 mg/kg)	Reproduction (Reproductive success)	110.5	160.5	0.16 USEPA, 1993	17.7	25.7	4	1	1	1	1	4	4	4.4E+00	6.4E+00
Red Fox (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV ²																				2.2E+00	3.2E+00
American Robin (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																				2.0E+00	3.0E+00
American Robin (diet)	Jackson & Stevenson, 1981	Copper oxide	Oral Diet	Chicken	Chronic; 40 weeks	22 animals per dose group	6 exposures (0 control, 150, 300, 450, 600, 750 ppm)	Reproduction	300	450	0.067 Measured in study	20.1	30.2	5	1	1	1	1	5	5	4.0E+00	6.0E+00
American Kestrel (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																				2.0E+00	3.0E+00
American Kestrel (diet)	Jackson & Stevenson, 1981	Copper oxide	Oral Diet	Chicken	Chronic; 40 weeks	22 animals per dose group	6 exposures (0 control, 150, 300, 450, 600, 750 ppm)	Reproduction	300	450	0.067 Measured in study	20.1	30.2	5	1	1	1	1	5	5	4.0E+00	6.0E+00
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																				2.0E+00	3.0E+00
Belted Kingfisher (diet)	Jackson & Stevenson, 1981	Copper oxide	Oral Diet	Chicken	Chronic; 40 weeks	22 animals per dose group	6 exposures (0 control, 150, 300, 450, 600, 750 ppm)	Reproduction	300	450	0.067 Measured in study	20.1	30.2	5	1	1	1	1	5	5	4.0E+00	6.0E+00
Mallard Duck (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																				2.0E+00	3.0E+00
Mallard Duck (diet)	Jackson & Stevenson, 1981	Copper oxide	Oral Diet	Chicken	Chronic; 40 weeks	22 animals per dose group	6 exposures (0 control, 150, 300, 450, 600, 750 ppm)	Reproduction	300	450	0.067 Measured in study	20.1	30.2	5	1	1	1	1	5	5	4.0E+00	6.0E+00
Greater-Sage Grouse (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																				2.0E+00	3.0E+00
Greater-Sage Grouse (diet)	Jackson & Stevenson, 1981	Copper oxide	Oral Diet	Chicken	Chronic; 40 weeks	22 animals per dose group	6 exposures (0 control, 150, 300, 450, 600, 750 ppm)	Reproduction	300	450	0.067 Measured in study	20.1	30.2	5	1	1	1	1	5	5	4.0E+00	6.0E+00

NOAEL & LOAEL TRVs - LEAD

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) ¹	Uncertainty Factors (UF)				Other	Total UF ⁵		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
					Source	Inter-species	Duration	Endpoint			NOAEL			LOAEL	NOAEL	LOAEL						
								NOAEL									LOAEL					
Deer Mice (water)	Schroeder & Mitchener, 1971	Soluble lead salt	Oral	Charles River CD Mice	Chronic; 3 generations	10 animals per dose group	1 exposure (25 mg/L + 0.2 ppm in diet)	Reproduction	25	0.25	NA	6.25	1	1	1	1	10 Effects seen in utero	10	10	2.1E-01	6.3E-01	
Deer Mice (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV ²																			4.2E-01	1.3E+00	
Mink (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																			1.6E-01	3.1E-01	
Mink (diet)	Horwitt & Cowgill, 1938	Lead acetate	Oral	Dogs	Chronic; prenatal + 7 months	2 to 4 animals per dose group	4 exposures (2 control, 25, 50, 100 ppm)	Reproduction, Growth	52	102	0.024	1.25	2.45	4	1	1	1	1	4	4	3.1E-01	6.1E-01
Masked Shrew (water)	Schroeder & Mitchener, 1971	Soluble lead salt	Oral	Charles River CD Mice	Chronic; 3 generations	10 animals per dose group	1 exposure (25 mg/L + 0.2 ppm in diet)	Reproduction	25	0.25	NA	6.25	5	1	1	1	10 Effects seen in utero	50	50	4.2E-02	1.3E-01	
Masked Shrew (diet)	No Reliable TRV Establishing Studies Found Derive from Water TRV ²																			8.3E-02	2.5E-01	
Red Fox (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																			2.1E-01	4.1E-01	
Red Fox (diet)	Horwitt & Cowgill, 1938	Lead acetate	Oral	Dogs	Chronic; prenatal + 7 months	2 to 4 animals per dose group	4 exposures (2 control, 25, 50, 100 ppm)	Reproduction, Growth	52	102	0.024	1.25	2.45	3	1	1	1	1	3	3	4.2E-01	8.2E-01
American Robin (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																			4.4E-01	8.8E-01	
American Robin (diet)	Edens & Garlich, 1983	Lead acetate	Oral	Leghorn hens	Chronic; 10 weeks (during reproduction)	20 or 40 animals per dose group	3 or 5 exposures Exp 1 - 0, 25, 50 ppm; Exp 2 - 0, 50, 100, 200, 400 ppm	Reproduction (Egg production)	25	50	0.175	4.38	8.75	5	1	1	1	1	5	5	8.8E-01	1.8E+00
American Kestrel (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																			4.4E-01	8.8E-01	
American Kestrel (diet)	Edens & Garlich, 1983	Lead acetate	Oral	Leghorn hens	Chronic; 10 weeks (during reproduction)	20 or 40 animals per dose group	3 or 5 exposures Exp 1 - 0, 25, 50 ppm; Exp 2 - 0, 50, 100, 200, 400 ppm	Reproduction (Egg production)	25	50	0.175	4.38	8.75	5	1	1	1	1	5	5	8.8E-01	1.8E+00
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																			4.4E-01	8.8E-01	
Belted Kingfisher (diet)	Edens & Garlich, 1983	Lead acetate	Oral	Leghorn hens	Chronic; 10 weeks (during reproduction)	20 or 40 animals per dose group	3 or 5 exposures Exp 1 - 0, 25, 50 ppm; Exp 2 - 0, 50, 100, 200, 400 ppm	Reproduction (Egg production)	25	50	0.175	4.38	8.75	5	1	1	1	1	5	5	8.8E-01	1.8E+00
Mallard Duck (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																			4.4E-01	8.8E-01	
Mallard Duck (diet)	Edens & Garlich, 1983	Lead acetate	Oral	Leghorn hens	Chronic; 10 weeks (during reproduction)	20 or 40 animals per dose group	3 or 5 exposures Exp 1 - 0, 25, 50 ppm; Exp 2 - 0, 50, 100, 200, 400 ppm	Reproduction (Egg production)	25	50	0.175	4.38	8.75	5	1	1	1	1	5	5	8.8E-01	1.8E+00
Greater-Sage Grouse (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																			4.4E-01	8.8E-01	
Greater-Sage Grouse (diet)	Edens & Garlich, 1983	Lead acetate	Oral	Leghorn hens	Chronic; 10 weeks (during reproduction)	20 or 40 animals per dose group	3 or 5 exposures Exp 1 - 0, 25, 50 ppm; Exp 2 - 0, 50, 100, 200, 400 ppm	Reproduction (Egg production)	25	50	0.175	4.38	8.75	5	1	1	1	1	5	5	8.8E-01	1.8E+00

NOAEL & LOAEL TRVs - NICKEL

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) ¹	Uncertainty Factors (UF)				Other	Total UF ⁵		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
					Duration	N	Doses	Endpoint						Source	Inter-species	Duration	Endpoint		NOAEL	LOAEL		
											NOAEL						LOAEL					
Deer Mice (water)	Smith et al., 1993	Nickel chloride	Oral Water	Long-Evans rats	Chronic; 4 month (11 wks pre-gestation)	34 females per dose grp	4 exposures (control, XX, XX, XX ppm)	Reproduction		1.3	1	NA	1.30	3	1	1	1	1	3	3	1.4E-01	4.3E-01
Deer Mice (diet)	Ambrose et al., 1976	Nickel sulfate hexahydrate	Oral Diet	Rat	3 generations Chronic	60 animals per dose grp	3 exposures 250, 500, 1000 ppm	Reproduction	500		0.08 BW & FCNS - EPA 1988a	40	NA	3	1	1	1	1	3	3	1.3E+01	4.0E+01
Mink (water)	Smith et al., 1993	Nickel chloride	Oral Water	Long-Evans rats	Chronic; 4 month (11 wks pre-gestation)	34 females per dose grp	4 exposures (control, XX, XX, XX ppm)	Reproduction		1.3	1	NA	1.30	5	1	1	1	1	5	5	8.7E-02	2.6E-01
Mink (diet)	Ambrose et al., 1976	Nickel sulfate hexahydrate	Oral Diet	Rat	3 generations Chronic	60 animals per dose grp	3 exposures 250, 500, 1000 ppm	Reproduction	500		0.08 BW & FCNS - EPA 1988a	40	NA	5	1	1	1	1	5	5	8.0E+00	2.4E+01
Masked Shrew (water)	Smith et al., 1993	Nickel chloride	Oral Water	Long-Evans rats	Chronic; 4 month (11 wks pre-gestation)	34 females per dose grp	4 exposures (control, XX, XX, XX ppm)	Reproduction		1.3	1	NA	1.30	5	1	1	1	1	5	5	8.7E-02	2.6E-01
Masked Shrew (diet)	Ambrose et al., 1976	Nickel sulfate hexahydrate	Oral Diet	Rat	3 generations Chronic	60 animals per dose grp	3 exposures 250, 500, 1000 ppm	Reproduction	500		0.08 BW & FCNS - EPA 1988a	40	NA	5	1	1	1	1	5	5	8.0E+00	2.4E+01
Red Fox (water)	Smith et al., 1993	Nickel chloride	Oral Water	Long-Evans rats	Chronic; 4 month (11 wks pre-gestation)	34 females per dose grp	4 exposures (control, XX, XX, XX ppm)	Reproduction		1.3	1	NA	1.30	5	1	1	1	1	5	5	8.7E-02	2.6E-01
Red Fox (diet)	Ambrose et al., 1976	Nickel sulfate hexahydrate	Oral Diet	Rat	3 generations Chronic	60 animals per dose grp	3 exposures 250, 500, 1000 ppm	Reproduction	500		0.08 BW & FCNS - EPA 1988a	40	NA	5	1	1	1	1	5	5	8.0E+00	2.4E+01
American Robin (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				2.6E+00	7.7E+00
American Robin (diet)	Cain & Pafford, 1981	Nickel sulfate	Oral Diet	Mallard duck	90 days Subchronic	36 animals per dose grp	3 exposures 176, 774, 1069 ppm	Mortality; Growth; Behavior	774		0.1 From study	77.4	NA	5	3	1	1	1	15	15	5.2E+00	1.5E+01
American Kestrel (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				2.6E+00	7.7E+00
American Kestrel (diet)	Cain & Pafford, 1981	Nickel sulfate	Oral Diet	Mallard duck	90 days Subchronic	36 animals per dose grp	3 exposures 176, 774, 1069 ppm	Mortality; Growth; Behavior	774		0.1 From study	77.4	NA	5	3	1	1	1	15	15	5.2E+00	1.5E+01
Belted Kingfisher (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				2.6E+00	7.7E+00
Belted Kingfisher (diet)	Cain & Pafford, 1981	Nickel sulfate	Oral Diet	Mallard duck	90 days Subchronic	36 animals per dose grp	3 exposures 176, 774, 1069 ppm	Mortality; Growth; Behavior	774		0.1 From study	77.4	NA	5	3	1	1	1	15	15	5.2E+00	1.5E+01
Mallard Duck (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				2.6E+00	7.7E+00
Mallard Duck (diet)	Cain & Pafford, 1981	Nickel sulfate	Oral Diet	Mallard duck	90 days Subchronic	36 animals per dose grp	3 exposures 176, 774, 1069 ppm	Mortality; Growth; Behavior	774		0.1 From study	77.4	NA	5	3	1	1	1	15	15	5.2E+00	1.5E+01
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				2.6E+00	7.7E+00
Greater-Sage Grouse (diet)	Cain & Pafford, 1981	Nickel sulfate	Oral Diet	Mallard duck	90 days Subchronic	36 animals per dose grp	3 exposures 176, 774, 1069 ppm	Mortality; Growth; Behavior	774		0.1 From study	77.4	NA	5	3	1	1	1	15	15	5.2E+00	1.5E+01

NOAEL & LOEL TRVs - MANGANESE

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) ¹	Uncertainty Factors (UF)					NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)		
					Duration	N	Doses	Endpoint						Inter-species	Duration	Endpoint		Other			Total UF ⁵	
																NOAEL	LOAEL				NOAEL	LOAEL
Deer Mice (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				1.5E+01	4.7E+01
Deer Mice (diet)	Laskey et al 1982	Manganese oxide	Oral Diet	Rat	224 days (through gestation) Critical lifestage		3 exposures 350, 1050, 3500 ppm (+50 ppm basal diet)	Reproduction	1100	3550	0.08 BW & FCNS - EPA 1988a	88	284	3	1	1	1	1	3	3	2.9E+01	9.5E+01
Mink (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				8.8E+00	2.8E+01
Mink (diet)	Laskey et al 1982	Manganese oxide	Oral Diet	Rat	224 days (through gestation) Critical lifestage		3 exposures 350, 1050, 3500 ppm (+50 ppm basal diet)	Reproduction	1100	3550	0.08 BW & FCNS - EPA 1988a	88	284	5	1	1	1	1	5	5	1.8E+01	5.7E+01
Masked Shrew (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				8.8E+00	2.8E+01
Masked Shrew (diet)	Laskey et al 1982	Manganese oxide	Oral Diet	Rat	224 days (through gestation) Critical lifestage		3 exposures 350, 1050, 3500 ppm (+50 ppm basal diet)	Reproduction	1100	3550	0.08 BW & FCNS - EPA 1988a	88	284	5	1	1	1	1	5	5	1.8E+01	5.7E+01
Red Fox (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				8.8E+00	2.8E+01
Red Fox (diet)	Laskey et al 1982	Manganese oxide	Oral Diet	Rat	224 days (through gestation) Critical lifestage		3 exposures 350, 1050, 3500 ppm (+50 ppm basal diet)	Reproduction	1100	3550	0.08 BW & FCNS - EPA 1988a	88	284	5	1	1	1	1	5	5	1.8E+01	5.7E+01
American Robin (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				3.3E+01	9.8E+01
American Robin (diet)	Laskey and Edens 1985	Manganese oxide	Oral Diet	Japanese quail	75 days Chronic exposure		1 exposure 5000 ppm (+56 ppm basal diet)	Growth; Aggressive behavior			1 None required	NA	977 Reported in study	5	1	1	1	1	5	5	6.5E+01	2.0E+02
American Kestrel (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				3.3E+01	9.8E+01
American Kestrel (diet)	Laskey and Edens 1985	Manganese oxide	Oral Diet	Japanese quail	75 days Chronic exposure		1 exposure 5000 ppm (+56 ppm basal diet)	Growth; Aggressive behavior			1 None required	NA	977 Reported in study	5	1	1	1	1	5	5	6.5E+01	2.0E+02
Belted Kingfisher (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				3.3E+01	9.8E+01
Belted Kingfisher (diet)	Laskey and Edens 1985	Manganese oxide	Oral Diet	Japanese quail	75 days Chronic exposure		1 exposure 5000 ppm (+56 ppm basal diet)	Growth; Aggressive behavior			1 None required	NA	977 Reported in study	5	1	1	1	1	5	5	6.5E+01	2.0E+02
Mallard Duck (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				3.3E+01	9.8E+01
Mallard Duck (diet)	Laskey and Edens 1985	Manganese oxide	Oral Diet	Japanese quail	75 days Chronic exposure		1 exposure 5000 ppm (+56 ppm basal diet)	Growth; Aggressive behavior			1 None required	NA	977 Reported in study	5	1	1	1	1	5	5	6.5E+01	2.0E+02
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				3.3E+01	9.8E+01
Greater-Sage Grouse (diet)	Laskey and Edens 1985	Manganese oxide	Oral Diet	Japanese quail	75 days Chronic exposure		1 exposure 5000 ppm (+56 ppm basal diet)	Growth; Aggressive behavior			1 None required	NA	977 Reported in study	5	1	1	1	1	5	5	6.5E+01	2.0E+02

NOAEL & LOAEL TRVs - INORGANIC MERCURY

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) ¹	Uncertainty Factors (UF)				Other	Total UF ⁵		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)	
					Duration	N	Doses	Endpoint						Source	Inter-species	Duration	Endpoint		NOAEL	LOAEL			
											NOAEL						LOAEL						
Deer Mice (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					3.30	9.9
Deer Mice (diet)	Revis et al., 1989	Mercuric sulfide	Oral Diet	Mouse (Mus sp.)	Chronic; 20 months (included 6 month reprod.)		30 exposures (Highest dose = 13.2 mg/kg-day)	Reproduction, Mortality, Histology (liver, kidney)		1 None required	13.2	NA	2	1	1	1	1	1	2	2		6.6	20
Mink (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.69	2.1
Mink (diet)	Aulerich et al., 1974	Mercuric chloride	Oral Diet	Mink	Subchronic; 6 month Critical life stage (kit develop.)	15 animals per dose group	1 exposure (10 ppm)	Reproduction, Developmental	10	0.137 Bleavins & Aulerich, 1981	1.4	NA	1	1	1	1	1	1	1	1		1.4	4.1
Masked Shrew (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					1.32	4.0
Masked Shrew (diet)	Revis et al., 1989	Mercuric sulfide	Oral Diet	Mouse (Mus sp.)	Chronic; 20 months (included 6 month reprod.)		30 exposures (Highest dose = 13.2 mg/kg-day)	Reproduction, Mortality, Histology (liver, kidney)		1 None required	13.2	NA	5	1	1	1	1	1	5	5		2.6	7.9
Red Fox (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.17	0.5
Red Fox (diet)	Aulerich et al., 1974	Mercuric chloride	Oral Diet	Mink	Subchronic; 6 month Critical life stage (kit develop.)	15 animals per dose group	1 exposure (10 ppm)	Reproduction, Developmental	10	0.137 Bleavins & Aulerich, 1981	1.4	NA	4	1	1	1	1	4	4		0.3	1.0	
American Robin (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.05	0.1
American Robin (diet)	Hill & Schaffner, 1976	Mercuric chloride	Oral Diet	Japanese quail	Chronic; 1 year Critical life stage (hatchling)		5 exposures (2, 4, 8, 16, 32 ppm)	Reproduction, Developmental	4	8 0.113 ORNL, 1996	0.45	0.90	5	1	1	1	1	5	5		0.09	0.18	
American Kestrel (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.05	0.1
American Kestrel (diet)	Hill & Schaffner, 1976	Mercuric chloride	Oral Diet	Japanese quail	Chronic; 1 year Critical life stage (hatchling)		5 exposures (2, 4, 8, 16, 32 ppm)	Reproduction, Developmental	4	8 0.113 ORNL, 1996	0.45	0.90	5	1	1	1	1	5	5		0.09	0.18	
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.05	0.1
Belted Kingfisher (diet)	Hill & Schaffner, 1976	Mercuric chloride	Oral Diet	Japanese quail	Chronic; 1 year Critical life stage (hatchling)		5 exposures (2, 4, 8, 16, 32 ppm)	Reproduction, Developmental	4	8 0.113 ORNL, 1996	0.45	0.90	5	1	1	1	1	5	5		0.09	0.18	
Mallard Duck (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.05	0.1
Mallard Duck (diet)	Hill & Schaffner, 1976	Mercuric chloride	Oral Diet	Japanese quail	Chronic; 1 year Critical life stage (hatchling)		5 exposures (2, 4, 8, 16, 32 ppm)	Reproduction, Developmental	4	8 0.113 ORNL, 1996	0.45	0.90	5	1	1	1	1	5	5		0.09	0.18	
Greater-Sage Grouse (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.05	0.1
Greater-Sage Grouse (diet)	Hill & Schaffner, 1976	Mercuric chloride	Oral Diet	Japanese quail	Chronic; 1 year Critical life stage (hatchling)		5 exposures (2, 4, 8, 16, 32 ppm)	Reproduction, Developmental	4	8 0.113 ORNL, 1996	0.45	0.90	5	1	1	1	1	5	5		0.09	0.18	

NOAEL & LOAEL TRVs - ORGANIC MERCURY

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) ¹	Uncertainty Factors (UF)				Other	Total UF ⁵		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)	
					Duration	N	Doses	Endpoint						Inter-species	Duration	Endpoint			NOAEL	LOAEL			
											NOAEL					LOAEL							
Deer Mice (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.004	0.019
Deer Mice (diet)	Vershuuren et al., 1976	Methylmercury chloride	Oral Diet	Rat	Chronic; 2 year	sex per dose group	4 exposures (0 control, 0.1, 0.5, 2.5 ppm)	Reproduction, Histology	0.5	2.5	0.045 Measures in study controls	0.02	0.11	3	1	1	1	1	3	3		0.01	0.04
Mink (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.04	0.07
Mink (diet)	Wobeser et al., 1976	Methylmercury chloride	Oral Diet	Mink	Subchronic; 93 days	5 females per dose group	6 exposures (0 control, 1.1, 1.8, 4.8, 8.3, 15 ppm)	Mortality, Clinical tox. (weight loss, ataxia)	1.1	1.8	0.22 USEPA, 1993	0.24	0.40	1	3	1	1	1	3	3		0.08	0.13
Masked Shrew (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.002	0.011
Masked Shrew (diet)	Vershuuren et al., 1976	Methylmercury chloride	Oral Diet	Rat	Chronic; 2 year	sex per dose group	4 exposures (0 control, 0.1, 0.5, 2.5 ppm)	Reproduction, Histology	0.5	2.5	0.045 Measures in study controls	0.02	0.11	5	1	1	1	1	5	5		0.005	0.02
Red Fox (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.03	0.05
Red Fox (diet)	Wobeser et al., 1976	Methylmercury chloride	Oral Diet	Mink	Subchronic; 93 days	5 females per dose group	6 exposures (0 control, 1.1, 1.8, 4.8, 8.3, 15 ppm)	Mortality, Clinical tox. (weight loss, ataxia)	1.1	1.8	0.22 USEPA, 1993	0.24	0.40	4	1	1	1	1	4	4		0.06	0.10
American Robin (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.02	0.1
American Robin (diet)	Hill & Soares, 1984	Methylmercury chloride	Oral Diet	Japanese quail	Chronic; 9 weeks Critical life stage	15 animals per dose group	5 exposures (0 control, 0.125, 0.5, 2, 8 ppm)	Survivability	2	8	0.113 ORNL, 1996	0.23	0.90	5	1	1	1	1	5	5		0.05	0.18
American Kestrel (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.02	0.1
American Kestrel (diet)	Hill & Soares, 1984	Methylmercury chloride	Oral Diet	Japanese quail	Chronic; 9 weeks Critical life stage	15 animals per dose group	5 exposures (0 control, 0.125, 0.5, 2, 8 ppm)	Survivability	2	8	0.113 ORNL, 1996	0.23	0.90	5	1	1	1	1	5	5		0.05	0.18
Belted Kingfisher (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.02	0.1
Belted Kingfisher (diet)	Hill & Soares, 1984	Methylmercury chloride	Oral Diet	Japanese quail	Chronic; 9 weeks Critical life stage	15 animals per dose group	5 exposures (0 control, 0.125, 0.5, 2, 8 ppm)	Survivability	2	8	0.113 ORNL, 1996	0.23	0.90	5	1	1	1	1	5	5		0.05	0.18
Mallard Duck (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.02	0.1
Mallard Duck (diet)	Hill & Soares, 1984	Methylmercury chloride	Oral Diet	Japanese quail	Chronic; 9 weeks Critical life stage	15 animals per dose group	5 exposures (0 control, 0.125, 0.5, 2, 8 ppm)	Survivability	2	8	0.113 ORNL, 1996	0.23	0.90	5	1	1	1	1	5	5		0.05	0.18
Greater-Sage Grouse (water)	No Reliable TRV Establishing Studies Found Derive from Dietary TRV ⁴																					0.02	0.1
Greater-Sage Grouse (diet)	Hill & Soares, 1984	Methylmercury chloride	Oral Diet	Japanese quail	Chronic; 9 weeks Critical life stage	15 animals per dose group	5 exposures (0 control, 0.125, 0.5, 2, 8 ppm)	Survivability	2	8	0.113 ORNL, 1996	0.23	0.90	5	1	1	1	1	5	5		0.05	0.18

NOAEL & LOAEL TRVs - SELENIUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) ¹	Uncertainty Factors (UF)					Other	Total UF ⁵		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
					Duration	N	Doses	Endpoint						Inter-species	Duration	Endpoint		NOAEL		LOAEL			
											NOAEL					LOAEL							
Deer Mice (water)	Rosenfeld & Beath 1954	Potassium selenate	Oral Water	Rat	1 year (2 generations) Critical lifestage		3 exposures 1.5, 2.5, 7.5 mg/L	Reproduction	1.5	2.5	0.13 BW & WCNS - EPA 1988a	0.20	0.33	3	1	1	1	1	3	3	6.6E-02	1.1E-01	
Deer Mice (diet)	No Reliable TRV Establishing Study Derive from water TRV																				1.3E-01	2.2E-01	
Mink (water)	Rosenfeld & Beath 1954	Potassium selenate	Oral Water	Rat	1 year (2 generations) Critical lifestage		3 exposures 1.5, 2.5, 7.5 mg/L	Reproduction	1.5	2.5	0.13 BW & WCNS - EPA 1988a	0.20	0.33	5	1	1	1	1	5	5	3.9E-02	6.6E-02	
Mink (diet)	No Reliable TRV Establishing Study Derive from water TRV																				7.9E-02	1.3E-01	
Masked Shrew (water)	Rosenfeld & Beath 1954	Potassium selenate	Oral Water	Rat	1 year (2 generations) Critical lifestage		3 exposures 1.5, 2.5, 7.5 mg/L	Reproduction	1.5	2.5	0.13 BW & WCNS - EPA 1988a	0.20	0.33	5	1	1	1	1	5	5	3.9E-02	6.6E-02	
Masked Shrew (diet)	No Reliable TRV Establishing Study Derive from water TRV																				7.9E-02	1.3E-01	
Red Fox (water)	Rosenfeld & Beath 1954	Potassium selenate	Oral Water	Rat	1 year (2 generations) Critical lifestage		3 exposures 1.5, 2.5, 7.5 mg/L	Reproduction	1.5	2.5	0.13 BW & WCNS - EPA 1988a	0.20	0.33	5	1	1	1	1	5	5	3.9E-02	6.6E-02	
Red Fox (diet)	No Reliable TRV Establishing Study Derive from water TRV																				7.9E-02	1.3E-01	
American Robin (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				5.0E-02	1.0E-01	
American Robin (diet)	Heinz et al 1987	Sodium selenite	Oral Diet	Mallard	78 days Critical lifestage		5 exposures 1, 5, 10, 25, 100 ppm	Reproduction	5	10	0.10 Measured in study	0.5	1.0	5	1	1	1	1	5	5	1.0E-01	2.0E-01	
American Kestrel (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				5.0E-02	1.0E-01	
American Kestrel (diet)	Heinz et al 1987	Sodium selenite	Oral Diet	Mallard	78 days Critical lifestage		5 exposures 1, 5, 10, 25, 100 ppm	Reproduction	5	10	0.10 Measured in study	0.5	1.0	5	1	1	1	1	5	5	1.0E-01	2.0E-01	
Belted Kingfisher (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				5.0E-02	1.0E-01	
Belted Kingfisher (diet)	Heinz et al 1987	Sodium selenite	Oral Diet	Mallard	78 days Critical lifestage		5 exposures 1, 5, 10, 25, 100 ppm	Reproduction	5	10	0.10 Measured in study	0.5	1.0	5	1	1	1	1	5	5	1.0E-01	2.0E-01	
Mallard Duck (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				5.0E-02	1.0E-01	
Mallard Duck (diet)	Heinz et al 1987	Sodium selenite	Oral Diet	Mallard	78 days Critical lifestage		5 exposures 1, 5, 10, 25, 100 ppm	Reproduction	5	10	0.10 Measured in study	0.5	1.0	5	1	1	1	1	5	5	1.0E-01	2.0E-01	
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study Derive from dietary TRV																				5.0E-02	1.0E-01	
Greater-Sage Grouse (diet)	Heinz et al 1987	Sodium selenite	Oral Diet	Mallard	78 days Critical lifestage		5 exposures 1, 5, 10, 25, 100 ppm	Reproduction	5	10	0.10 Measured in study	0.5	1.0	5	1	1	1	1	5	5	1.0E-01	2.0E-01	

NOAEL & LOAEL TRVs - THALLIUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/ kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) †	Uncertainty Factors (UF)					Total UF ⁵		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
					Duration	N	Doses	Endpoint						Inter-species	Duration	Endpoint		Other	NOAEL	LOAEL		
											NOAEL					LOAEL						
Deer Mice (water)	Formigli et al 1986	Thallium sulfate	Oral	Rat	60 days Subchronic		1 exposure	Reproduction		10	0.007	NA	0.074	3	5	1	1	1	15	15	1.6E-03	4.9E-03
		Water					10 ppm	Male testicular function			Measured in study				Subchronic							
Deer Mice (diet)	No Reliable TRV Establishing Study Derive from water TRV																				3.3E-03	9.9E-03
Mink (water)	Formigli et al 1986	Thallium sulfate	Oral	Rat	60 days Subchronic		1 exposure	Reproduction		10	0.007	NA	0.074	5	5	1	1	1	25	25	9.9E-04	3.0E-03
		Water					10 ppm	Male testicular function			Measured in study				Subchronic							
Mink (diet)	No Reliable TRV Establishing Study Derive from water TRV																				2.0E-03	5.9E-03
Masked Shrew (water)	Formigli et al 1986	Thallium sulfate	Oral	Rat	60 days Subchronic		1 exposure	Reproduction		10	0.007	NA	0.074	5	5	1	1	1	25	25	9.9E-04	3.0E-03
		Water					10 ppm	Male testicular function			Measured in study				Subchronic							
Masked Shrew (diet)	No Reliable TRV Establishing Study Derive from water TRV																				2.0E-03	5.9E-03
Red Fox (water)	Formigli et al 1986	Thallium sulfate	Oral	Rat	60 days Subchronic		1 exposure	Reproduction		10	0.007	NA	0.074	5	5	1	1	1	25	25	9.9E-04	3.0E-03
		Water					10 ppm	Male testicular function			Measured in study				Subchronic							
Red Fox (diet)	No Reliable TRV Establishing Study Derive from water TRV																				2.0E-03	5.9E-03
American Robin (water)	No Reliable TRV Establishing Study																				NA	NA
American Robin (diet)	No Reliable TRV Establishing Study																				NA	NA
American Kestrel (water)	No Reliable TRV Establishing Study																				NA	NA
American Kestrel (diet)	No Reliable TRV Establishing Study																				NA	NA
Belted Kingfisher (water)	No Reliable TRV Establishing Study																				NA	NA
Belted Kingfisher (diet)	No Reliable TRV Establishing Study																				NA	NA
Mallard Duck (water)	No Reliable TRV Establishing Study																				NA	NA
Mallard Duck (diet)	No Reliable TRV Establishing Study																				NA	NA
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study																				NA	NA
Greater-Sage Grouse (diet)	No Reliable TRV Establishing Study																				NA	NA

NOAEL & LOAEL TRVs - VANADIUM

Receptor	Study	Chemical	Route	Study Test Species	Study Factors				NOAEL study conc (ppm)	LOAEL study conc (ppm)	Conversion Factor (kg food/kg BW/day)	NOAEL dose (mg/kg-day)	LOAEL dose (mg/kg-day) ¹	Uncertainty Factors (UF)				Other	Total UF ⁵		NOAEL TRV (mg/kg-day)	LOAEL TRV (mg/kg-day)
					Duration	N	Doses	Endpoint						Inter-species	Duration	Endpoint			NOAEL	LOAEL		
											NOAEL					LOAEL						
Deer Mice (water)	Domingo et al 1986	Sodium metavanadate	Oral Gavage	Rat	60 days pre-gestation through lactation; Chronic		3 exposures 5, 10, 20 mg/kg-day	Reproduction	5	1	NA	5.0	3	1	1	1	1	3	3	5.6E-01	1.7E+00	
Deer Mice (diet)	No Reliable TRV Establishing Study Derive from water TRV																			1.1E+00	3.3E+00	
Mink (water)	Domingo et al 1986	Sodium metavanadate	Oral Gavage	Rat	60 days pre-gestation through lactation; Chronic		3 exposures 5, 10, 20 mg/kg-day	Reproduction	5	1	NA	5.0	5	1	1	1	1	5	5	3.3E-01	1.0E+00	
Mink (diet)	No Reliable TRV Establishing Study Derive from water TRV																			6.7E-01	2.0E+00	
Masked Shrew (water)	Domingo et al 1986	Sodium metavanadate	Oral Gavage	Rat	60 days pre-gestation through lactation; Chronic		3 exposures 5, 10, 20 mg/kg-day	Reproduction	5	1	NA	5.0	5	1	1	1	1	5	5	3.3E-01	1.0E+00	
Masked Shrew (diet)	No Reliable TRV Establishing Study Derive from water TRV																			6.7E-01	2.0E+00	
Red Fox (water)	Domingo et al 1986	Sodium metavanadate	Oral Gavage	Rat	60 days pre-gestation through lactation; Chronic		3 exposures 5, 10, 20 mg/kg-day	Reproduction	5	1	NA	5.0	5	1	1	1	1	5	5	3.3E-01	1.0E+00	
Red Fox (diet)	No Reliable TRV Establishing Study Derive from water TRV																			6.7E-01	2.0E+00	
American Robin (water)	No Reliable TRV Establishing Study Derive from dietary TRV																			1.1E+00	3.4E+00	
American Robin (diet)	White & Dieter 1978	Vanadyl sulfate	Oral Diet	Mallard	12 weeks Chronic		3 exposures 2.84, 10.36, 110 ppm	Mortality; Body weight	110	0.10 Measured in study	11.38	NA	5	1	1	1	1	5	5	2.3E+00	6.8E+00	
American Kestrel (water)	No Reliable TRV Establishing Study Derive from dietary TRV																			1.1E+00	3.4E+00	
American Kestrel (diet)	White & Dieter 1978	Vanadyl sulfate	Oral Diet	Mallard	12 weeks Chronic		3 exposures 2.84, 10.36, 110 ppm	Mortality; Body weight	110	0.10 Measured in study	11.38	NA	5	1	1	1	1	5	5	2.3E+00	6.8E+00	
Belted Kingfisher (water)	No Reliable TRV Establishing Study Derive from dietary TRV																			1.1E+00	3.4E+00	
Belted Kingfisher (diet)	White & Dieter 1978	Vanadyl sulfate	Oral Diet	Mallard	12 weeks Chronic		3 exposures 2.84, 10.36, 110 ppm	Mortality; Body weight	110	0.10 Measured in study	11.38	NA	5	1	1	1	1	5	5	2.3E+00	6.8E+00	
Mallard Duck (water)	No Reliable TRV Establishing Study Derive from dietary TRV																			1.1E+00	3.4E+00	
Mallard Duck (diet)	White & Dieter 1978	Vanadyl sulfate	Oral Diet	Mallard	12 weeks Chronic		3 exposures 2.84, 10.36, 110 ppm	Mortality; Body weight	110	0.10 Measured in study	11.38	NA	5	1	1	1	1	5	5	2.3E+00	6.8E+00	
Greater-Sage Grouse (water)	No Reliable TRV Establishing Study Derive from dietary TRV																			1.1E+00	3.4E+00	
Greater-Sage Grouse (diet)	White & Dieter 1978	Vanadyl sulfate	Oral Diet	Mallard	12 weeks Chronic		3 exposures 2.84, 10.36, 110 ppm	Mortality; Body weight	110	0.10 Measured in study	11.38	NA	5	1	1	1	1	5	5	2.3E+00	6.8E+00	

