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PCP EcoSSL
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Ecological Soil Screening Levels for Pentachlorophenol

Interim Final

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TABLE OF CONTENTS

1.0	INTRODUCTION	<u>1</u>
2.0	SUMMARY OF ECO-SSLs FOR PENTACHLOROPHENOL	<u>1</u>
3.0	ECO-SSL FOR TERRESTRIAL PLANTS	<u>3</u>
4.0	ECO-SSL FOR SOIL INVERTEBRATES	<u>3</u>
5.0	ECO-SSL FOR AVIAN WILDLIFE	<u>6</u>
5.1	Avian TRV	<u>6</u>
5.2	Estimation of Dose and Calculation of the Eco-SSL	<u>9</u>
6.0	ECO-SSL FOR MAMMALIAN WILDLIFE	<u>9</u>
6.1	Mammalian TRV	<u>9</u>
6.2	Estimation of Dose and Calculation of the Eco-SSL	<u>12</u>
7.0	REFERENCES	<u>14</u>
7.1	General Pentachlorophenol References	<u>14</u>
7.2	References for Plants and Soil Invertebrates	<u>15</u>
7.3	References Rejected for Use in Deriving Plant and Soil Invertebrate Eco-SSLs ..	<u>16</u>
7.4	References Used in Deriving Wildlife TRVs	<u>21</u>
7.5	References Rejected for Use in Derivation of Wildlife TRV	<u>22</u>

LIST OF TABLES

Table 2.1	Pentachlorophenol Eco-SSLs (mg/kg dry weight in soil)	<u>2</u>
Table 3.1	Plant Toxicity Data - Pentachlorophenol	<u>4</u>
Table 4.1	Invertebrate Toxicity Data - Pentachlorophenol	<u>5</u>
Table 5.1	Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV) - Pentachlorophenol	<u>7</u>
Table 5.2	Calculation of the Avian Eco-SSLs for Pentachlorophenol	<u>9</u>
Table 6.1	Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value - Pentachlorophenol	<u>10</u>
Table 6.2	Calculation of the Mammalian Eco-SSLs for Pentachlorophenol	<u>12</u>

LIST OF FIGURES

Figure 5.1	Avian TRV Derivation for Pentachlorophenol	<u>8</u>
Figure 6.1	Mammalian TRV Derivation for Pentachlorophenol	<u>13</u>

LIST OF APPENDICES

Appendix 5-1	Avian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Pentachlorophenol
Appendix 6-1	Mammalian Toxicity Data Extracted and Reviewed for Wildlife Toxicity Reference Value (TRV) - Pentachlorophenol

1.0 INTRODUCTION

Ecological Soil Screening Levels (Eco-SSLs) are concentrations of contaminants in soil that are protective of ecological receptors that commonly come into contact with and/or consume biota that live in or on soil. Eco-SSLs are derived separately for four groups of ecological receptors: plants, soil invertebrates, birds, and mammals. As such, these values are presumed to provide adequate protection of terrestrial ecosystems. Eco-SSLs are derived to be protective of the conservative end of the exposure and effects species distribution, and are intended to be applied at the screening stage of an ecological risk assessment. These screening levels should be used to identify the contaminants of potential concern (COPCs) that require further evaluation in the site-specific baseline ecological risk assessment that is completed according to specific guidance (U.S. EPA, 1997, 1998, and 1999). The Eco-SSLs are not designed to be used as cleanup levels and the United States (U.S.) Environmental Protection Agency (EPA) emphasizes that it would be inappropriate to adopt or modify the intended use of these Eco-SSLs as national cleanup standards.

The detailed procedures used to derive Eco-SSL values are described in separate documentation (U.S. EPA, 2003). The derivation procedures represent the collaborative effort of a multi-stakeholder group consisting of federal, state, consulting, industry, and academic participants led by the U.S. EPA Office of Solid Waste and Emergency Response.

This document provides the Eco-SSL values for pentachlorophenol and the documentation for their derivation. This document provides guidance and is designed to communicate national policy on identifying pentachlorophenol concentrations in soil that may present an unacceptable ecological risk to terrestrial receptors. The document does not, however, substitute for EPA's statutes or regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on EPA, states, or the regulated community, and may not apply to a particular situation based upon the circumstances of the site. EPA may change this guidance in the future, as appropriate. EPA and state personnel may use and accept other technically sound approaches, either on their own initiative, or at the suggestion of potentially responsible parties, or other interested parties. Therefore, interested parties are free to raise questions and objections about the substance of this document and the appropriateness of the application of this document to a particular situation. EPA welcomes public comments on this document at any time and may consider such comments in future revisions of this document.

2.0 SUMMARY OF ECO-SSLs FOR PENTACHLOROPHENOL

The use of pentachlorophenol (PCP) in the United States as an industrial wood preservative for utility poles, cross arms, and fenceposts accounts for 97% of its production and has resulted in its release to the environment through various waste streams. Other uses of PCP include the manufacture of sodium pentachlorophenate (Hagenmaier and Berchtold, 1986) and minor uses as a fungicide, bactericide, algicide, or herbicide for crops, or in the production of leathers and textiles (IARC, 1991, Lewis, 1993; HSDB).

Organic acids such as PCP can exist in soil as either a nonionic species or as an organic anion, which is dependent on the acid dissociation constant (pKa) and pH. In the pH range relevant to most environmental scenarios, PCP can exist as both a neutral species and as an anionic species; however, the majority exist as the organic anion (Lee et al., 1990). For the neutral form of PCP, sorption by soil is primarily related to hydrophobicity and the amount of organic matter present in the soil (Lagrega, 1994; Lee et al., 1990; HSDB). Differences in the distribution of several nonionic organic contaminants in diverse soil-water and sediment-water systems have been minimized by normalization to organic matter or more specifically organic carbon (OC) with OC-normalized distribution coefficients, referred to as K_{oc} values. The greater the affinity of a contaminant for organic matter, the larger the organic carbon-normalized partition coefficient (K_{oc}), and a soil with higher amounts of organic matter has a higher propensity to sorb nonionic organic contaminants (e.g., Gertsch, 1990; Lyman et al., 1990; HSDB).

For the ionic form of PCP, the anionic species has a greater tendency relative to the neutral PCP to remain in the pore-water similar to metal anions. Therefore, the soil pH modifies the solubility, sorption, transport, and bioavailability of PCP. The fraction of PCP existing as an anion increases with increasing pH. The anion has a lower affinity for the soil relative to the neutral species. Increasing soil pH also results in an increase in the number of negatively charged soil sites with a concomitant decrease in the positively charged sites. Therefore, increasing the soil pH directly impacts the sorption and removal from the pore-water of the PCP ions (Bohn et al., 1985; HSDB).

Adsorption of PCP to soil appears to be pH dependent, with stronger adsorption under acid conditions (Callahan et al., 1979; HSDB). PCP is expected to have slight to no mobility in soil where the pH is acidic (Swann et al., 1983; HSDB). The fraction of PCP which is sorbed decreases linearly with pH to a pH of 6; above pH 6, significant adsorption of the anion again occurs, contributing as much as 20% of the total adsorption effect at pH 8 (Bengtsson et al., 1993; HSDB).

The half-life of PCP in soil is approximately weeks to months (Ide et al., 1972; Murthy et al., 1979 and Rao and Davidson, 1982; HSDB). The main degradation products of PCP in soil are 2,3,7,8-tetrachlorophenol and CO_2 (Knowlton and Huckins, 1983; HSDB). Both aerobic and anaerobic biodegradation rates are dependant on the concentration of PCP present in the soil. PCP does not appear to oxidize or hydrolyze under environmental conditions (Callahan et al., 1979; Weiss et al., 1982; HSDB); however, photolysis of the dissociated form from moist soil surfaces may be a significant fate process (Donaldson and Miller, 1997; HSDB).

Eco-SSL values were derived for all receptor groups (Table 2.1). The Eco-SSL values for PCP range from 2.1 mg/kg dry weight (dw) for avian wildlife to 31 mg/kg dw for soil invertebrates.

Table 2.1 Pentachlorophenol Eco-SSLs (mg/kg dry weight in soil)			
Plants	Soil Invertebrates	Wildlife	
		Avian	Mammalian
5.0	31	2.1	2.8

3.0 ECO-SSL FOR TERRESTRIAL PLANTS

Of the papers identified from the literature search process, 43 papers were selected for acquisition for further review. Of those papers acquired, four met all 11 Study Acceptance Criteria (U.S. EPA, 2003; Attachment 3-1). Each of these papers were reviewed and the studies were scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 3-2). Two studies received an Evaluation Score greater than ten (U.S. EPA, 2003; Attachment 3-1). These studies are listed in Table 3.1.

All studies eligible for Eco-SSL derivation with a bioavailability score of two were used to derive the plant Eco-SSL for PCP (U.S. EPA, 2003; Attachment 3-2). The bioavailability of PCP, an ionic organic contaminant, was scored as a metal anion using Table 2.6 in the second chapter of the Eco-SSL guidance (U.S. EPA, 2003). The Eco-SSL is the geometric mean of the effective concentration for 20% of the test population (EC_{20}) values for three species under one test conditions (pH and % organic matter (OM)) and is equal to 5.0 mg/kg dw.

4.0 ECO-SSL FOR SOIL INVERTEBRATES

Of the papers identified from the literature search process, 58 papers were selected for acquisition for further review. Of those papers acquired, 22 met all 11 Study Acceptance Criteria (U.S. EPA 2003; Attachment 3-1). Each of these papers were reviewed and the studies were scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 3-2). Ten studies received an Evaluation Score greater than ten. These studies are listed in Table 4.1.

The studies in Table 4.1 are sorted by bioavailability score. The bioavailability of PCP, an ionic organic contaminant, was scored as a metal anion using Table 2.6 in the second chapter of the Eco-SSL guidance (U.S. EPA, 2003). There are four studies eligible for Eco-SSL derivation and all were used to derive the soil invertebrate Eco-SSL for PCP (U.S. EPA, 2003; Attachment 3-2). The Eco-SSL is the geometric mean of the maximum acceptable toxicant concentration (MATC) values for four test species under three different test conditions (pH and OM) and is equal to 31 mg/kg dw.

Table 3.1 Plant Toxicity Data - Pentachlorophenol

Reference	IP Number	Study ID	Test Organism		Soil pH	OM %	Bio-availability Score	ERE	Tox Parameter	Tox Value-Soil Conc. (mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL	Used for Eco-SSL?
TN&Associates Inc , 2000	56444	P	Alfalfa	<i>Medicago sativa</i>	6.3	0.1	2	GRO	EC ₂₀	5.0	18	Y	Y
TN&Associates Inc , 2000	56444	Q	Turnip	<i>Brassica rapa</i>	6.3	0.1	2	GRO	EC ₂₀	5.0	18	Y	Y
TN&Associates Inc , 2000	56444	R	Radish	<i>Raphanus sativa</i>	6.3	0.1	2	GRO	EC ₂₀	5.0	18	Y	Y
Geometric Mean										5.0			
Data Not Used to Derive Plant Eco-SSL													
Aben et al , 1992	1294	a	Thale cress	<i>Arabidopsis thaliana</i>	5.7	2.4	1	GRO	EC ₅₀	3.0	12	N	N
Aben et al , 1992	1294	b	Thale cress	<i>Arabidopsis thaliana</i>	6.2	8.1	1	GRO	EC ₅₀	9.0	12	N	N
TN&Associates Inc , 2000	56444	M	Alfalfa	<i>Medicago sativa</i>	5.0	5.0	0	GRO	EC ₂₀	7.0	16	Y	N
TN&Associates Inc , 2000	56444	N	Turnip	<i>Brassica rapa</i>	5.0	5.0	0	GRO	EC ₂₀	3.2	16	Y	N
TN&Associates Inc , 2000	56444	O	Radish	<i>Raphanus sativa</i>	5.0	5.0	0	GRO	EC ₂₀	3.0	16	Y	N

dw = dry weight

EC₂₀ = Effect concentration for 20% of test population

ERE = Ecologically relevant endpoint

GRO = Growth

N = No

OM = Organic matter content

Y = yes

Bioavailability Score described in *Guidance for Developing Eco-SSLs* (U S EPA, 2003)

Total Evaluation Score described in *Guidance for Developing Eco-SSLs* (U S EPA, 2003)

Table 4.1 Invertebrate Toxicity Data - Pentachlorophenol

Reference	IP Number	Study ID	Test Organism		Soil pH	OM%	Bio-availability Score	ERE	Tox Parameter	Tox Value (Soil Conc mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
Crouau et al , 1999	18893	a	Springtail	<i>Folsomia candida</i>	6.0	10.0	1	REP	MATC	85	17	Y	Y
Kammenga et al , 1996	5515		Nematode	<i>Plectiscus acuminatus</i>	5.5	10.0	1	REP	MATC	42	13	Y	Y
Van Gestel et al , 1992	12874	a	Earthworm	<i>Eisenia andrei</i>	6.7	10.0	1	REP	MATC	14	16	Y	Y
Van Gestel et al , 1989	4111		Earthworm	<i>Eisenia fetida andrei</i>	6.0	10.0	1	REP	MATC	18	12	Y	Y
Geometric Mean										31			
Data not Used to Derive Soil Invertebrate Eco-SSL													
Aben et al , 1992	1294	a	Nematode	<i>Globodera rostochiensis</i>	5.7	2.4	1	MOR	LC ₅₀	130	12	N	N
Aben et al , 1992	1294	b	Nematode	<i>Globodera rostochiensis</i>	6.2	8.1	1	MOR	LC ₅₀	310	12	N	N
Heimbach, 1984	7843		Earthworm	<i>Eisenia fetida</i>	7.0	10.0	1	MOR	LC ₅₀	87	11	N	N
Houx et al , 1993	2446	b	Nematode	<i>Globodera rostochiensis</i>	5.9	8.1	1	MOR	LC ₅₀	310	11	N	N
Lanno et al , 1997	3996	a	Earthworm	<i>Lumbricus terrestris</i>	7.8	1.5	2	MOR	LC ₅₀	<10	11	N	N
Van Gestel and Van Dis, 1988	7889	b	Earthworm	<i>Eisenia fetida</i>	7.0	1.7	2	MOR	LC ₅₀	16	11	N	N
Van Gestel et al , 1991	6826	a	Earthworm	<i>Eisenia andrei</i>	5.8	10.0	1	MOR	LC ₅₀	28	16	N	N
Van Gestel et al , 1991	6826	b	Earthworm	<i>Eisenia andrei</i>	5.8	10.0	1	GRO	NOAEC	32	16	N	N

dw = dry weight

ERE = Ecologically relevant endpoint

GRO = Growth

LC₅₀ = Concentration lethal to 50% of test population

LOAEC = Lowest observed adverse effect concentration

MATC = Maximum acceptable toxicant concentration

MOR = Mortality

N = No

NOAEC = No observed adverse effect concentration

OM = Organic matter content

REP = Reproduction

Y = Yes

Bioavailability Score described in *Guidance for Developing Eco-SSLs* (U.S.EPA, 2003)

Total Evaluation Score described in *Guidance for Developing Eco-SSLs* (U.S. EPA, 2003)

5.0 ECO-SSL FOR AVIAN WILDLIFE

The derivation of the Eco-SSL for avian wildlife was completed as two parts. First, the toxicity reference value (TRV) was derived according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5). Second, the Eco-SSL (soil concentration) was back-calculated for each of three surrogate species representing different trophic levels based on the wildlife exposure model and the TRV (U.S. EPA, 2003).

5.1 Avian TRV

The literature search completed according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-1) identified 1,073 papers with possible toxicity data for either avian or mammalian species. Of these studies, 1054 were rejected for use as described in Section 7.5. Of the remaining papers, three contained data for avian test species. These papers were reviewed and the data were extracted and scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-3 and 4-4). The results of the data extraction and review are provided as Table 5.1. The complete results are included as Appendix 5-1.

Within the reviewed papers, there are seven results for pathology (PTH), growth (GRO), and survival (MOR) effects that meet the Data Evaluation Score of >65 for use to derive the TRV (U.S. EPA, 2003; Attachment 4-4). These data are plotted in Figure 5.1 and correspond directly with the data presented in Table 5.1. The no-observed adverse effect level (NOAEL) results for growth and reproduction are used to calculate a geometric mean. This result is examined in relationship to the lowest bounded lowest-observed adverse effect level (LOAEL) for reproduction, growth, and survival to derive the TRV according to procedures in the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5).

A geometric mean of the NOAEL values for reproduction and growth could not be calculated as there were not enough data. Therefore, the TRV is equal to the lowest NOAEL for reproduction, growth or survival and is equal to 6.73 mg PCP/kg bw/day.

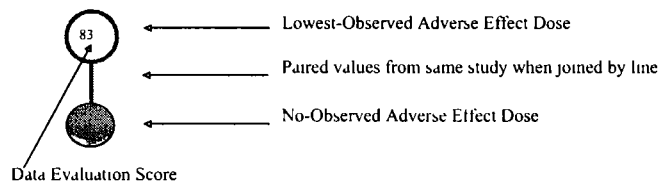
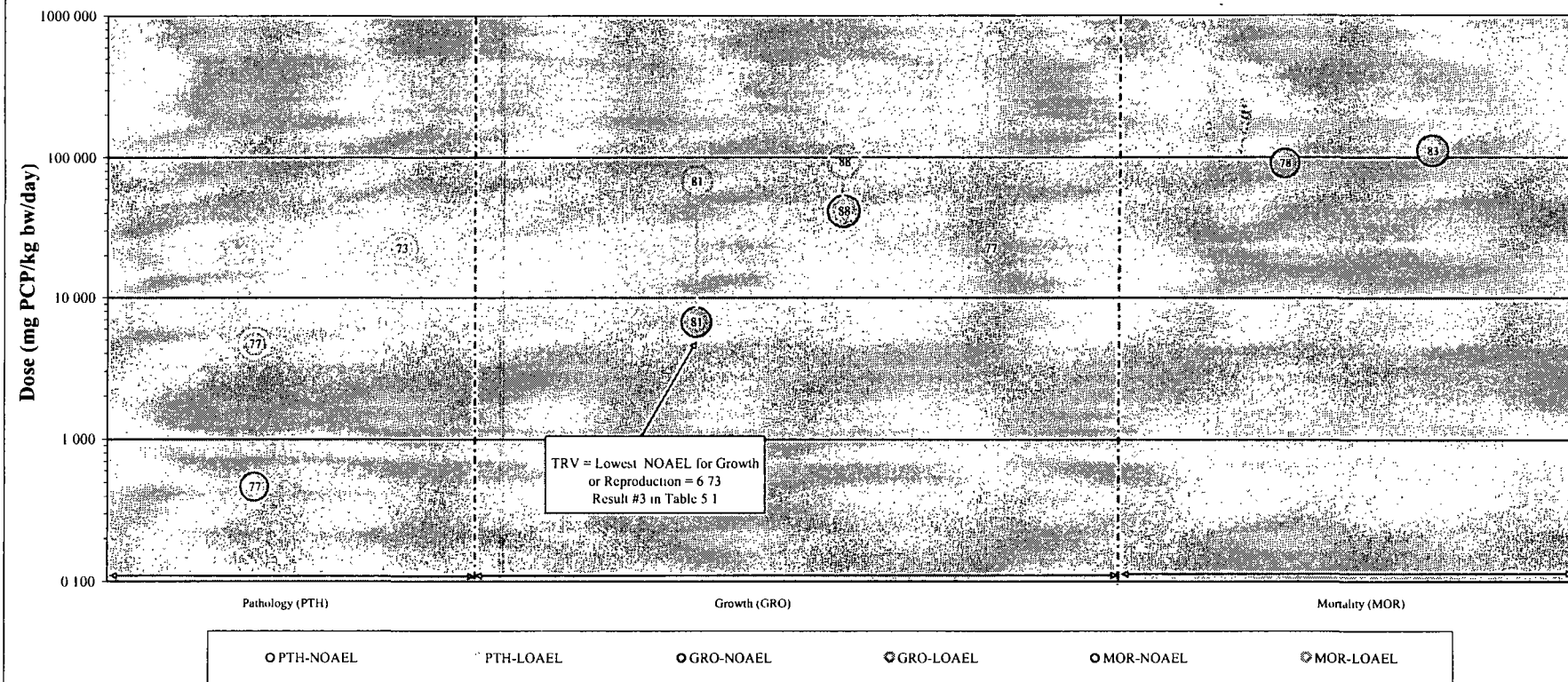
Table 5.1 Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Pentachlorophenol
Page 1 of 1

Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose* (mg/kg bw/day)	LOAEL Dose* (mg/kg bw/day)	Data Evaluation Score
Pathology (PTH)																		
1	Stedman et al, 1980	6573	Chicken (<i>Gallus domesticus</i>)	5	U	FD	8	w	1	d	JV	NR	ORW	ORWT	KI	0.466	4.66	77
2	Prescott et al, 1982	6439	Chicken (<i>Gallus domesticus</i>)	4	U	FD	8	w	1	d	JV	NR	ORW	SMIX	KI		22.5	73
Growth (GRO)																		
3	Stedman et al, 1980	6573	Chicken (<i>Gallus domesticus</i>)	5	U	FD	1	w	1	d	JV	NR	GRO	BDWT	WO	6.73	67.3	81
4	Nebeker et al, 1994	5520	Duck (<i>Anas platyrhynchos</i>)	7	M	FD	11	d	4	d	JV	NR	GRO	BDWT	WO	40.9	92.9	88
5	Prescott et al, 1982	6439	Chicken (<i>Gallus domesticus</i>)	4	U	FD	1	w	1	d	JV	NR	GRO	BDWT	WO		22.5	77
Survival (MOR)																		
6	Prescott et al, 1982	6439	Chicken (<i>Gallus domesticus</i>)	4	U	FD	8	w	1	d	JV	NR	MOR	MORT	WO	90.0		78
7	Nebeker et al, 1994	5520	Duck (<i>Anas platyrhynchos</i>)	7	M	FD	11	d	4	d	JV	NR	MOR	MORT	WO	111		83

BDWT = body weight changes, d = days, FD = food, GRO = growth, JV = juvenile, KI = kidney, LOAEL = lowest observed adverse effect level, M = measured, MOR = mortality, MORT = mortality, NOAEL = no observed adverse effect level, NR = Not reported, ORW = organ weight changes, ORWT = organ weight, SMIX = weight relative to body weight, U = unmeasured, w = weeks, WO = whole organism

*NOAEL and LOAEL values that are equal and from the same reference represent different experimental designs

Figure 5.1 Avian TRV Derivation for Pentachlorophenol



Wildlife TRV Derivation Process

- 1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups
There are enough data to derive a TRV
- 2) There are only two NOAEL results available within the growth and reproduction effect groups, there are not enough values for calculation of a geometric mean
- 3) The avian wildlife TRV for pentachlorophenol is equal to 6.73 mg pentachlorophenol/kg bw/day which is the lowest NOAEL value for reproduction, growth or survival

5.2 Estimation of Dose and Calculation of the Eco-SSL

Three separate Eco-SSL values were calculated for avian wildlife, one for each of three surrogate receptor species representing different trophic levels. The avian Eco-SSLs were calculated according to the Eco-SSL guidance (U.S. EPA, 2003) and are summarized in Table 5.2.

Table 5.2 Calculation of the Avian Eco-SSLs for Pentachlorophenol (PCP)						
Surrogate Receptor Group	TRV for PCP (mg dw/kg bw/d) ¹	Food Ingestion Rate (FIR) ² (kg dw/kg bw/d)	Soil Ingestion as Proportion of Diet (P) ³	Concentration of PCP in Biota Type (i) ^{4,5} (B _i) (mg/kg dw)	PCP in Diet of Prey ⁴ (C _{diet})	Eco-SSL (mg/kg dw) ⁵
Avian herbivore (dove)	6.73	0.190	0.139	$B_i = \text{Soil}_i * 5.93$ where i = plants	NA	5.9
Avian ground insectivore (woodcock)	6.73	0.209	0.030	$B_i = 14.63 * \text{Soil}_i$ where i = earthworms	NA	2.1
Avian carnivore (hawk)	6.73	0.12	0.05	$B_i = 0.00452 * C_{\text{diet}} + 0.198$ where i = mammals	$C_{\text{diet}} = 14.63 * \text{Soil}_i$	1,500
¹ The process for derivation of wildlife TRVs is described in Attachment 4-5 of U.S. EPA (2003) ² Parameters (FIR, P, B _i values, regressions) are provided in U.S. EPA (2003) Attachment 4-1 (revised February 2005). ³ B _i = Concentration in biota type (i) which represents 100% of the diet for the respective receptor. ⁴ C _{diet} = Concentration in the diet of small mammals consumed by predatory species (hawk). ⁵ $HQ = FIR * (\text{Soil}_i * P_i + B_i) / \text{TRV}$ solved for $HQ=1$ where Soil_i = Eco-SSL (Equation 4-2; U.S. EPA, 2003). NA = Not Applicable						

6.0 ECO-SSL FOR MAMMALIAN WILDLIFE

The derivation of the Eco-SSL for mammalian wildlife was completed as two parts. First, the TRV was derived according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5). Second, the Eco-SSL (soil concentration) was back-calculated for each of three surrogate receptor species based on the wildlife exposure model and the TRV (U.S. EPA, 2003).

6.1 Mammalian TRV

The literature search was completed according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-2) and identified 1,073 papers with possible toxicity data for PCP for either avian or mammalian species. Of these studies, 1,054 were rejected for use as described in Section 7.5. Of the remaining papers, 16 contained data for mammalian test species. These papers were reviewed and the data were extracted and scored according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-3 and 4-4). The results of the data extraction and review are summarized in Table 6.1. The complete results are provided as Appendix 6-1.

Table 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Pentachlorophenol
 Page 1 of 2

Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose* (mg/kg bw/day)	LOAEL Dose* (mg/kg bw/day)	Total
Biochemical (BIO)																		
1	Knudsen et al, 1974	20229	Rat (<i>Rattus norvegicus</i>)	4	U	FD	6	w	NR	NR	JV	M	CHM	HMCT	BL	1 71	3 42	77
2	Schwetz et al, 1978	20023	Rat (<i>Rattus norvegicus</i>)	5	U	FD	22	mo	NR	NR	NR	B	ENZ	GPTR	SR	9 04	27 1	80
3	Rawlings et al, 1998	20124	Sheep (<i>Ovis aries</i>)	2	U	OR	36	d	1-4	yr	GE	F	HRM	THYR	SR		0 571	77
4	Beard et al, 1999	20024	Sheep (<i>Ovis aries</i>)	2	U	FD	34	w	1-3	yr	GE	F	HRM	THYR	SR		1 0	74
5	Jekat et al, 1994	20093	Rat (<i>Rattus norvegicus</i>)	3	U	GV	28	d	NR	NR	JV	F	HRM	THYR	SR		3 0	77
6	Jekat et al, 1994	20093	Rat (<i>Rattus norvegicus</i>)	2	U	GV	28	d	NR	NR	JV	F	HRM	THYR	SR		3 0	77
7	Renner et al, 1987	19997	Rat (<i>Rattus norvegicus</i>)	2	U	GV	28	d	3 5	mo	JV	F	CHM	PCLV	BL		52 7	80
8	Umemura et al, 1999	19990	Mouse (<i>Mus musculus</i>)	3	U	FD	8	w	6	w	JV	M	ENZ	GENZ	LI		75 2	69
Behavior (BEH)																		
9	Welsh et al, 1987	20813	Rat (<i>Rattus norvegicus</i>)	4	U	FD	201	d	32	d	GE	F	FDB	FCNS	WO	12 9	42 6	83
10	Kimbrough and Linder, 1978	20197	Rat (<i>Rattus norvegicus</i>)	4	U	FD	220	d	NR	NR	JV	B	FDB	FCNS	WO	23 7		68
11	Kimbrough and Linder, 1978	20197	Rat (<i>Rattus norvegicus</i>)	4	U	FD	220	d	NR	NR	JV	B	FDB	FCNS	WO	27 7		68
Pathology (PTH)																		
12	Knudsen et al, 1974	20229	Rat (<i>Rattus norvegicus</i>)	4	U	FD	12	w	NR	NR	JV	F	ORW	SMIX	LI	1 17	2 34	80
13	Jekat et al, 1994	20093	Rat (<i>Rattus norvegicus</i>)	3	U	GV	28	d	NR	NR	JV	F	ORW	ORWT	LI	3 0	30 0	84
14	Kimbrough and Linder, 1978	20197	Rat (<i>Rattus norvegicus</i>)	4	U	FD	8	mo	NR	NR	JV	B	ORW	ORWT	LI	4 23	23 7	81
15	Kerkvliet et al, 1982	20129	Mouse (<i>Mus musculus</i>)	4	U	FD	8	w	6	w	JV	F	ORW	SMIX	LI	5 38	26 9	77
16	Kerkvliet et al, 1982	20129	Mouse (<i>Mus musculus</i>)	4	U	FD	8	w	8	w	JV	F	ORW	SMIX	LI	5 55	11 1	79
17	Schwetz et al, 1978	20023	Rat (<i>Rattus norvegicus</i>)	5	U	FD	12	mo	NR	NR	NR	F	GRS	BDWT	WO	9 04	27 1	83
18	Welsh et al, 1987	20813	Mouse (<i>Mus musculus</i>)	4	U	FD	181	d	32	d	GE	F	PTH	HEMR	VA	13 0	42 6	81
19	Kimbrough and Linder, 1978	20197	Rat (<i>Rattus norvegicus</i>)	4	U	FD	8	mo	NR	NR	JV	B	ORW	ORWT	LI	27 7		77
20	Courtney et al, 1976	20333	Rat (<i>Rattus norvegicus</i>)	2	U	GV	9	d	NR	NR	GE	F	ORW	SMIX	LI	74 3		71
21	Beard et al, 1999	20024	Sheep (<i>Ovis aries</i>)	2	U	FD	36	w	1-3	yr	GE	F	HIS	GHIS	TY		1 0	77
22	Kerkvliet et al, 1985	20686	Mouse (<i>Mus musculus</i>)	4	U	FD	8	w	6-7	w	JV	F	ORW	ORWT	LI		11 5	73
23	Renner et al, 1987	19997	Rat (<i>Rattus norvegicus</i>)	2	U	GV	28	d	3 5	mo	JV	F	ORW	SMIX	LI		52 7	83
24	Umemura et al, 1999	19990	Mouse (<i>Mus musculus</i>)	2	U	FD	25	w	23	w	JV	M	ORW	ORWT	LI		70 7	73
25	Umemura et al, 1999	19990	Mouse (<i>Mus musculus</i>)	3	U	FD	8	w	6	w	JV	M	HIS	GHIS	LI		75 2	72
26	Kerkvliet et al, 1982	20129	Mouse (<i>Mus musculus</i>)	2	U	FD	8	w	NR	NR	NR	F	ORW	SMIX	LI		122	73
Reproduction (REP)																		
27	Beard and Rawlings, 1998	19985	Mink (<i>Mustela vison</i>)	2	U	FD	162	d	NR	NR	GE	F	REP	PRWT	WO	0 0753		69
28	Beard et al, 1999	20024	Sheep (<i>Ovis aries</i>)	2	U	FD	36	w	1-3	yr	GE	F	REP	PRWT	WO	1 0		79
29	Knudsen et al, 1974	20229	Rat (<i>Rattus norvegicus</i>)	4	U	FD	12	w	NR	NR	JV	F	REP	GREP	OV	2 36	9 45	84
30	Schwetz et al, 1978	20023	Rat (<i>Rattus norvegicus</i>)	3	U	FD	89	d	NR	NR	GE	F	REP	PROG	WO	2 71	27 1	87
31	Welsh et al, 1987	20813	Rat (<i>Rattus norvegicus</i>)	4	U	FD	181	d	32	d	GE	F	REP	RSEM	WO	3 96	12 9	87
32	Schwetz et al, 1974	20203	Rat (<i>Rattus norvegicus</i>)	5	U	GV	10	d	NR	NR	GE	F	REP	RSEM	WO	5 13	13 3	87
33	Exon and Koller, 1982	20454	Rat (<i>Rattus norvegicus</i>)	4	M	FD	13	w	21	d	GE	F	REP	PROG	WO	5 51	31 7	87
34	Schwetz et al, 1974	20203	Rat (<i>Rattus norvegicus</i>)	4	U	GV	10	d	NR	NR	GE	F	REP	RSEM	WO	14 7	29 4	92
35	Rawlings et al, 1998	20124	Sheep (<i>Ovis aries</i>)	2	U	OR	43	d	1-4	yr	GE	F	REP	RHIS	OD		0 571	86
36	Schwetz et al, 1974	20203	Rat (<i>Rattus norvegicus</i>)	2	U	GV	4	d	NR	NR	GE	F	REP	PRWT	WO		29 4	86
37	Schwetz et al, 1974	20203	Rat (<i>Rattus norvegicus</i>)	2	U	GV	4	d	NR	NR	GE	F	REP	RSEM	WO		29 4	86
38	Schwetz et al, 1974	20203	Rat (<i>Rattus norvegicus</i>)	2	U	GV	4	d	NR	NR	GE	F	REP	ODVP	WO		30 7	86
39	Schwetz et al, 1974	20203	Rat (<i>Rattus norvegicus</i>)	2	U	GV	4	d	NR	NR	GE	F	REP	RSEM	WO		30 7	86
40	Courtney et al, 1976	20333	Rat (<i>Rattus norvegicus</i>)	2	U	GV	9	d	NR	NR	GE	F	REP	PRWT	WO		74 3	86
Growth (GRO)																		
41	Huwe et al, 2000	19901	Rat (<i>Rattus norvegicus</i>)	2	UX	FD	14	d	NR	NR	JV	NR	GRO	BDWT	WO	0 427		73
42	Knudsen et al, 1974	20229	Rat (<i>Rattus norvegicus</i>)	4	U	FD	12	w	NR	NR	JV	F	GRO	BDWT	WO	2 50	10 0	82
43	Schwetz et al, 1978	20023	Rat (<i>Rattus norvegicus</i>)	3	U	FD	110	d	NR	NR	JV	F	GRO	BDWT	WO	2 71	27 1	85
44	Kimbrough and Linder, 1978	20197	Rat (<i>Rattus norvegicus</i>)	4	U	FD	8	mo	NR	NR	JV	M	GRO	BDWT	WO	4 23	23 7	85
45	Kimbrough and Linder, 1978	20197	Rat (<i>Rattus norvegicus</i>)	4	U	FD	220	d	NR	NR	JV	M	GRO	BDWT	WO	4 95	27 7	85
46	Welsh et al, 1987	20813	Rat (<i>Rattus norvegicus</i>)	4	U	FD	181	d	32	d	GE	F	GRO	BDWT	WO	12 9	42 6	85
47	Schwetz et al, 1974	20203	Rat (<i>Rattus norvegicus</i>)	5	U	GV	10	d	NR	NR	GE	F	GRO	BDWT	WO	13 3	30 7	85
48	Schwetz et al, 1974	20203	Rat (<i>Rattus norvegicus</i>)	4	U	GV	10	d	NR	NR	GE	F	GRO	BDWT	WO	14 7	29 4	90
49	Kerkvliet et al, 1982	20129	Mouse (<i>Mus musculus</i>)	4	U	FD	8	w	8	w	JV	F	GRO	BDWT	WO	27 8		77
50	Schwetz et al, 1974	20203	Rat (<i>Rattus norvegicus</i>)	2	U	GV	4	d	NR	NR	GE	F	GRO	BDWT	WO	29 4		84
51	Schwetz et al, 1974	20203	Rat (<i>Rattus norvegicus</i>)	2	U	GV	4	d	NR	NR	GE	F	GRO	BDWT	WO	30 7		84
52	Exon and Koller, 1982	20454	Rat (<i>Rattus norvegicus</i>)	4	M	FD	10	w	21	d	JV	F	GRO	BDWT	WO	31 7		72
53	Renner et al, 1987	19997	Rat (<i>Rattus norvegicus</i>)	2	U	GV	28	d	3 5	mo	JV	F	GRO	BDWT	WO	52 7		78
54	Kerkvliet et al, 1982	20129	Mouse (<i>Mus musculus</i>)	4	U	FD	8	w	6	w	JV	F	GRO	BDWT	WO	54 8		77
55	Kerkvliet et al, 1985	20686	Mouse (<i>Mus musculus</i>)	4	U	FD	8	w	6-7	w	JV	F	GRO	BDWT	WO	57 6		77
56	Umemura et al, 1999	19990	Mouse (<i>Mus musculus</i>)	2	U	FD	25	w	23	w	JV	M	GRO	BDWT	WO	70 7		77

Table 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)
Pentachlorophenol
 Page 2 of 2

Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose* (mg/kg bw/day)	LOAEL Dose* (mg/kg bw/day)	Total
57	Kerkvliet et al, 1982	20129	Mouse (<i>Mus musculus</i>)	2	U	FD	8	w	NR	NR	NR	NR	GRO	BDWT	WO	122		77
58	Schwetz et al, 1974	20203	Rat (<i>Rattus norvegicus</i>)	2	U	GV	4	d	NR	NR	GE	F	GRO	BDWT	WO		29.4	84
59	Schwetz et al, 1974	20203	Rat (<i>Rattus norvegicus</i>)	2	U	GV	4	d	NR	NR	GE	F	GRO	BDWT	WO		30.7	84
60	Courtney et al, 1976	20333	Rat (<i>Rattus norvegicus</i>)	2	U	GV	9	d	NR	NR	GE	F	GRO	BDWT	WO		74.3	84
Survival (MOR)																		
61	Beard and Rawlings, 1998	19985	Mink (<i>Mustela vison</i>)	2	U	FD	162	d	NR	NR	GE	F	MOR	MORT	WO	0.0753		77
62	Kimbrough and Linder, 1978	20197	Rat (<i>Rattus norvegicus</i>)	4	U	FD	8	mo	NR	NR	JV	B	MOR	MORT	WO	23.7		82
63	Kimbrough and Linder, 1978	20197	Rat (<i>Rattus norvegicus</i>)	4	U	FD	8	mo	NR	NR	JV	B	MOR	MORT	WO	27.7		82
64	Welsh et al, 1987	20813	Rat (<i>Rattus norvegicus</i>)	4	U	FD	181	d	32	d	GE	F	MOR	MORT	WO	42.6		82
65	Umemura et al, 1999	19990	Mouse (<i>Mus musculus</i>)	2	U	FD	25	w	23	w	JV	M	MOR	SURV	WO	70.7		78
66	Renner et al, 1987	19997	Rat (<i>Rattus norvegicus</i>)	2	U	GV	28	d	3.5	mo	JV	F	MOR	MORT	WO		52.7	88

B = both, BDWT = body weight changes, BL = blood, bw = body weight, CHM = chemical changes, d- day, ENZ = enzyme level changes, F = female, FCNS = food consumption, FD = food, FDB = feeding behavior, GE = gestation, GENZ = general enzyme changes, GHIS = general histology, GPTR = glutamic pyruvic transaminase, GREP = general reproductive effect, GRO = growth, GRS = gross body weight changes, GV = gavage, HEMR = hemorrhage, HIS = histological changes, HMCT = hematocrit, HRM = hormone changes, JV = juvenile, kg = kilograms, LI = liver, LOAEL = lowest observed adverse effect level, mo = months, M = male, M = measured, MOR = effects on mortality and survival, MORT = mortality, NOAEL = No Observed Adverse Effect Level, NR = Not reported, OD = oviduct, ODVP = offspring development, OR = other oral, ORW = organ weight changes, ORWT = organ weight changes, OV = ovary, PCLV = packed cell volume, PROG = progeny numbers/counts, PRWT = progeny weight, PTH = pathology, REP = reproduction, RHIS = reproductive histology, RSEM = resorbed embryos, SMIX = weight relative to body weight, SR = serum, SURV = survival, THYR = thyroxone, TY = thyroid, U = unmeasured, UX = measured but values not reported, VA = vagina, w = weeks, WO = whole organism, yr = year

*NOAEL and LOAEL values that are equal and from the same reference represent different experimental designs

Within the 16 papers there are 66 results for biochemical (BIO), behavior (BEH), pathology (PTH), reproduction (REP), growth (GRO), and survival (MOR) endpoints with a total Data Evaluation Score >65 that were used to derive the TRV (U.S. EPA 2003; Attachment 4-4). These data are plotted in Figure 6.1 and correspond directly with the data presented in Table 6.1. The NOAEL results for growth and reproduction are used to calculate a geometric mean NOAEL. This geometric mean is examined in relationship to the lowest bounded LOAEL for reproduction, growth, and survival to derive the TRV according to the Eco-SSL guidance (U.S. EPA 2003; Attachment 4-5).

A geometric mean of the NOAEL values for reproduction and growth was calculated at 8.42 mg PCP/kg bw/day. This value is lower than the the lowest bounded LOAEL for reproduction, growth, or mortality results. Therefore, the TRV is equal to the geometric mean of NOAEL values for reproduction and growth and is equal to 8.42 mg PCP/kg bw/day.

6.2 Estimation of Dose and Calculation of the Eco-SSL

Three separate Eco-SSL values were calculated for mammalian wildlife, one for each of three surrogate receptor groups representing different trophic levels. The mammalian Eco-SSLs derived for PCP were calculated according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5) and are summarized in Table 6.2.

Surrogate Receptor Group	TRV for PCP (mg dw/kg bw/d) ¹	Food Ingestion Rate (FIR) ² (kg dw/kg bw/d)	Soil Ingestion as Proportion of Diet (P _s) ²	Concentration of PCP in Biota Type (i) ^{2,3} (B _i) (mg/kg dw)	PCP in Diet of Prey ⁴ (C _{diet})	Eco-SSL (mg/kg dw) ⁵
Mammalian herbivore (vole)	8.42	0.0875	0.032	B _i = Soil _j * 5.93 where i = plants	NA	16
Mammalian ground insectivore (shrew)	8.42	0.209	0.030	B _i = 14.63 * Soil _j where i = earthworms	NA	2.8
Mammalian carnivore (weasel)	8.42	0.130	0.057	B _i = 0.00452 * C _{diet} + 0.198 where i = mammals	C _{diet} = 14.63 * Soil _j	590

¹ The process for derivation of wildlife TRVs is described in Attachment 4-5 of U.S. EPA (2003)

² Parameters (FIR, P_s, B_i values, regressions) are provided in U.S. EPA (2003) Attachment 4-1 (revised February 2005).

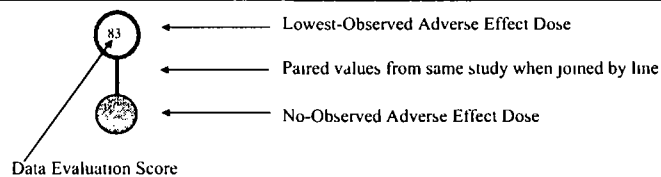
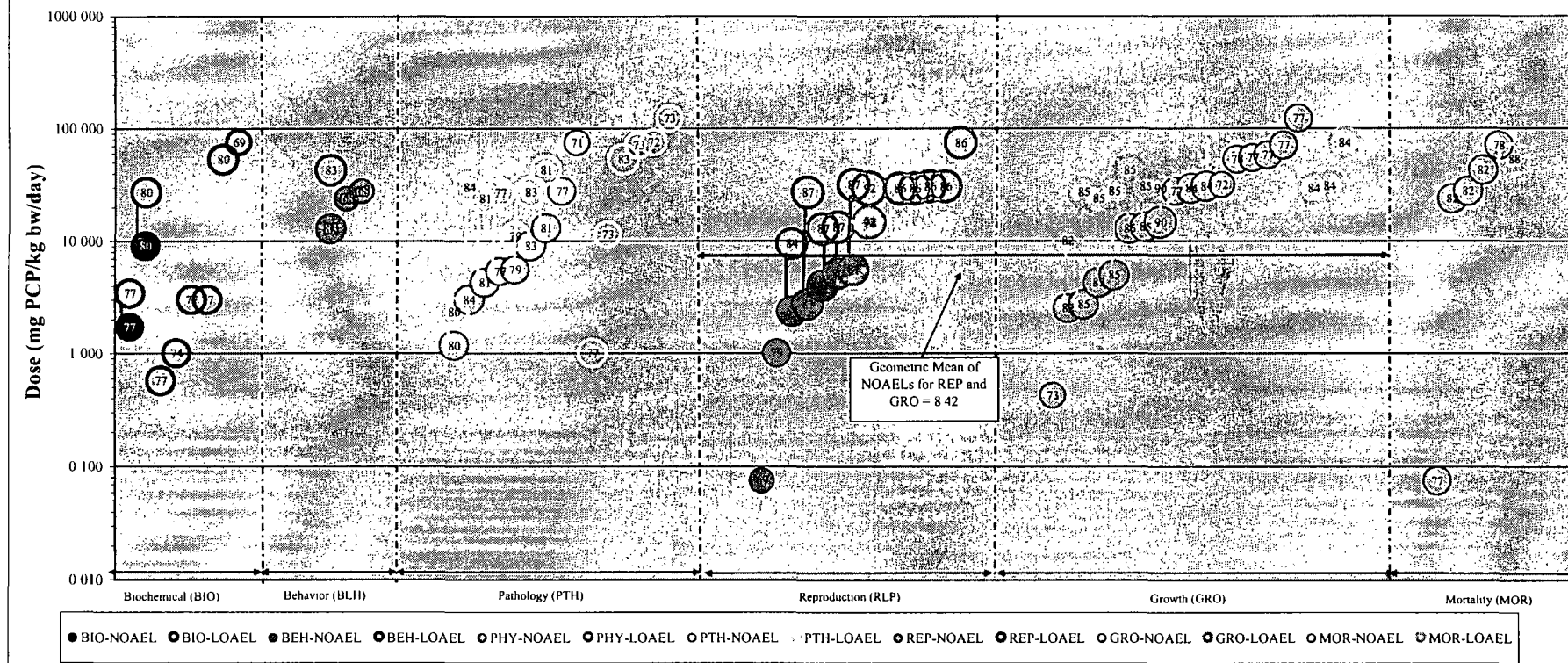
³ B_i = Concentration in biota type (i) which represents 100% of the diet for the respective receptor.

⁴ C_{diet} = Concentration in the diet of small mammals consumed by predatory species (weasel).

⁵ HQ = FIR * (Soil_j * P_s + B_i) / TRV solved for HQ=1 where Soil_j = Eco-SSL (Equation 4-2, U.S. EPA, 2003).

NA = Not Applicable

Figure 6.1 Mammalian TRV Derivation for Pentachlorophenol



Wildlife TRV Derivation Process

- 1) There are at least three results available for two test species within the growth, reproduction, and mortality effect groups
There are enough data to derive a TRV
- 2) There are three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean
- 4) The geometric mean is equal to 8.42 mg pentachlorophenol /kg bw/d but is lower than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups
- 5) The mammalian wildlife TRV for pentachlorophenol is equal to 8.42 mg pentachlorophenol/kg bw/day which is the geometric mean of NOAEL values for reproduction and growth

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7.3 References Rejected for Use in Deriving Plant and Soil Invertebrate Eco-SSLs

These references were reviewed and rejected for use in derivation of the Eco-SSL. The definition of the codes describing the basis for rejection is provided at the end of the reference sections.

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7.5 References Rejected for Use in Derivation of Wildlife TRV

These references were reviewed and rejected for use in derivation of the Eco-SSL. The definition of the codes describing the basis for rejection is provided at the end of the reference sections.

Diss	The action of phencyclidine upon hippocampal neurons. 917024 ORDER NO NOT AVAILABLE FROM UNIVERSITY MICROFILMS INT'L
Diss	Alteration in central nervous system noradrenergic function associated with aging in the rat. 884182 ORDER NO: AAD85-12017
No COC	Analysis of the interaction of pcp-like agents on operant behaviors in the rat. 01156309 ORDER NO: AAD91-06059
Diss	Antibody-based medications as short- and long-term antagonists of. 01691223 ORDER NO: AAD99-20411
Diss	Behavioral and biochemical analysis of phencyclidine. 1045920 ORDER NO: AAD89-05455
Diss	Behavioral and neurochemical consequences of prenatal exposure to phencyclidine in mice: mid versus late gestation. 0985614 ORDER NO: AAD88-03536
Diss	Behavioral characterization of sigma site compounds (sigma site compounds) 01107453 ORDER NO: AAD90-13894

Diss	The behavioral effects of drug interactions: phencyclidine and central nervous system depressant. 828556 ORDER NO: AAD83-25721
Diss	Behavioral interactions between delta-9-tetrahydrocannabinol, phencyclidine and ethanol in rats (delta-9-tetrahydrocannabinol). 01222636 ORDER NO AAD92-16707
Diss	A behavioral model for evaluating the interaction between phencyclidine (pcp) and the sigma receptor. 1071025 ORDER NO AAD89-15599
Diss	The behavioral pharmacology of novel n-methyl-d-aspartate receptor channel blockers (nmda). 01695959 ORDER NO AAD99-23749
Diss	Behavioral pharmacology of phencyclidine (pcp) in the rat (aggression, opioid, dopamine). 868518 ORDER NO AAD84-28919
Diss	Biochemical and pharmacological studies of transmethylation mechanisms in the central nervous system (clioquinol). 01706096 ORDER NO. NOT AVAILABLE FROM UNIVERSITY MICROFILMS INT'L.
Diss	Comparison of central sites of action and cns depressant properties of phencyclidine and (+)-n-allylnormetazocine. 901393 ORDER NO: AAD85-25979
Diss	Comparison of the behavioral pharmacology of phencyclidine to related compounds (pcp). 808941 ORDER NO AAD83-06301
Diss	Conditioned taste aversions in rats as a behavioral baseline to assess the discriminative stimulus properties of phencyclidine. 945938 ORDER NO: AAD87-05009
Diss	Creativity at the task and process level: what is responsible for age differences? (divergent thinking, convergent thinking). 01636929 ORDER NO: AAD98-26255
Diss	Cyclazocine: dissociation of its opioid and non-opioid effects using eeg, eeg power spectra and behavior in the rat. 955014 ORDER NO: AAD87-12470
No COC	Dependence on phencyclidine: behavioral and biochemical aspects,(drug dependence, operant behavior). 01164407 ORDER NO: AAD91-19378
Diss	Development of an improved rat model of pneumocystis carinii pneumonia and investigations of novel chemotherapeutic agents (immune deficiency, aids. 01413015 ORDER NO AADAA-I9514430
Diss	Development of dicationic compounds as anti-microbial agents (pneumocystis carinii, opportunistic infections, diamidoximes, immune deficiency). 01681862 ORDER NO AAD99-14926
No Oral	Differential effect of metaphit on the biochemical and functional properties of receptors for n-methyl-d-aspartate (nmda) and phencyclidine (pcp) (methyiaspartate). 01204627 ORDER NO: AAD92-05488
No Oral	Discriminative learning with an interoceptive drug stimulus and an exteroceptive stimulus: stimulus interaction and relative salience. 01403622 ORDER NO AADAA-I9509216
Diss	Dissociative anesthetics selectively block long-term potentiation in the rat hippocampus. 858440 ORDER NO: AAD84-19907

- Diss** The effect of a single administration of phencyclidine on behavior and some neurochemical parameters in the rat. 816980 ORDER NO: AAD83-17163
- Diss** The effect of pentachlorophenol on the reproductive performance in rats. 718584 ORDER NO: AAD13-16620
- No COC** Effects of opioids on the acquisition and performance of discriminations in squirrel monkeys (monkeys). 01147464 ORDER NO: AAD91-08037
- Diss** Evaluation of the effectiveness of molybdate as an inhibitor of xenobiotic sulfation in rats (sulfation inhibition, intestinal absorption, biotransformation). 01613685 ORDER NO: AAD98-11345
- Diss** Evaluation of the reinforcing efficacy of orally-delivered phencyclidine and ethanol in rhesus monkeys under fixed- and progressive-ratio schedules (drug abuse). 01613652 ORDER NO: AAD98-11275
- Diss** Examination of the cerebrospinal fluid of the dog original title: laboruntersuchung des liquor cerebrospinalis beim hund. 01230230 ORDER NO: NOT AVAILABLE FROM UNIVERSITY MICROFILMS INT'L.
- Diss** Fos induction within the ventral tegmental area following infusions of phencyclidine, mk-801, and nomifensine into the core and shell subterritories of the nucleus accumbens septi. 01707933 ORDER NO: AADMQ-39442
- Diss** Immunotherapy for phencyclidine abuse (drug abuse, pcg). 01432793 ORDER NO: AADAA-19532080
- Diss** Inactivation of cytochrome p450 2b1 by clorgyline, deprenyl and phencyclidine 01619796 ORDER NO: AAD98-15374
- Diss** The investigation of n-benzylpiperidines: as possible phencyclidine antagonists. 0959781 ORDER NO: AAD87-16499
- Diss** The investigation of some analogs of phencyclidine (pcp) as possible antagonists to phencyclidine. 778671 ORDER NO: AAD82-10469
- Diss** Involvement of sigma binding sites in the regulation of posture and movement. 1084730 ORDER NO: AAD90-02260
- Diss** Locomotor sensitization and neural degeneration associated with chronic phencyclidine administration in rats: a potential model of schizophrenia. 01698470 ORDER NO: AAD99-24635
- Diss** Metabolic and neurochemical aspects of phencyclidine toxicity.
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- No COC** Yanai, J, Avraham, Y., Levy, S., Maslaton, J., Pick, C. G., Rogel-Fuchs, Y., and Zahalka, E. A. 1992. alterations in septohippocampal cholinergic innervations and related behaviors after early exposure to heroin and phencyclidine. *Brain Research. Developmental Brain Research* 69(2): 207-14.
- No Oral** Yang, Q, Moroji, T., Takamatsu, Y, Hagino, Y, and Okuwa, M the effects of intraperitoneally administered phencyclidine on the central nervous system behavioral and neurochemical studies. *Neuropeptides. 19 (2) 1991* 77-90
- Prim** Yang, R. S. H., Pittman, K. A., Rourke, D. R., and et, a l. 1978 pharmacokinetics and metabolism of hexachlorobenzene in the rat and rhesus monkey. *Journal of Agricultural and Food Chemistry* 26(5): 1076-1083

FL	Yershova L.K. and Khomenko N.R. 1981. effect of some organochlorine pesticides on central nervous system Function. <i>Fiziologich Zh, Kiev</i> VOL. 27, NO. 4: pp. 557-560.
No COC	Yonezawa Y(A), Hondo, H., Hashimoto, K., Matsumoto, T., Hirano, M , Uchimura, H., and Kuroki, T. 1993. effect of phencyclidine on endogenous excitatory amino acid release from the rat anterior cingulate cortex: an in vivo microdialysis study. <i>Journal of Neural Transmission General Section</i> 94(3): 235-240.
No COC	Yonezawa Yuji(A), Kuroki Toshihide, Kawahara Takeshi, Tashiro Nobutada, and Uchimura Hideyuki. 1998. involvement of gamma-aminobutyric acid neurotransmission in phencyclidine-induced dopamine release in the medial prefrontal cortex. <i>European Journal of Pharmacology</i> 341(1): 45-56
Unrel	Yoshida, S , Numachi, Y., Matsuoka, H., Fuse, Y , and Sato, M. 1995. [reverse-tolerance phenomenon in methamphetamine-induced behavioral stereotypy and impairment of cliff avoidance reaction after subchronic methamphetamine administration in rats]. <i>Nihon Shinkei Seishin Yakurigaku Zasshi</i> 15(5): 397-403.
No COC	Young, T , Lawson, G. W , and Gacono, C. B. 1987 clinical aspects of phencyclidine (pcp). <i>International Journal Of The Addictions</i> 22(1): 1-15.
Food	Yuan, J 1995. effects of drinking pattern on the peak/trough blood concentrations in drinking water studies. <i>Food And Chemical Toxicology : An International Journal Published For The British Industrial Biological Research Association</i> 33(7): 565-571.
Method	Yuan, Jinhua. modeling blood/plasma concentrations in dosed feed and dosed drinking water toxicology studies. <i>Toxicol. Appl. Pharmacol. (1993)</i> 119(1): 131-41.
No Oral	Yukhananov, R. Yu. and Larson, A. A. 1994. morphine modulates excitatory amino acid-induced activity in the mouse spinal cord: short-term effects on n-methyl-d-aspartate (nmda) and long-term effects on kainic acid. <i>Vol. 646, No. 2, Pp. 194-200 Brain Res.</i>
Acu	Zbinden, G. and Flury-Roversi, M. significance of the ld50-test for the toxicological evaluation of chemical substances. <i>Arch. Toxicol.</i> 47(2): 77-99 1981 (52 References)
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No Oral	Zhang, K , Tang, C , Rashed, M , Cui, D., Tombret, F., Botte, H., Lepage, F., Levy, R. H., and Baillie, T. A. 1994. metabolic chiral inversion of stiripentol in the rat. i. mechanistic studies. <i>Drug Metabolism and Disposition</i> 22(4): 544-53.
No COC	Zimmerman, D. M., Schoepp, D D , Leander, J D., and Ornstein, P L. the discovery and characterization of the competitive nmda antagonists ly274614 ly233536 and ly233053. <i>Mol Neuropharmacol</i> 2 (1) 1992. 77-81.
No COC	Zukin, S. R. 1982. differing stereospecificities distinguish opiate receptor subtypes. <i>Life Sciences</i> 31(12-13): 1307-10.
Unrel	Zukin, S. R., Brady, K. T., Slifer, B. L., and Balster, R. L. 1984 behavioral and biochemical stereoselectivity of sigma opiate pcp receptors. <i>Brain Research</i> 294(1): 174-177
No COC	Zukin, S. R , Fitz-Syage, M. L , Nichtenhauser, R , and Zukin, R S. specific binding of tritium labeled phencyclidine in rat central nervous tissue further characterization and technical

considerations.. *Brain Research*. 258 (2) 1983 277-284.

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- No COC** Zukin, S. R , Fitz-Syage, M. L., Nichtenhauser, R , and Zukin, R. S 1983. specific binding of [3h]phencyclidine in rat central nervous tissue: further characterization and technical considerations. *Brain Research* 258(2): 277-84.
- No COC** Zukin, S. R. and Zukin, R. S. specific tritium labeled phencyclidine binding in rat central nervous system. *PROC NATL ACAD SCI U S A Proceedings of the National Academy of Sciences of the United States of America* 76 (10). 1979 5372-5381.

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Literature Rejection Categories		
Rejection Criteria	Description	Receptor
ABSTRACT (Abstract)	Abstracts of journal publications or conference presentations.	Wildlife Plants and Soil Invertebrates
ACUTE STUDIES (Acu)	Single oral dose or exposure duration of three days or less.	Wildlife
AIR POLLUTION (Air P)	Studies describing the results for air pollution studies.	Wildlife Plants and Soil Invertebrates
ALTERED RECEPTOR (Alt)	Studies that describe the effects of the contaminant on surgically-altered or chemically-modified receptors (e.g., right nephrectomy, left renal artery ligation, hormone implant, etc.).	Wildlife
AQUATIC STUDIES (Aquatic)	Studies that investigate toxicity in aquatic organisms	Wildlife Plants and Soil Invertebrates
ANATOMICAL STUDIES (Anat)	Studies of anatomy Instance where the contaminant is used in physical studies (e.g., silver nitrate staining for histology).	Wildlife
BACTERIA (Bact)	Studies on bacteria or susceptibility to bacterial infection.	Wildlife Plants and Soil Invertebrates
BIOACCUMULATION SURVEY (Bio Acc)	Studies reporting the measurement of the concentration of the contaminant in tissues.	Wildlife Plants and Soil Invertebrates
BIOLOGICAL PRODUCT (BioP)	Studies of biological toxicants, including venoms, fungal toxins, <i>Bacillus thuringiensis</i> , other plant, animal, or microbial extracts or toxins.	Wildlife Plants and Soil Invertebrates
BIOMARKER (Biom)	Studies reporting results for a biomarker having no reported association with an adverse effect and an exposure dose (or concentration).	Wildlife
CARCINOGENICITY STUDIES (Carcin)	Studies that report data only for carcinogenic endpoints such as tumor induction. Papers that report systemic toxicity data are retained for coding of appropriate endpoints.	Wildlife Plants and Soil Invertebrates
CHEMICAL METHODS (Chem Meth)	Studies reporting methods for determination of contaminants, purification of chemicals, etc. Studies describing the preparation and analysis of the contaminant in the tissues of the receptor.	Wildlife Plants and Soil Invertebrates
CONFERENCE PROCEEDINGS (CP)	Studies reported in conference and symposium proceedings.	Wildlife Plants and Soil Invertebrates
DEAD (Dead)	Studies reporting results for dead organisms. Studies reporting field mortalities with necropsy data where it is not possible to establish the dose to the organism.	Wildlife Plants and Soil Invertebrates
DISSERTATIONS (Diss)	Dissertations are excluded However, dissertations are flagged for possible future use.	Wildlife
DRUG (Drug)	Studies reporting results for testing of drug and therapeutic effects and side-effects. Therapeutic drugs include vitamins and minerals Studies of some minerals may be included if there is potential for adverse effects.	Wildlife Plants and Soil Invertebrates
DUPLICATE DATA (Dup)	Studies reporting results that are duplicated in a separate publication. The publication with the earlier year is used.	Wildlife Plants and Soil Invertebrates

Literature Rejection Categories		
Rejection Criteria	Description	Receptor
ECOLOGICAL INTERACTIONS (Ecol)	Studies of ecological processes that do not investigate effects of contaminant exposure (e.g., studies of "silver" fox natural history; studies on ferrets identified in iron search)	Wildlife Plants and Soil Invertebrates
EFFLUENT (Effl)	Studies reporting effects of effluent, sewage, or polluted runoff.	Wildlife Plants and Soil Invertebrates
ECOLOGICALLY RELEVANT ENDPOINT (ERE)	Studies reporting a result for endpoints considered as ecologically relevant but is not used for deriving Eco-SSLs (e.g., behavior, mortality).	Plants and Soil Invertebrates
CONTAMINANT FATE/METABOLISM (Fate)	Studies reporting what happens to the contaminant, rather than what happens to the organism. Studies describing the intermediary metabolism of the contaminant (e.g., radioactive tracer studies) without description of adverse effects.	Wildlife Plants and Soil Invertebrates
FOREIGN LANGUAGE (FL)	Studies in languages other than English.	Wildlife Plants and Soil Invertebrates
FOOD STUDIES (Food)	Food science studies conducted to improve production of food for human consumption.	Wildlife
FUNGUS (Fungus)	Studies on fungus.	Wildlife Plants and Soil Invertebrates
GENE (Gene)	Studies of genotoxicity (chromosomal aberrations and mutagenicity)	Wildlife Plants and Soil Invertebrates
HUMAN HEALTH (HHE)	Studies with human subjects.	Wildlife Plants and Soil Invertebrates
IMMUNOLOGY (IMM)	Studies on the effects of contaminants on immunological endpoints.	Wildlife Plants and Soil Invertebrates
INVERTEBRATE (Invert)	Studies that investigate the effects of contaminants on terrestrial invertebrates are excluded.	Wildlife
IN VITRO (In Vit)	<i>In vitro</i> studies, including exposure of cell cultures, excised tissues and/or excised organs.	Wildlife Plants and Soil Invertebrates
LEAD SHOT (Lead shot)	Studies administering lead shot as the exposure form. These studies are labeled separately for possible later retrieval and review.	Wildlife
MEDIA (Media)	Authors must report that the study was conducted using natural or artificial soil. Studies conducted in pore water or any other aqueous phase (e.g., hydroponic solution), filter paper, petri dishes, manure, organic or histosols (e.g., peat muck, humus), are not considered suitable for use in defining soil screening levels.	Plants and Soil Invertebrates
METHODS (Meth)	Studies reporting methods or methods development without usable toxicity test results for specific endpoints.	Wildlife Plants and Soil Invertebrates
MINERAL REQUIREMENTS (Mineral)	Studies examining the minerals required for better production of animals for human consumption, unless there is potential for adverse effects.	Wildlife
MIXTURE (Mix)	Studies that report data for combinations of single toxicants (e.g., cadmium and copper) are excluded. Exposure in a field setting from contaminated natural soils or waste application to soil may be coded as Field Survey.	Wildlife Plants and Soil Invertebrates

Literature Rejection Categories		
Rejection Criteria	Description	Receptor
MODELING (Model)	Studies reporting the use of existing data for modeling, i.e., no new organism toxicity data are reported. Studies which extrapolate effects based on known relationships between parameters and adverse effects.	Wildlife Plants and Soil Invertebrates
NO CONTAMINANT OF CONCERN (No COC)	Studies that do not examine the toxicity of Eco-SSL contaminants of concern.	Wildlife Plants and Soil Invertebrates
NO CONTROL (No Control)	Studies which lack a control or which have a control that is classified as invalid for derivation of TRVs.	Wildlife Plants and Soil Invertebrates
NO DATA (No Data)	Studies for which results are stated in text but no data is provided. Also refers to studies with insufficient data where results are reported for only one organism per exposure concentration or dose (wildlife).	Wildlife Plants and Soil Invertebrates
NO DOSE or CONC (No Dose)	Studies with no usable dose or concentration reported, or an insufficient number of doses/concentrations are used based on Eco-SSL SOPs. These are usually identified after examination of full paper. This includes studies which examine effects after exposure to contaminant ceases. This also includes studies where offspring are exposed in utero and/or lactation by doses to parents and then after weaning to similar concentrations as their parents. Dose cannot be determined.	Wildlife Plants and Soil Invertebrates
NO DURATION (No Dur)	Studies with no exposure duration. These are usually identified after examination of full paper.	Wildlife Plants and Soil Invertebrates
NO EFFECT (No Efect)	Studies with no relevant effect evaluated in a biological test species or data not reported for effect discussed.	Wildlife Plants and Soil Invertebrates
NO ORAL (No Oral)	Studies using non-oral routes of contaminant administration including intraperitoneal injection, other injection, inhalation, and dermal exposures	Wildlife
NO ORGANISM (No Org) or NO SPECIES	Studies that do not examine or test a viable organism (also see in vitro rejection category)	Wildlife Plants and Soil Invertebrates
NOT AVAILABLE (Not Avail)	Papers that could not be located. Citation from electronic searches may be incorrect or the source is not readily available	Wildlife Plants and Soil Invertebrates
NOT PRIMARY (Not Prim)	Papers that are not the original compilation and/or publication of the experimental data.	Wildlife Plants and Soil Invertebrates
NO TOXICANT (No Tox)	No toxicant used. Publications often report responses to changes in water or soil chemistry variables, e.g., pH or temperature. Such publications are not included.	Wildlife Plants and Soil Invertebrates
NO TOX DATA (No Tox Data)	Studies where toxicant used but no results reported that had a negative impact (plants and soil invertebrates).	Plants and Soil Invertebrates
NUTRIENT (Nutrient)	Nutrition studies reporting no concentration related negative impact	Plants and Soil Invertebrates
NUTRIENT DEFICIENCY (Nut def)	Studies of the effects of nutrient deficiencies. Nutritional deficient diet is identified by the author. If reviewer is uncertain then the administrator should be consulted. Effects associated with added nutrients are coded.	Wildlife
NUTRITION (Nut)	Studies examining the best or minimum level of a chemical in the diet for improvement of health or maintenance of animals in captivity.	Wildlife
OTHER AMBIENT CONDITIONS (OAC)	Studies which examine other ambient conditions: pH, salinity, DO, UV, radiation, etc.	Wildlife Plants and Soil Invertebrates

Literature Rejection Categories		
Rejection Criteria	Description	Receptor
OIL (Oil)	Studies which examine the effects of oil and petroleum products.	Wildlife Plants and Soil Invertebrates
OM, pH (OM, pH)	Organic matter content of the test soil must be reported by the authors, but may be presented in one of the following ways, total organic carbon (TOC), particulate organic carbon (POC), organic carbon (OC), coarse particulate organic matter (CPOM), particulate organic matter (POM), ash free dry weight of soil, ash free dry mass of soil, percent organic matter, percent peat, loss on ignition (LOI), organic matter content (OMC) With the exception of studies on non-ionizing substances, the study must report the pH of the soil, and the soil pH should be within the range of • 4 and • 8.5. Studies that do not report pH or report pH outside this range are rejected.	Plants and Soil Invertebrates
ORGANIC METAL (Org Met)	Studies which examine the effects of organic metals. This includes tetraethyl lead, triethyl lead, chromium picolinate, phenylarsonic acid, roxarsone, 3-nitro-4-phenylarsonic acid, zinc phosphide, monomethylarsonic acid (MMA), dimethylarsinic acid (DMA), trimethylarsine oxide (TMAO), or arsenobetaine (AsBe) and other organo metallic fungicides. Metal acetates and methionines are not rejected and are evaluated.	Wildlife
LEAD BEHAVIOR OR HIGH DOSE MODELS (Pb Behav)	There are a high number of studies in the literature that expose rats or mice to high concentrations of lead in drinking water (0.1, 1 to 2% solutions) and then observe behavior in offspring, and/or pathology changes in the brain of the exposed dam and/or the progeny. Only a representative subset of these studies were coded. Behavior studies examining complex behavior (learned tasks) were also not coded.	Wildlife
PHYSIOLOGY STUDIES (Phys)	Physiology studies where adverse effects are not associated with exposure to contaminants of concern	Wildlife
PLANT (Plant)	Studies of terrestrial plants are excluded.	Wildlife
PRIMATE (Prim)	Primate studies are excluded.	Wildlife
PUBL AS (Publ as)	The author states that the information in this report has been published in another source. Data are recorded from only one source. The secondary citation is noted as Publ As.	Wildlife Plants and Soil Invertebrates
QSAR (QSAR)	Derivation of Quantitative Structure-Activity Relationships (QSAR) is a form of modeling. QSAR publications are rejected if raw toxicity data are not reported or if the toxicity data are published elsewhere as original data.	Wildlife Plants and Soil Invertebrates
REGULATIONS (Reg)	Regulations and related publications that are not a primary source of data.	Wildlife Plants and Soil Invertebrates
REVIEW (Rev)	Studies in which the data reported in the article are not primary data from research conducted by the author. The publication is a compilation of data published elsewhere. These publications are reviewed manually to identify other relevant literature.	Wildlife Plants and Soil Invertebrates

Literature Rejection Categories		
Rejection Criteria	Description	Receptor
SEDIMENT CONC (Sed)	Studies in which the only exposure concentration/dose reported is for the level of a toxicant in sediment	Wildlife Plants and Soil Invertebrates
SCORE (Score)	Papers in which all studies had data evaluation scores at or lower than the acceptable cut-off (≤ 10 of 18) for plants and soil invertebrates).	Plants and Soil Invertebrates
SEDIMENT CONC (Sed)	Studies in which the only exposure concentration/dose reported is for the level of a toxicant in sediment.	Wildlife Plants and Soil Invertebrates
SLUDGE	Studies on the effects of ingestion of soils amended with sewage sludge	Wildlife Plants and Soil Invertebrates
SOIL CONC (Soil)	Studies in which the only exposure concentration/dose reported is for the level of a toxicant in soil.	Wildlife
SPECIES	Studies in which the species of concern was not a terrestrial invertebrate or plant or mammal or bird.	Plants and Soil Invertebrates Wildlife
STRESSOR (QAC)	Studies examining the interaction of a stressor (e.g , radiation, heat, etc) and the contaminant, where the effect of the contaminant alone cannot be isolated.	Wildlife Plants and Soil Invertebrates
SURVEY (Surv)	Studies reporting the toxicity of a contaminant in the field over a period of time. Often neither a duration nor an exposure concentration is reported.	Wildlife Plants and Soil Invertebrates
REPTILE OR AMPHIBIAN (Herp)	Studies on reptiles and amphibians. These papers flagged for possible later review	Wildlife Plants and Soil Invertebrates
UNRELATED (Unrel)	Studies that are unrelated to contaminant exposure and response and/or the receptor groups of interest	Wildlife
WATER QUALITY STUDY (Wqual)	Studies of water quality	Wildlife Plants and Soil Invertebrates
YEAST (Yeast)	Studies of yeast.	Wildlife Plants and Soil Invertebrates

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Appendix 5-1

*Avian Toxicity Data Extracted and Reviewed for Wildlife Toxicity
Reference Value (TRV) - Pentachlorophenol*

March 2005

Revised April 2007

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2010

2011

2012

2013

Appendix 5.1 Avian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)

Pentachlorophenol

Page 1 of 1

Ref	Ref #	Ref N	Reference	Chemical Form	NW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported*	Percent Moisture	Application Frequency	Method of Analysis	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Litterage	Sex	Control Type	Treat Location	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported*	Body Weight in kg	Ingestion Rate Reported*	Ingestion Rate in kg/day or L/day	NOAEL Dose (mg/kg/day)	LOAEL Dose (mg/kg/day)	Data Source	Dose Route	Test Concentration	Chemical Form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Stat
Pathology																																													
1	6573	Siedman et al. 1980	PCP - Purified	100	Chicken (<i>Gallus domesticus</i>)	1	5	0/1/10/100/1000	mg/kg diet	N	na	ADL	U	FD	8	w	1	d	JV	NR	C	Lab	ORW	ORWT	KI	10.0	100	Y	1.889	N	0.0881	0.466	4.66	10	10	5	10	6	4	8	10	10	4	77	
2	6439	Prusant et al. 1982	PLP - Purified (Dowicide 1-7)	88	Chicken (<i>Gallus domesticus</i>)	1	4	0/600/1200/2400	mg/kg diet	N	na	ADI	U	FD	8	w	1	d	JV	NR	V	Lab	ORW	SMIN	KI		600	Y	2.44	N	0.1040		22.5	10	10	5	10	6	4	4	10	10	4	73	
Growth																																													
3	6573	Siedman et al. 1980	PCP - Purified	100	Chicken (<i>Gallus domesticus</i>)	1	5	0/1/10/100/1000	mg/kg diet	N	na	ADL	U	FD	1	w	1	d	JV	NR	C	Lab	GRO	BDWT	WO	100	1000	Y	0.6584	N	0.04434	6.73	67.3	10	10	5	10	6	8	8	10	10	4	81	
4	5520	Neheker et al. 1994	PCP - Reagent grade	100	Duck (<i>Anas platyrhynchos</i>)	1	7	0/25 0/54 2/105 0/233 2/423 2/961 0	ug/g diet	N	na	DLY	M	FD	11	d	4	d	JV	NR	C	Lab	GRO	BDWT	WO	423.2	961	Y	0.2337	N	0.02359	40.9	92.9	10	10	10	10	6	8	10	10	10	4	88	
5	6439	Prusant et al. 1982	PCP - Purified (Dowicide 1-7)	88	Chicken (<i>Gallus domesticus</i>)	1	4	0/600/1200/2400	mg/kg diet	N	na	ADL	U	FD	1	w	1	d	JV	NR	V	Lab	GRO	BDWT	WO		600	Y	2.44	N	0.1040		22.5	10	10	5	10	6	8	4	10	10	4	77	
Survival																																													
6	6439	Prusant et al. 1982	PCP - Purified (Dowicide 1-7)	88	Chicken (<i>Gallus domesticus</i>)	1	4	0/600/1200/2400	mg/kg diet	N	na	ADL	U	FD	8	w	1	d	JV	NR	V	Lab	MOR	MORT	WO	2400		Y	2.44	N	0.1040	90.0			10	10	5	10	6	9	4	10	10	4	78
7	5520	Neheker et al. 1994	PCP - Reagent grade	100	Duck (<i>Anas platyrhynchos</i>)	1	7	0/25 0/54 2/105 0/233 2/423 2/961 0	ug/g diet	N	na	DLY	M	FD	11	d	4	d	JV	NR	C	Lab	MOR	MORT	WO	961		Y	0.1419	N	0.01633	111			10	10	10	10	6	9	4	10	10	4	83

All abbreviations and definitions are used in coding studies are available from Attachment 4-3 of the Eco-SSL guidance. (U.S. EPA 2003)



Appendix 6-1

*Mammalian Toxicity Data Extracted and Reviewed for Wildlife
Toxicity Reference Value (TRV) - Pentachlorophenol*

March 2005

Revised April 2007

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Appendix 6.1 Mammalian Toxicity Data Extracted for Wildlife Toxicity Reference Value (TRV)

Pentachlorophenol

Page 1 of 2

Ref	Ref N	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wt Weight Reported*	Percent Moisture	Application Frequency	Method of Analysis	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifespan	Sex	Control Type	Test Location	Endpoint Number	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported*	Reported Body Weight	Ingestion Rate Reported*	Ingestion Rate in kg or L/day	NOAEL Dose (mg/kg/day)*	LOAEL Dose (mg/kg/day)*	Data Source	Dose Route	Test Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total					
Biochemical																																																	
1	20229	Knudsen et al. 1974	PCP - Not Purified	100	Rat (<i>Rattus norvegicus</i>)	1	4	0/25/50/200	mg/kg diet	N	na	ADL	U	FD	6	w	NR	NR	JV	M	C	Lab	3	CHIM	IIMCT	BL	25.0	50.0	Y	0.2590	Y	0.0177	1.71	3.42	10	10	5	10	7	1	10	10	4	77					
2	20023	Schwartz et al. 1978	PCP - Purified	90.4	Rat (<i>Rattus norvegicus</i>)	2	5	0/1/3/10/30	mg/kg bw/d	N	na	ADL	U	FD	22	mo	NR	NR	JV	B	V	Lab	2	ENZ	GPTR	SR	10.0	30.0	Y	0.3780	N	0.03088	9.04	27.1	10	10	5	10	10	1	10	10	4	80					
3	20124	Rawlings et al. 1998	PCP - Purified	99.9	Sheep (<i>Ovis aries</i>)	1	2	0/2	mg/kg bw/d	N	na	2 per w	U	OR	36	d	1-4	yr	GF	F	C	Lab	2	IIRM	THYR	SR		2.0	Y	54.7	N	1.843	0.571	10	8	10	10	1	4	10	10	4	77						
4	20024	Beard et al. 1999	PCP - Purity not specified	100	Sheep (<i>Ovis aries</i>)	1	2	0/1	mg/kg bw/d	N	na	DLY	U	FD	34	w	1-3	yr	GE	F	V	FieldA	2	IIRM	THYR	SR		1.0	Y	70.0	N	0.00772	1.0	10	10	5	10	10	1	4	10	10	4	74					
5	20093	Jakat et al. 1994	PCP - Purified	100	Rat (<i>Rattus norvegicus</i>)	1	3	0/3/30	mg/kg bw/d	N	na	2 per d	U	GV	28	d	NR	NR	JV	F	V	Lab	1	IIRM	THYR	SR		3.0	Y	0.2000	N	0.01830	3.0	10	8	10	10	1	4	10	10	4	77						
6	20093	Jakat et al. 1994	Sodium pentachlorophenolate	100	Rat (<i>Rattus norvegicus</i>)	2	3	0/3	mg/kg bw/d	N	na	2 per d	U	GV	28	d	NR	NR	JV	F	V	Lab	1	IIRM	THYR	SR		3.0	Y	0.2000	N	0.01830	3.0	10	8	10	10	1	4	10	10	4	77						
7	19997	Renner et al. 1987	PCP - Purified	99	Rat (<i>Rattus norvegicus</i>)	1	2	0/53.27	mg/kg bw/d	N	na	DLY	U	GV	28	d	3.5	mo	JV	F	V	Lab	3	CHIM	PCLV	BL		52.7	Y	0.2710	N	0.02349	52.7	10	8	10	10	1	4	10	10	7	80						
8	19990	Umemura et al. 1999	PCP - Purified	98.6	Mouse (<i>Mus musculus</i>)	1	3	0/600/1200	mg/kg diet	N	na	DLY	U	FD	8	w	6	w	JV	M	C	Lab	1	ENZ	GENZ	LI		600	N	0.0316	N	0.004015	75.2	10	10	5	10	5	1	4	10	10	4	69					
Behavior																																																	
9	20813	Welsh et al. 1987	PCP - Purified	99	Rat (<i>Rattus norvegicus</i>)	1	4	0/4/13/43	mg/kg bw/d	N	na	ADL	U	FD	201	d	32	d	GE	F	C	Lab	2	FDB	FCNS	WO	13.0	43.0	Y	0.3214	Y	0.02320	12.9	42.6	10	10	5	10	10	4	10	10	4	83					
10	20197	Kimbrough and Linder. 1978	PCP - Technical	84.6	Rat (<i>Rattus norvegicus</i>)	1	4	0/0.9/5/28	mg/kg bw/d	N	na	ADL	U	FD	220	d	NR	NR	JV	B	C	Lab	2	FDB	FCNS	WO	28.0		Y	0.5340	Y	0.07491	23.7		10	10	5	10	10	4	4	1	10	4	68				
11	20197	Kimbrough and Linder. 1978	PCP - Purified	99	Rat (<i>Rattus norvegicus</i>)	2	4	0/0.9/5/28	mg/kg bw/d	N	na	ADL	U	FD	220	d	NR	NR	JV	B	C	Lab	2	FDB	FCNS	WO	28.0		Y	0.4950	Y	0.08081	27.7		10	10	5	10	10	4	4	1	10	4	68				
Pathology																																																	
12	20229	Knudsen et al. 1974	PCP - Not Purified	100	Rat (<i>Rattus norvegicus</i>)	1	4	0/25/50/200	mg/kg diet	N	na	ADL	U	FD	12	w	NR	NR	JV	F	C	Lab	4	ORW	SMIX	LI	25.0	50.0	Y	0.2010	Y	0.0094	1.17	2.34	10	10	5	10	7	4	10	10	4	80					
13	20093	Jakat et al. 1994	PCP - Purified	100	Rat (<i>Rattus norvegicus</i>)	1	3	0/3/30	mg/kg bw/d	N	na	2 per d	U	GV	28	d	NR	NR	JV	F	V	Lab	2	ORW	ORWT	LI	3.0	30.0	Y	0.2000	N	0.01830	3.0	30.0	10	8	10	10	1	4	10	10	4	84					
14	20197	Kimbrough and Linder. 1978	PCP - Technical	84.6	Rat (<i>Rattus norvegicus</i>)	1	4	0/0.9/5/28	mg/kg bw/d	N	na	ADL	U	FD	8	mo	NR	NR	JV	B	C	Lab	4	ORW	ORWT	LI	5.0	28.0	Y	0.5340	Y	0.07491	4.23	23.7	10	10	5	10	10	4	8	10	10	4	81				
15	20129	Kerkvliet et al. 1982	PCP - Technical	86	Mouse (<i>Mus musculus</i>)	1	4	0/50/250/500	mg/kg diet	N	na	ADL	U	FD	8	w	6	w	JV	F	V	Lab	2	ORW	SMIX	LI	50.0	250	Y	0.0343	N	0.004295	5.38	26.9	10	10	5	10	6	4	8	10	10	4	77				
16	20129	Kerkvliet et al. 1982	PCP - Technical	86	Mouse (<i>Mus musculus</i>)	2	4	0/50/100/250	mg/kg diet	N	na	ADL	U	FD	8	w	8	w	JV	F	V	Lab	2	ORW	SMIX	LI	50.0	100	Y	0.0290	N	0.003742	5.55	11.1	10	10	5	10	6	4	10	10	4	79					
17	20023	Schwartz et al. 1978	PCP - Purified	90.4	Rat (<i>Rattus norvegicus</i>)	2	5	0/1/3/10/30	mg/kg bw/d	N	na	ADL	U	FD	12	mo	NR	NR	JV	F	V	Lab	1	GRS	BDWT	WO	10.0	30.0	Y	0.3780	N	0.03088	9.04	27.1	10	10	5	10	10	4	10	10	4	83					
18	20813	Welsh et al. 1987	PCP - Purified	99	Rat (<i>Rattus norvegicus</i>)	4	0/4/13/43	mg/kg bw/d	N	na	ADL	U	FD	181	d	32	d	GE	F	C	Lab	4	PTH	IIFMR	VA	13.0	42.6	Y	0.3214	Y	0.02320	13.0	42.6	10	10	5	10	10	4	8	10	10	4	81					
19	20197	Kimbrough and Linder. 1978	PCP - Purified	99	Rat (<i>Rattus norvegicus</i>)	2	4	0/0.9/5/28	mg/kg bw/d	N	na	ADL	U	FD	8	mo	NR	NR	JV	B	C	Lab	4	ORW	ORWT	LI	28.0		Y	0.4950	Y	0.08081	27.7		10	10	5	10	10	4	4	1	10	4	77				
20	20333	Courtney et al. 1976	PCP - Analytical	99	Rat (<i>Rattus norvegicus</i>)	1	2	0/75	mg/kg bw/d	N	na	DLY	U	GV	9	d	NR	NR	GF	F	V	Lab	2	ORW	SMIX	LI	75.0		Y	0.3846	N	0.03132	74.3		10	8	10	10	4	4	1	10	4	71					
21	20024	Beard et al. 1999	PCP - Purity not specified	100	Sheep (<i>Ovis aries</i>)	1	2	0/1	mg/kg bw/d	N	na	DLY	U	FD	36	w	1-3	yr	GE	F	V	FieldA	1	HIS	GHIS	TY		1.0	Y	70.0	N	0.00772	1.0	10	10	5	10	10	4	4	1	10	4	77					
22	20686	Kerkvliet et al. 1985	PCP - Technical	86	Mouse (<i>Mus musculus</i>)	1	4	0/100/250/500	mg/kg diet	N	na	ADL	U	FD	8	w	6-7	w	JV	F	V	Lab	2	ORW	ORWT	LI		100	Y	0.0242	N	0.003224	11.5	10	10	5	10	6	4	4	10	10	4	73					
23	19997	Renner et al. 1987	PCP - Purified	99	Rat (<i>Rattus norvegicus</i>)	1	2	0/53.27	mg/kg bw/d	N	na	DLY	U	GV	28	d	3.5	mo	JV	F	V	Lab	2	ORW	SMIX	LI		52.7	Y	0.2710	N	0.02349	52.7	10	8	10	10	1	4	10	10	7	83						
24	19990	Umemura et al. 1999	PCP - Purified	98.6	Mouse (<i>Mus musculus</i>)	2	2	0/600	mg/kg diet	N	na	DLY	U	FD	25	w	23	w	JV	M	C	Lab	3	ORW	ORWT	LI		600	Y	0.0445	N	0.005320	70.7	10	10	5	10	6	4	4	10	10	4	73					
25	19990	Umemura et al. 1999	PCP - Purified	98.6	Mouse (<i>Mus musculus</i>)	1	3	0/600/1200	mg/kg diet	N	na	DLY	U	FD	8	w	6	w	JV	M	C	Lab	2	HIS	GHIS	LI		600	N	0.0316	N	0.004015	75.2	10	10	5	10	5	4	4	10	10	4	72					
26	20129	Kerkvliet et al. 1982	PCP - Analytical	99	Mouse (<i>Mus musculus</i>)	3	2	0/1000	mg/kg diet	N	na	ADL	U	FD	8	w	NR	NR	NR	F	C	Lab	2	ORW	SMIX	LI		1000	Y	0.0380	N	0.004672	122	10	10	5	10	6	4	4	10	10	4	73					
Reproduction																																																	
27	19985	Beard and Rawlings. 1998	PCP - Purity not specified	100	Mink (<i>Mustela vison</i>)	1	2	0/1	mg/kg/d	N	na	NR	U	FD	162	d	NR	NR	GF	F	C	Lab	1	REP	PRWT	WO	1.0		N	0.5960	N	0.04490	0.0753		10	10	5	10	5	10	4	1	10	4	69				
28	20024	Beard et al. 1999	PCP - Purity not specified	100	Sheep (<i>Ovis aries</i>)	1	2	0/1	mg/kg bw/d	N	na	DLY	U	FD	36	w	1-3	yr	GE	F	V	FieldA	3	REP	PRWT	WO	1.0		Y	70.0	N	0.00772	1.0		10	10	5	10	10	4	6	10	4	79					
29	20229	Knudsen et al. 1974	PCP - Not Purified	100	Rat (<i>Rattus norvegicus</i>)	1	4	0/25/50/200	mg/kg diet	N	na	ADL	U	FD	12	w	NR	NR	JV	F	C	Lab	5	RFP	GRFP	OV	50.0	200	Y	0.2010	Y	0.0095	2.36	9.45	10	10	5	10	7	10	8	10	10	4	84				
30	20023	Schwartz et al. 1978	PCP - Purified	90.4	Rat (<i>Rattus norvegicus</i>)	1	3	0/3/30	mg/kg bw/d	N	na	ADL	U	FD	89	d	NR	NR	GF	F	V	Lab	2	REP	PROG	WO	3.00	30.0	Y	0.3340	N	0.02789	2.71	27.1	10	10	5	10	10	8	10	10	4	87					
31	20813	Welsh et al. 1987	PCP - Purified	99	Rat (<i>Rattus norvegicus</i>)	1	4	0/4/13/43	mg/kg bw/d	N	na	ADL	U	FD	201	d	32	d	GE	F	C	Lab	3	REP	RSFM	WO	4.0	13.0	Y	0.4701	Y	0.02410	3.96	12.9	10	10	5	10	10	8	1								
32	20203	Schwartz et al. 1974	PCP - Commercial	88.4	Rat (<i>Rattus norvegicus</i>)	2	5	0/5.8/15/34/750	mg/kg bw/d	N	na	DLY	U	GV	10	d	NR	NR	GF	F	V	Lab	2	REP	RSFM	WO	5.8	15.0	Y	0.3940	N	0.03195	5.13	13.3	10	8	5	10	10	10	10	10	4	87					
33	20454	Faxon and Koller. 1982	PCP - Purified	100	Rat (<i>Rattus norvegicus</i>)	1	4	0/4.8/71.3/411.5	mg/kg diet	N	na	ADL	M	FD	13	w	21	d	GF	F	C	Lab	2	REP	PROG	WO	71.4	411.5	N	0.5230	N	0.0403	5.51	31.7	10	10	10	10	5	10	8	10	10</						

Page 2 of 2

*Duplicate values for NOAELs and LOAELs for the same reference represent results from different experimental designs and are identified by different Phase numbers