Ecological Soil Screening Levels for Copper

Interim Final

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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.

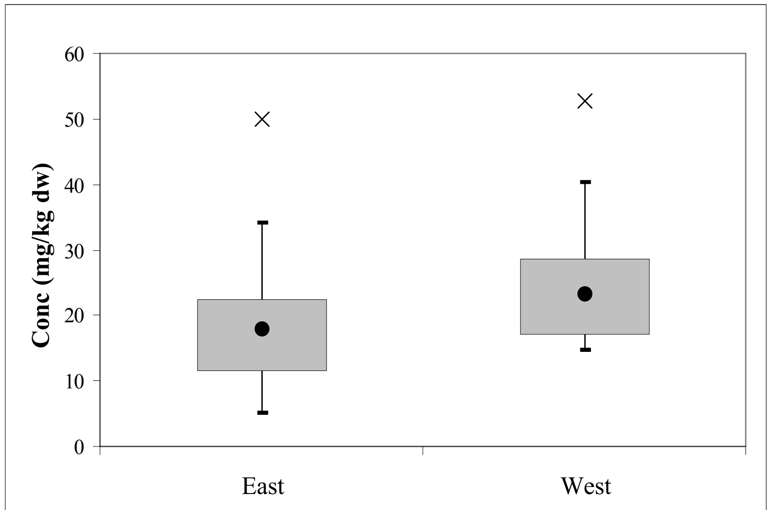
The detailed procedures used to derive Eco-SSL values are described in separate documentation (U.S. EPA, 2003, 2005). The derivation procedures represent the collaborative effort of a multi-stakeholder group consisting of federal, state, consulting, industry, and academic participants led by what is now the U.S. EPA Office of Solid Waste and Emergency Response (OSWER).

This document provides the Eco-SSL values for copper and the documentation for their derivation. This document provides guidance and is designed to communicate national policy on identifying copper 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 COPPER

Copper is a naturally occurring element which can be found in all environmental media: air, soil, sediment, and water. In the metal state, copper is malleable, ductile, and a good conductor of heat and electricity (Alloway, 1990). Copper occurs in numerous minerals including cuprite, tenorite, malachite, azurite, and native copper (George, 1993). Copper forms sulphides, sulphates, sulphosalts, carbonates and other compounds and occurs in reducing environments as the native metal. Copper ranks 26th, behind zinc in abundance in the lithosphere (Alloway, 1990).

The principal uses of copper are in the production of wire, and of its alloys, brass and bronze (Alloway, 1990). Copper compounds may also be released to the environment through their use in dyes, catalysts, feed additives, pesticides, pigments, iron and steel production, coal and oil combustion, copper sulfate production, municipal incineration, and mining activities (Alloway, 1990; U.S. EPA 1987). Copper may also be released from natural sources, such as volcanoes, windblown dusts, the weathering of soil, decaying vegetation, and forest fires (http://toxnet.nlm.nih.gov).



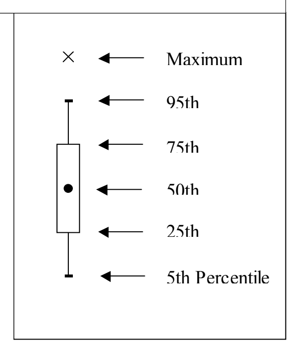


Figure 2.1 Typical Background Concentrations of Copper in U.S. Soils

Background concentrations reported for many metals in U.S. soils are described in Attachment 1-4 of the Eco-SSL guidance (U.S. EPA, 2003). Typical background concentrations of copper in U.S. soils are plotted in Figure 2.1 for both eastern and western U.S. soils.

In soils, copper may be present as soluble compounds including nitrates, sulfates, and chlorides, and insoluble compounds such as oxides, hydroxides, carbonates, and sulfides (Bodek et al. 1988; Budavari 1996). Soluble copper compounds strongly sorb to particles of organic matter, clay, soil, or sand, and demonstrate low mobility in soils (Bodek et al. 1988). Insoluble copper compounds are solid salts and are effectively immobile in soils. Most copper compounds have a high melting point and low vapor pressure, and are not expected to volatilize from moist or dry soil surfaces (Bodek et al. 1988; HSDB). Alloway (1990) describes six “pools” of copper in soils including soluble ions, inorganic and organic complexes in soil solution, exchangeable copper, stable organic complexes in humus, copper adsorbed by hydrous oxides of manganese, iron, and aluminum, copper adsorbed on the clay-humus colloidal complex and the crystal lattice-bound copper in soil minerals.

Copper is an essential element in both plants and animals. In animals, copper is essential for hemoglobin formation, carbohydrate metabolism, catecholamine biosynthesis, and cross-linking of collagen, elastin, and hair keratin (U.S. EPA 1987). Nutritional requirements of copper for common mammalian and avian test organisms are compiled in Attachment 4-3 of the Eco-SSL guidance (U.S. EPA, 2003, 2005). The primary route of exposure for animals to copper is through ingestion. Generally, the normal intake of copper by inhalation is a negligible fraction of the total (Friberg et al., 1986) and absorption through the skin is minimal (Venugopal and

Luckey, 1978). In animal tissues, copper exists as complexes with proteins, peptides, and amino acids in tissues such as the liver, brain, and kidney which retain more copper than do other soft tissues (Seiler et al., 1988). Muscle tissues contain about 35% of the total body copper. In tissues, copper cannot exist in the ionic form in appreciable amounts except in the acidic environment of the stomach (Seiler et al., 1988). Copper is excreted by the biliary system mainly through feces and bile, and to a smaller extent through urine and sweat (Venugopal and Luckey 1978). Absorption, distribution, metabolism, and utilization of copper can be affected by interaction with other metals such as iron, molybdenum, and zinc (U.S. EPA 1987; HSDB).

In plants, copper is especially important in oxidation, photosynthesis, and protein and carbohydrate metabolism. Also, copper concentrations may affect nitrogen fixation, valence changes, and cell wall metabolism (Kabata-Pendias and Pendias, 1992). Since copper is unlikely to be transported across leaf cuticles, the primary route of uptake by plants is through soil as opposed to atmospheric deposition (Hutchinson, 1979). Copper tends to affect various plant species differently, and low growing grasses tend to accumulate copper at higher levels than tree foliage (U.S. EPA, 1987). In plants, copper deficiency is demonstrated by wilting leaves, melanism, white twisted tips, and reduction in panicle formation (HSDB).

In mammals, the mechanism of copper toxicity is complex. Copper can increase cell permeability in erythrocytes leading to lysis and inhibition of intracellular enzymes. Thus, copper poisoning can lead to oxidative stress in erythrocytes and to accelerated loss of intracellular glutathione. In addition, copper ions can cause mitochondrial swelling and inhibit oxygen consumption, which leads to cell degeneration. In copper deficient animals, failure to form collagen in the walls of arterioles leads to subcutaneous bleeding and anemia. Other symptoms of acute copper toxicity in mammals include sporadic fever, tachycardia, hypotension, oliguria, uremia, coma, cardiovascular collapse, and death. Chronic copper poisoning in mammals may induce nausea, vomiting, epigastric pain, dizziness, jaundice, and general debility (Venugopal and Luckey, 1978).

The Eco-SSL values derived to date for copper are summarized in Table 2.1.

Table 2.1 Copper Eco-SSLs (mg/kg dry weight in soil)

Plants	Soil Invertebrates	Wildlife	
		Avian	Mammalian
70	80	28	49

Eco-SSL values were derived for all receptor groups. The Eco-SSL values for copper range from 28 mg/kg dry weight (dw) for avian wildlife to 80 mg/kg dw for soil invertebrates. With the exception of the avian value, these concentrations are higher than the 95^{th} percentile of reported background soil concentrations of copper in eastern and western U.S. soils (Figure 2.1). The Eco-SSL for avian wildlife is equal to the median value for western U.S. soils and is higher than the median value for eastern U.S. soils.

3.0 ECO-SSL FOR TERRESTRIAL PLANTS

Of the papers identified from the literature search process, 479 papers were selected for acquisition for further review. Of those papers acquired, 49 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). Fifty-six study results received an Evaluation Score greater than ten (U.S. EPA, 2003; Attachment 3-1). These studies are listed in Table 3.1.

The studies in Table 3.1 are sorted by bioavailability score. There are 6 studies eligible for Eco-SSL derivation with a bioavailability score of two. These results are used to derive the plant Eco-SSL for copper (U.S. EPA, 2003; Attachment 3-2). The Eco-SSL is the geometric mean of the maximum acceptable toxicant concentration (MATC) and 10% effective concentration (EC_{10}) values for 4 species under different test conditions (pH and % organic matter (OM)) and is equal to 70 mg/kg dw.

4.0 ECO-SSL FOR SOIL INVERTEBRATES

Of the papers identified from the literature search process, 173 papers were selected for acquisition for further review. Of those papers acquired, 44 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). Fifty-five 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. There are ten studies eligible for Eco-SSL derivation with a bioavailability score of 2 that were used to derive the soil invertebrate Eco-SSL for copper (U.S. EPA, 2003; Attachment 3-2). The Eco-SSL is the geometric mean of the MATC and EC_{10} values for at least 6 test species under different test conditions (pH and OM%) and is equal to 80 mg/kg dw.

Table 3.1 Plant Toxicity Data - Copper

Reference	IP Number	Study ID	Test Organism		Soil pH	OM%	Bio-availability Score	ERE	Tox Parameter	Tox Value (Soil Conc at mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
Kjaer and Elmegaard, 1996	4231	c	Black bindweed	*Polygonum convolvulus*	6.4	1.7	2	REP	MATC	251	14	Y	Y
Mozaffari et al, 1996	4176	b	Citrus cultivar	Cleopatra mandarin	6.0	0.98	2	GRO	MATC	141	13	Y	Y
Torres and De Varennes, 1998	13958	--	Perennial ryegrass	*Lolium perenne L.*	4.4 - 5.4	1.0	2	GRO	MATC	16	12	Y	Y
Gonzalez, 1991	4609	d	Alfalfa	*Medicago sativa*	6.3	1.3	2	GRO	EC_{10}	115	13	Y	Y
Gonzalez, 1991	4609	e	Alfalfa	*Medicago sativa*	5.5	2.8	2	GRO	EC_{10}	58	13	Y	Y
Gonzalez, 1991	4609	g	Alfalfa	*Medicago sativa*	5.4	1.1	2	GRO	EC_{10}	32	13	Y	Y
									Geometric Mean	70			
Data Not Used to Derive Plant Eco-SSL													
Rehab and Wallace, 1978	46710	--	Cotton	*Gossypium spp.*	6.6	2.4	1	GRO	MATC	141.4	14	Y	N
Chhibba et al, 1994	12325	a	Wheat	*Triticum aestivum*	7.8	0.2	1	GRO	MATC	28	13	Y	N
Gonzalez, 1991	4609	b	Alfalfa	*Medicago sativa*	7.8	1.8	1	GRO	EC_{10}	1253	12	Y	N
Gonzalez, 1991	4609	c	Alfalfa	*Medicago sativa*	7.5	1.1	1	GRO	EC_{10}	821	12	Y	N
Gonzalez, 1991	4609	f	Alfalfa	*Medicago sativa*	7.3	0.5	1	GRO	EC_{10}	41	12	Y	N
Aquaterra, 2000	22616	a	Alfalfa	*Medicago sativa*	7.8	2.9	0	GRO	EC_{20}	326.4	12	Y	N
Aquaterra, 2000	22616	b	Alfalfa	*Medicago sativa*	8.1	3.5	0	GRO	EC_{20}	674	12	Y	N
Aquaterra, 2000	22616	c	Barley	*Hordeum vulgare* var. Chapais	6.1	9.0	0	GRO	EC_{20}	143	12	Y	N
Aquaterra, 2000	22616	d	Barley	*Hordeum vulgare var. Chapais*	7.8	2.9	0	GRO	EC_{20}	0.74	12	Y	N
Aquaterra, 2000	22616	e	Barley	*Hordeum vulgare var. Chapais*	8.1	3.5	0	GRO	EC_{20}	234.8	12	Y	N
Aquaterra, 2000	22616	f	Carrot	*Daucus carota* var. Royal Chatenay	7.8	2.9	0	GRO	EC_{20}	659.0	12	Y	N
Aquaterra, 2000	22616	g	Corn	*Zea mays* var. Kandy Korn	7.8	2.9	0	GRO	EC_{20}	407.6	12	Y	N
Aquaterra, 2000	22616	h	Corn	*Zea mays* var. Kandy Korn	8.1	3.5	0	GRO	EC_{20}	776.2	12	Y	N
Aquaterra, 2000	22616	i	Cucumber	*Cucumis sativa* var. Marketer	7.8	2.9	0	GRO	EC_{20}	506.0	12	Y	N
Aquaterra, 2000	22616	j	Cucumber	*Cucumis sativa* var. Marketer	8.1	3.5	0	GRO	EC_{20}	804.9	12	Y	N
Aquaterra, 2000	22616	k	Grama grass	*Bouteloua graciiss*	7.8	2.9	0	GRO	EC_{20}	471.3	12	Y	N
Aquaterra, 2000	22616	l	Northern wheatgrass	*Agropyron dasystachyum*	6.1	9.0	0	GRO	EC_{20}	151.7	12	Y	N
Aquaterra, 2000	22616	m	Northern wheatgrass	*Agropyron dasystachyum*	7.8	2.9	0	GRO	EC_{20}	391.3	12	Y	N
Aquaterra, 2000	22616	n	Northern wheatgrass	*Agropyron dasystachyum*	8.1	3.5	0	GRO	EC_{20}	801.6	12	Y	N
Aquaterra, 2000	22616	o	Radish	*Raphanus sativus* var. Champion	7.8	2.9	0	GRO	EC_{20}	347.3	12	Y	N
Aquaterra, 2000	22616	p	Radish	*Raphanus sativus* var. Champion	8.1	3.5	0	GRO	EC_{20}	322.7	12	Y	N
Mitchell et al, 1988	15861	a	Common oat	*Avena sativa*	5.5	2.0	2	GRO	EC_{50}	535	14	N	N
Mitchell et al, 1988	15861	b	Cucumber	*Cucumis sativus*	5.5	2.0	2	GRO	EC_{50}	540	14	N	N
Mitchell et al, 1988	15861	c	Soybean	*Glycine max*	5.5	2.0	2	GRO	EC_{50}	550	14	N	N
Mitchell et al, 1988	15861	d	Heath-leaf banksia	*Banksia ericifolia*	5.5	2.0	2	GRO	EC_{50}	610	14	N	N
Mitchell et al, 1988	15861	e	She-oak	*Casuarina distyla Vent.*	5.5	2.0	2	GRO	EC_{50}	205	14	N	N
Mitchell et al, 1988	15861	f	Yellow bloodwood	*Eucalyptus eximia Shau.*	5.5	2.0	2	GRO	EC_{50}	560	14	N	N
Kjaer and Elmegaard, 1996	4231	a	Black bindweed	*Polygonum convolvulus*	6.4	1.7	2	GRO	EC_{50}	272	14	N	N
Kjaer and Elmegaard, 1996	4231	d	Black bindweed	*Polygonum convolvulus*	6.4	1.7	2	MOR	EC_{50}	219	14	N	N
Tikhomirav et al, 1988	4757	d	Common oat	*Avena sativa*	4.6	2.5	2	GRO	LOAEC	150	14	N	N

Table 3.1 Plant Toxicity Data - Copper

Reference	IP Number	Study ID	Test Organism		Soil pH	OM%	Bio-availability Score	ERE	Tox Parameter	Tox Value (Soil Conc at mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
Mitchell et al, 1988	15861	g	Common oat	*Avena sativa*	5.5	2.0	2	GRO	LC_{50}	1765	13	N	N
Mitchell et al, 1988	15861	h	Cucumber	*Cucumis sativus*	5.5	2.0	2	GRO	LC_{50}	1725	13	N	N
Mitchell et al, 1988	15861	I	Soybean	*Glycine max*	5.5	2.0	2	GRO	LC_{50}	1140	13	N	N
Mitchell et al, 1988	15861	j	Heath-leaf banksia	*Banksia ericifolia*	5.5	2.0	2	GRO	LC_{50}	1520	13	N	N
Mitchell et al, 1988	15861	k	She-oak	*Casuarina distyla Vent.*	5.5	2.0	2	GRO	LC_{50}	580	13	N	N
Mitchell et al, 1988	15861	l	Yellow bloodwood	*Eucalyptus eximia Schau.*	5.5	2.0	2	GRO	LC_{50}	1845	13	N	N
Mozaffari et al, 1996	4176	a	Citrus cultivar	Cleopatra mandarin	5.0	0.98	2	GRO	NOAEC	200	13	N	N
Spencer, 1966	15004	--	citrus cultivar	Cleopatra mandarin	5.4	1.0	2	GRO	LOAEC	5	11	N	N
De Haan, 1985	5048	a	Common oat	*Avena sativa*	5.6	1.6	2	REP	MATC	283	11	N	N
Pedersen et al, 2000a	56463	a	Black bindweed	*Fallopia, convolvulus*	6.0-6.7	4.5	1	GRO	EC_{50}	284	16	N	N
Pedersen et al, 2000a	56463	b	Black bindweed	*Fallopia, convolvulus*	6.0-6.7	4.5	1	GRO	EC_{50}	258	16	N	N
Pedersen et al, 2000a	56463	c	Black bindweed	*Fallopia, convolvulus*	6.0-6.7	4.5	1	GRO	EC_{50}	259	16	N	N
Pedersen et al, 2000a	56463	d	Black bindweed	*Fallopia, convolvulus*	6.0-6.7	4.5	1	GRO	EC_{50}	329	16	N	N
Pedersen et al, 2000a	56463	e	Black bindweed	*Fallopia, convolvulus*	6.0-6.7	4.5	1	GRO	EC_{50}	260	16	N	N
Pedersen et al, 2000a	56463	f	Black bindweed	*Fallopia, convolvulus*	6.0-6.7	4.5	1	GRO	EC_{50}	291	16	N	N
Genovese, 1978	58147	a	Jack pine	*Pinus banksiana* Lamb.	0.04	7.7	1	GRO	NOAEC	400	11	N	N
Genovese, 1978	58147	b	Black spruce	*Pinus mariana* (Mill) B.S.P.	0.04	7.7	1	GRO	NOAEC	400	11	N	N
Tikhomirav et al, 1988	4757	c	Common oat	*Avena sativa*	5.9	2.9	1	GRO	LOAEC	400	13	N	N
Mozaffari et al, 1996	4176	c	Citrus cultivar	*Cleopatra mandarin*	7.0	0.98	1	GRO	LOAEC	200	12	N	N
Gonzalez, 1991	4609	a	Alfalfa	*Medicago sativa*	7.1	0.3	1	GRO	NOAEC	1600	12	N	N

EC_{10} = Effect concentration for 10% of test population
EC_{20} = Effect concentration for 10% of test population
EC_{50} = Effect concentration for 50% of test population
ERE = Ecologically relevant endpoint
GRO = Growth
LOAEC = Lowest observed adverse effect concentration
MATC = Maximum acceptable toxicant concentration. Geometric mean of NOAEC and LOAEC.
N = No

NOAEC = No observed adverse effect concentration
ns = Not specified
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)

Table 4.1 Invertebrate Toxicity Data - Copper

Reference	IP Number	Study ID	Test Organism		Soil pH	OM%	Bio-availability Score	ERE	Tox Parameter	Tox Value (Soil Conc at mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
Scott-Fordsmand et al., 1997	2288	--	Springtail	*Folsomia fimetario*	5.5	4.0	2	REP	EC_{10}	38	16	Y	Y
Svendsen and Weeks, 1997a	11490	--	Earthworm	*Eisenia andrei*	5.6	<1.0	2	REP	MATC	133	15	Y	Y
Ma, 1984	11146	a	Earthworm	*Lumbricus rubellus*	4.8	5.7	2	REP	MATC	84	14	Y	Y
Korthals et al., 1996a	7848	a	Nematode	Not available	4.0	3.7	2	POP	MATC	116	14	Y	Y
Korthals et al., 1998	13828	--	Nematode	Not available	4.25	3.3	2	POP	MATC	141	13	Y	Y
Korthals et al., 1996b	4402	a	Nematode	Not available	4.1	3.2	2	REP	MATC	141	13	Y	Y
Svendsen and Weeks, 1997b	4449	--	Earthworm	*Lumbricus rubellus*	5.6	<1.0	2	GRO	MATC	188	13	Y	Y
Ma, 1988	7854	a	Earthworm	*Aporrectodea caliginosa*	5	5.0	2	REP	EC_{10}	27	13	Y	Y
Ma, 1988	7854	b	Earthworm	*Allolobophora chlorotica*	5	5.0	2	REP	EC_{10}	28	13	Y	Y
Ma, 1988	7854	c	Earthworm	*Lumbricus rubellus*	5	5.0	2	REP	EC_{10}	80	13	Y	Y
									Geometric Mean	80			
Data not Used to Derive Soil Invertebrate Eco-SSL													
Kula and Larink, 1997	11046	d	Earthworm	*Eisenia fetida*	5.8	4.0	1	REP	MATC	18	11	Y	N
Kula and Larink, 1997	11046	b	Earthworm	*Eisenia andrei*	5.8	4.0	1	REP	MATC	6	11	Y	N
Sandifer and Hopkin, 1996	4056	a	Springtail	*Folsomia candida*	5.8	10.0	1	REP	MATC	447	16	Y	N
Sandifer and Hopkin, 1996	4056	b	Springtail	*Folsomia candida*	5.1	10.0	1	REP	MATC	447	16	Y	N
Sandifer and Hopkin, 1996	4056	c	Springtail	*Folsomia candida*	4.5	10.0	1	REP	MATC	1732	16	Y	N
Bogomolov et al., 1996	4940	a	Earthworm	*A. tuberclata*	6.3	5.0	1	REP	MATC	141	16	Y	N
Bogomolov et al., 1996	4940	b	Nematode	Not available	6.3	5.0	1	POP	MATC	566	16	Y	N
Van Gestel et al., 1991	6826	b	Earthworm	*Eisenia andrei*	6.2	10.0	1	GRO	MATC	75	16	Y	N
Ma, 1984	11146	b	Earthworm	*Lumbricus rubellus*	7.1	5.7	1	REP	MATC	203	14	Y	N
Pedersen et al., 2000b	55995	a	Springtail	*Folsomia candida*	6.7	4.5	1	REP	EC_{10}	50	14	Y	N
Pedersen et al., 2000b	55995	b	Springtail	*F. fimetaria*	6.7	4.5	1	REP	EC_{10}	141	14	Y	N
Phillips et al., 1996	11508	a	Earthworm	*Eisenia fetida*	4.7	1.4	1	GRO	MATC	200	13	Y	N
Sandifer and Hopkin, 1997	758	--	Springtail	*Folsomia candida*	6.0	10.0	1	REP	MATC	447	13	Y	N
Kula and Larink, 1997	11046	a	Earthworm	*Eisenia fetida*	6.0	10.0	1	REP	MATC	18	11	Y	N
Van Gestel et al., 1989	4111	--	Earthworm	*Eisenia andrei*	6	10	1	REP	MATC	85	13	Y	N
Kula and Larink, 1997	11046	c	Earthworm	*Eisenia andrei*	6.0	10.0	1	REP	MATC	179	11	Y	N
Scott-Fordsman et al., 2000	22634	a	Springtail	*Folsomia fimetaria L.*	6.7-7.1	3.9-5.5	1	REP	MATC	500	15	Y	N
Aquaterra, 2000	22616	e	Springtail	*Onychiurus folsomi*	6.1	9.0	0	REP	EC_{20}	425	17	Y	N
Haque and Ebing, 1983	10944	--	Earthworm	*Lumbricus terrestris*	6.1	1.7	2	MOR	LC_{50}	98	13	N	N
Donkin and Dusenbery, 1993	7838	a	Nematode	*Caenorhabditis elegans*	5.2	1.7	2	MOR	LC_{50}	534	14	N	N
Donkin and Dusenbery, 1993	7838	b	Nematode	*Caenorhabditis elegans*	5.1	3.0	2	MOR	LC_{50}	413	13	N	N
Peredney and Williams, 2000b	56449	g	Nematode	*Caenorhabditis elegans*	4	1.14	2	MOR	LC_{50}	20	13	N	N
Peredney and Williams, 2000b	56449	h	Nematode	*Caenorhabditis elegans*	4	1.14	2	MOR	LC_{50}	25	13	N	N
Peredney and Williams, 2000b	56449	i	Nematode	*Caenorhabditis elegans*	4	4.2	2	MOR	LC_{50}	186	13	N	N
Peredney and Williams, 2000b	56449	j	Nematode	*Caenorhabditis elegans*	4	4.2	2	MOR	LC_{50}	252	13	N	N
Phillips et al., 1996	11508	b	Earthworm	*Eisenia fetida*	3.8	5.9	2	MOR	LOAEC	100	12	N	N
Korthals et al., 1996a	7848	b	Nematode	Not available	6.1	3.7	1	POP	NOAEC	168	13	N	N
Kammenga et al., 1996	5515	--	Nematode	*Plectus acuminatus*	5.5	10.0	1	REP	LOAEC	10	13	N	N
Posthuma et al., 1997	2380	a	Earthworm	*Enchytraeus crypticus*	5.5	10.0	1	REP	LC_{50}	477	16	N	N
Posthuma et al., 1997	2380	b	Earthworm	*Enchytraeus crypticus*	6.0	10.0	1	REP	LC_{50}	873	16	N	N
Spurgeon et al., 1994	4364	--	Earthworm	*Eisenia fetida*	6.3	10	1	REP	LC_{50}	53	15	N	N

Table 4.1 Invertebrate Toxicity Data - Copper

Reference	IP Number	Study ID	Test Organism		Soil pH	OM%	Bio-availability Score	ERE	Tox Parameter	Tox Value (Soil Conc at mg/kg dw)	Total Evaluation Score	Eligible for Eco-SSL Derivation?	Used for Eco-SSL?
Spurgeon and Hopkin, 1995	6822	a	Earthworm	*Eisenia fetida*	6.1	10.0	1	REP	NOAEC	29	15	N	N
Donkin and Dusenbery, 1993	7838	c	Nematode	*Caenorhabditis elegans*	6.1	3.4	1	MOR	LC_{50}	1061	12	N	N
Donkin and Dusenbery, 1993	7838	d	Nematode	*Caenorhabditis elegans*	6.2	2.2	1	MOR	LC_{50}	629	12	N	N
Data not Used to Derive Soil Invertebrate Eco-SSL													
Neuhauser et al., 1986	17707	--	Earthworm	*Eisenia fetida*	6.0	10.0	1	MOR	LC_{50}	643	14	N	N
Peredney and Williams, 2000a	53082	--	Nematode	*Caenorhabditis elegans*	4	10	1	MOR	LC_{50}	1272	12	N	N
Peredney and Williams, 2000b	56449	k	Nematode	*Caenorhabditis elegans*	4	10	1	MOR	LC_{50}	431	12	N	N
Peredney and Williams, 2000b	56449	l	Nematode	*Caenorhabditis elegans*	4	10	1	MOR	LC_{50}	463	12	N	N
Neuhauser et al., 1985	6812	--	Earthworm	*Eisenia fetida*	6.0	10.0	1	MOR	LC_{50}	643	11	N	N
Aquaterra, 2000	22616	aa	Earthworm	*Eisenia fetida*	6.1	9.0	0	MOR	LC_{50}	632	15	N	N
Aquaterra, 2000	22616	ab	Earthworm	*Lumbricus terrestris*	6.1	9.0	0	MOR	LC_{50}	456	15	N	N
Aquaterra, 2000	22616	ca	Earthworm	*Eisenia fetida*	7.8	2.9	0	MOR	LC_{50}	721	14	N	N
Aquaterra, 2000	22616	cb	Earthworm	*Lumbricus terrestris*	7.8	2.9	0	MOR	LC_{50}	313	14	N	N
Aquaterra, 2000	22616	da	Earthworm	*Eisenia fetida*	8.1	3.5	0	MOR	LC_{50}	596	14	N	N
Aquaterra, 2000	22616	db	Earthworm	*Lumbricus terrestris*	8.1	3.5	0	MOR	LC_{50}	486	14	N	N
Data not Used to Derive Soil Invertebrate Eco-SSL													

EC_{10} = Effect concentration for 10% of test population
EC_{20} = Effect concentration for 50% of test population
ERE = Ecologically relevant endpoint
GRO = Growth
LC_{50} = 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
POP = Population
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 3,365 papers with possible toxicity data for either avian or mammalian species. Of these studies, 3,175 were rejected for use as described in Section 7.5. Of the remaining studies, 107 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 393 results for biochemical (BIO), behavior (BEH), physiology (PHY), pathology (PTH), reproduction (REP), 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 was calculated at 18.5 mg copper/kg bw/day. This value, however, is higher than the lowest bounded LOAEL for reproduction, growth, or survival. Therefore, the TRV is equal to the highest bounded NOAEL lower than the lowest bounded LOAEL for reproduction, growth or survival and is equal to 4.05 mg copper/kg bw/day.

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	Rangachar and Jayprakash, 1979	6530	Chicken (*Gallus domesticus*)	2	U	FD	105	d	10	w	JV	M	CHM	HMGL	BL	5.31		69
2	Chiou et al, 1999	2048	Chicken (*Gallus domesticus*)	4	U	FD	3	w	3	w	JV	NR	ENZ	CRKI	BL	5.32	13.3	77
3	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	2	M	DR	14	d	4	d	JV	NR	CHM	GLUC	BL	10.1		71
4	Pearce et al, 1983	2294	Chicken (*Gallus domesticus*)	4	U	FD	5	d	27	w	JV	F	CHM	LIPD	BL	12.3	24.7	75
5	Jackson et al, 1979	2160	Chicken (*Gallus domesticus*)	5	U	FD	224	d	17	w	SM	F	CHM	LIPD	LI	12.5	23.2	77
6	Pearce et al, 1983	2294	Chicken (*Gallus domesticus*)	5	U	FD	6	d	26	w	SM	F	CHM	LIPD	LI	13.9	27.8	76
7	Poupoulis and Jensen, 1976	36263	Chicken (*Gallus domesticus*)	5	U	FD	4	w	1	d	JV	M	CHM	FFTA	LD	14.3	28.7	69
8	Ward et al, 1995	6788	Turkey (*Melagris gallopavo*)	2	M	FD	10	d	5	d	JV	M	CHM	HMGL	BL	18.3		67
9	Stevenson and Jackson, 1980	2293	Chicken (*Gallus domesticus*)	4	U	FD	8	w	24	w	SM	F	CHM	LIPD	LI	22.6	45.2	76
10	Chiou et al, 1998	2049	Chicken (*Gallus domesticus*)	4	U	FD	1	w	38	w	SM	F	ENZ	LADH	SR	25.5	30.6	75
11	Chiou et al, 1997	2050	Chicken (*Gallus domesticus*)	5	M	FD	4	w	28	w	SM	F	ENZ	ASAT	SR	27.5	40.6	82
12	Jackson and Stevenson, 1981	2158	Chicken (*Gallus domesticus*)	6	U	FD	280	d	18	w	SM	F	CHM	LIPD	LI	30.0	37.5	76
13	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	CHM	LIPD	LI	35.3	44.1	77
14	Ledoux et al, 1987	2194	Chicken (*Gallus domesticus*)	3	UX	FD	21	d	1	d	JV	F	ENZ	GOTR	SR	36.3		73
15	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	CHM	LIPD	LI	40.0	50.0	77
16	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	5	M	DR	14	d	4	d	JV	NR	CHM	URIC	BL	51.6	258	75
17	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	2	M	FD	35	d	3	d	JV	NR	CHM	HEMT	BL	75.5		69
18	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	4	M	FD	35	d	3	d	JV	NR	CHM	GLUC	SR	297		76
19	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	M	CHM	CHOL	BT		2.21	69
20	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	3	U	FD	42	d	1	d	JV	M	CHM	CHOL	BT		2.80	69
21	Jackson et al, 1979	2160	Chicken (*Gallus domesticus*)	5	U	FD	336	d	17	w	SM	F	CHM	LIPD	LI		5.11	71
22	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	3	U	FD	42	d	1	d	JV	M	CHM	CHOL	BT		5.57	69
23	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	4	U	FD	21	d	1	d	JV	M	CHM	CHOL	PL		5.83	69
24	Gill et al, 1995	2107	Chicken (*Gallus domesticus*)	4	U	FD	2	w	4	w	JV	M	ENZ	SGOT	SR		7.99	71
25	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	2	U	FD	42	d	1	d	JV	M	CHM	CHOL	BT		8.19	69
26	Skrivan et al, 2000	25969	Chicken (*Gallus domesticus*)	2	M	FD	38	d	1	d	JV	M	CHM	CHOL	AD		9.72	75
27	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	2	U	FD	42	d	21	d	JV	M	CHM	CHOL	BT		11.5	69
28	Nam et al, 1984	2226	Chicken (*Gallus domesticus*)	3	U	FD	4	w	3	d	JV	NR	CHM	GBCM	NR		13.4	70
29	Poupoulis and Jensen 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	CHM	PHPH	GZ		14.3	69
30	Bakalli et al, 1995	3717	Chicken (*Gallus domesticus*)	2	U	FD	20	d	1	d	JV	M	CHM	CHOL	PL		17.8	69
31	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	SM	F	ENZ	AATT	SR		23.9	76
32	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	SM	F	ENZ	AATT	SR		30.4	76
33	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	SM	F	ENZ	AATT	SR		35.2	76
34	Ekperigin and Vohra, 1981	2084	Chicken (*Gallus domesticus*)	3	U	FD	4	w	12	d	JV	NR	CHM	GLCN	LI		35.5	69
35	Van Vleet et al, 1981	80	Duck (*Anas platyrhynchos*)	2	U	FD	15	d	1	d	JV	M	ENZ	GLPX	BL		201	69
			Behavior (BEH)															
36	Hoda and Maha, 1995	2007	Chicken (*Gallus domesticus*)	3	U	FD	6	w	1	d	JV	NR	FDB	FCNS	WO	1.92		67
37	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	FDB	FCNS	WO	10.4	20.8	80
38	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	2	M	DR	14	d	4	d	JV	NR	FDB	WCON	WO	12.6		67
39	Chiou et al, 1999	2048	Chicken (*Gallus domesticus*)	4	U	FD	3	w	3	w	JV	NR	FDB	FCNS	WO	13.3	26.6	80
40	Jenkins et al, 1970	2162	Chicken (*Gallus domesticus*)	2	M	FD	6	w	1	d	JV	B	FDB	FCNS	WO	13.4		69
41	Harms and Buresh, 1986	2117	Chicken (*Gallus domesticus*)	3	U	FD	6	w	64	w	SM	F	FDB	FCNS	WO	13.9	19.5	72
42	Ledoux et al, 1989	5812	Chicken (*Gallus domesticus*)	4	U	FD	3	w	1	d	JV	M	FDB	FCNS	WO	15.2	22.8	74
43	Funk and Baker, 1991	2099	Chicken (*Gallus domesticus*)	3	U	FD	14	d	8	d	JV	M	FDB	FCNS	WO	15.7	25.8	80
44	Miles et al, 1998	2221	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	B	FDB	FCNS	WO	16.5	24.7	80
45	Pearce et al, 1983	2294	Chicken (*Gallus domesticus*)	5	U	FD	48	d	26	w	SM	F	FDB	FCNS	WO	16.6	33.1	79
46	Stevenson and Jackson, 1980	2292	Chicken (*Gallus domesticus*)	5	U	FD	6	d	24	w	SM	F	FDB	FCNS	WO	16.7	33.4	79
47	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	FDB	FCNS	WO	17.0	25.5	80
48	Miles et al, 1998	2221	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	B	FDB	FCNS	WO	17.2	25.8	80
49	Jensen and Maurice, 1978	2165	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	FDB	FEFF	WO	17.8	35.5	79
50	Jackson and Stevenson, 1981	2158	Chicken (*Gallus domesticus*)	6	U	FD	280	d	18	w	SM	F	FDB	FCNS	WO	17.9	26.9	80
51	Stevenson et al, 1983	6170	Chicken (*Gallus domesticus*)	4	U	FD	5	d	27	w	SM	F	FDB	FCNS	WO	18.0	28.0	76
52	Ward et al, 1995	6788	Turkey (*Melagris gallopavo*)	2	M	FD	10	d	5	d	JV	M	FDB	WCON	WO	18.3		70
53	Funk and Baker, 1991	2099	Chicken (*Gallus domesticus*)	5	U	FD	14	d	8	d	JV	M	FDB	FCNS	WO	19.6	30.5	80
54	Jackson and Stevenson, 1981	2158	Chicken (*Gallus domesticus*)	6	U	FD	280	d	18	w	SM	F	FDB	FCNS	WO	20.1	26.8	80
55	Pimentel et al, 1992	5617	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	B	FDB	FCNS	WO	20.9		66
56	Miles et al, 1998	2221	Chicken (*Gallus domesticus*)	4	M	FD	21	d	1	d	JV	B	FDB	FCNS	WO	21.9	34.0	85
57	Kassim and Suwanpradit, 1996	2172	Chicken (*Gallus domesticus*)	4	U	FD	3	w	1	d	JV	M	FDB	FCNS	WO	22.7	34.1	79
58	Jackson et al, 1979	2160	Chicken (*Gallus domesticus*)	5	U	FD	224	d	17	w	SM	F	FDB	FCNS	WO	23.2	29.9	80
59	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	SM	F	FDB	FCNS	WO	23.9		70
60	Ledoux et al, 1987	2194	Chicken (*Gallus domesticus*)	3	UX	FD	21	d	1	d	JV	F	FDB	FCNS	WO	25.7	51.5	84

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
61	Chiou et al, 1997	2050	Chicken (*Gallus domesticus*)	5	M	FD	4	w	28	w	SM	F	FDB	FCNS	WO	27.5	40.6	85
62	Jackson, 1977	2157	Chicken (*Gallus domesticus*)	6	U	FD	35	d	NR	NR	SM	F	FDB	FCNS	WO	29.1	47.5	80
63	Miles et al, 1998	2221	Chicken (*Gallus domesticus*)	4	M	FD	21	d	1	d	JV	B	FDB	FCNS	WO	29.5		79
64	Hill, 1990	5734	Chicken (*Gallus domesticus*)	4	U	FD	19	d	1	d	JV	F	FDB	FCNS	WO	30.4		72
65	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	SM	F	FDB	FCNS	WO	30.4		70
66	Chiou et al, 1998	2049	Chicken (*Gallus domesticus*)	4	U	FD	4	w	38	w	SM	F	FDB	FCNS	WO	33.4	40.1	80
67	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	SM	F	FDB	FCNS	WO	35.2		70
68	Funk and Baker, 1991	2099	Chicken (*Gallus domesticus*)	5	U	FD	14	d	8	d	JV	M	FDB	FCNS	WO	35.2	63.9	80
69	Funk and Baker, 1991	2099	Chicken (*Gallus domesticus*)	3	U	FD	14	d	8	d	JV	M	FDB	FCNS	WO	36.3		74
70	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	5	M	DR	14	d	4	d	JV	NR	FDB	WCON	WO	51.6	258	78
71	Stevenson et al, 1983	6170	Chicken (*Gallus domesticus*)		U	GV	5	d	27	w	SM	F	FDB	FCNS	WO	65.4		68
72	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	2	M	FD	35	d	3	d	JV	NR	FDB	FCNS	WO	75.5		72
73	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	2	M	FD	35	d	3	d	JV	NR	FDB	FCNS	WO	143		67
74	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	4	M	FD	35	d	3	d	JV	NR	FDB	FCNS	WO	246		72
75	Ko et al, 1985	2181	Chicken (*Gallus domesticus*)	4	U	FD	3	w	3	d	JV	M	FDB	FCNS	WO		2.69	74
76	Gill et al, 1995	2107	Chicken (*Gallus domesticus*)	4	U	FD	4	w	4	w	JV	M	FDB	FCNS	WO		7.99	74
77	Griminger,1977	2112	Chicken (*Gallus domesticus*)	5	U	FD	2	w	7	mo	SM	F	FDB	FCNS	WO		22.4	73
78	Stevenson and Jackson, 1980	2293	Chicken (*Gallus domesticus*)	4	U	FD	8	w	24	w	SM	F	FDB	FCNS	WO		22.6	73
79	Yannakopoulos et al., 1990	2333	Japanese quail (*Coturnix japonica*)	4	U	FD	34	d	7	d	JV	B	FDB	FCNS	WO		27.5	74
80	Harms and Buresh, 1986	2118	Turkey (*Melagris gallopavo*)	3	U	FD	21	d	1	d	JV	B	FDB	FCNS	WO		30.8	74
81	Christmas and Harms, 1979	2052	Turkey (*Melagris gallopavo*)	3	U	FD	21	d	1	d	JV	B	FDB	FCNS	WO		31.4	74
82	Jensen and Maurice, 1978	2165	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	FDB	FEFF	WO		34.9	73
83	Jensen, 1975	1403	Chicken (*Gallus domesticus*)	2	U	FD	14	d	1	d	JV	M	FDB	FCNS	WO		92.9	74
									Physiology (PHY)									
84	Rangachar and Hegde, 1975	2259	Chicken (*Gallus domesticus*)	3	U	FD	120	d	1	d	JV	F	PHY	PROT	PL	3.93		72
85	Ankari et al, 1998	2006	Chicken (*Gallus domesticus*)	4	U	FD	84	d	25	w	SM	F	PHY	FDCV	WO	4.05	12.1	74
86	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	M	PHY	FDCV	WO	4.43		72
87	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	3	U	FD	42	d	1	d	JV	M	PHY	FDCV	WO	5.56		72
88	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	M	PHY	FDCV	WO	5.83	11.7	78
89	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	2	U	FD	42	d	1	d	JV	M	PHY	FDCV	WO	8.19		72
90	Skrivan et al, 2000	25969	Chicken (*Gallus domesticus*)	2	M	FD	39	d	1	d	JV	B	PHY	FDCV	WO	9.72		69
91	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	5	U	FD	35	d	1	d	JV	M	PHY	FDCV	WO	11.9		72
92	Jackson et al, 1979	2160	Chicken (*Gallus domesticus*)	5	U	FD	224	d	17	w	SM	F	PHY	FDCV	WO	12.5	23.2	80
93	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	PHY	FDCV	WO	14.3	28.7	78
94	Miles et al, 1998	2221	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	B	PHY	FDCV	WO	16.5	24.7	80
95	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	PHY	FDCV	WO	17.0	25.5	80
96	Miles et al, 1998	2221	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	B	PHY	FDCV	WO	17.2	25.8	80
97	Jackson and Stevenson, 1981	2158	Chicken (*Gallus domesticus*)	6	U	FD	280	d	18	w	SM	F	PHY	FDCV	WO	17.9	26.9	80
98	Ward et al, 1995	6788	Turkey (*Meleagris gallopavo*)	2	M	FD	10	d	5	d	JV	M	PHY	FDCV	WO	18.3		70
99	Jensen and Maurice, 1979	2166	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	NR	PHY	FDCV	WO	18.5	37.1	79
100	Robbins and Baker, 1980	2267	Chicken (*Gallus domesticus*)	3	U	FD	14	d	8	d	JV	NR	PHY	FDCV	WO	21.3	42.7	79
101	Ekperigin and Vohra, 1981	6474	Chicken (*Gallus domesticus*)	2	U	FD	8	d	7	d	JV	NR	PHY	FDCV	WO	21.5		72
102	Jackson and Stevenson, 1981	2158	Chicken (*Gallus domesticus*)	6	U	FD	280	d	18	w	SM	F	PHY	FDCV	WO	25.3	31.6	80
103	Robbins and Baker, 1980	2266	Chicken (*Gallus domesticus*)	3	U	FD	8	d	8	d	JV	M	PHY	FDCV	WO	26.4	52.8	79
104	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	w	26	w	SM	F	PHY	FDCV	WO	27.2	36.2	80
105	Chiou et al, 1999	2048	Chicken (*Gallus domesticus*)	4	U	FD	3	w	3	w	JV	NR	PHY	FDCV	WO	28.4		74
106	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	5	U	FD	4	w	1	d	JV	NR	PHY	FDCV	WO	28.7	57.4	78
107	Poupoulis and Jensen,1976	2250	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	NR	PHY	FDCV	WO	28.7	57.4	78
108	Wang et al, 1987	2319	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	M	PHY	FDCV	WO	35.5		72
109	Wang et al, 1987	2319	Chicken (*Gallus domesticus*)	4	U	FD	3	w	1	d	JV	M	PHY	FDCV	WO	35.5		72
110	Ledoux et al, 1987	2194	Chicken (*Gallus domesticus*)	3	UX	FD	21	d	1	d	JV	F	PHY	FDCV	WO	45.4		78
111	Funk and Baker, 1991	2099	Chicken (*Gallus domesticus*)	5	U	FD	14	d	8	d	JV	M	PHY	FDCV	WO	46.7	53.6	80
112	Yannakopoulos et al, 1990	2333	Japanese quail (*Coturnix japonica*)	4	U	FD	34	d	7	d	JV	B	PHY	FDCV	WO	82.0		74
113	Mehring and Brumbaugh, 1960	22	Chicken (*Gallus domesticus*)	5	M	FD	10	w	1	d	JV	B	PHY	FDCV	WO	84.3		69
114	Ko et al, 1985	2181	Chicken (*Gallus domesticus*)	4	U	FD	3	w	3	d	JV	M	PHY	FDCV	WO		2.69	74
115	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	2	U	FD	42	d	1	d	JV	M	PHY	FDCV	WO		2.70	72
116	Kashani et al, 1986	2171	Turkey (*Meleagris gallopavo*)	2	U	FD	8	w	1	d	JV	M	PHY	FDCV	WO		4.88	73
117	Pesti and Bakalli 1996	2244	Chicken (*Gallus domesticus*)	2	U	FD	42	d	1	d	JV	M	PHY	FDCV	WO		5.43	72
118	Jensen and Maurice 1978	2164	Chicken (*Gallus domesticus*)	3	U	FD	3	w	1	d	JV	NR	PHY	GPHY	WO		9.43	67
119	Pesti and Bakalli 1996	2244	Chicken (*Gallus domesticus*)	2	U	FD	42	d	21	d	JV	M	PHY	FDCV	WO		11.5	72
120	Nam et al 1984	2226	Chicken (*Gallus domesticus*)	3	U	FD	4	w	3	d	JV	NR	PHY	FDCV	WO		13.4	73
121	Bakalli et al, 1995	3717	Chicken (*Gallus domesticus*)	2	U	FD	41	d	1	d	JV	M	PHY	FDCV	WO		14.3	72

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

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
122	Jensen and Maurice, 1978	2164	Chicken (*Gallus domesticus*)	2	U	FD	4	w	1	d	JV	NR	PHY	IRRI	FE		16.6	67
123	Jensen and Maurice, 1978	2164	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	NR	PHY	GPHY	DT		18.2	73
124	Jensen and Maurice, 1978	2164	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	NR	PHY	GPHY	DT		18.3	73
125	Jensen and Maurice, 1978	2164	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	NR	PHY	GPHY	DT		18.4	73
126	Jensen and Maurice, 1978	2164	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	NR	PHY	GPHY	DT		18.6	73
127	Griminger, 1977	2112	Chicken (*Gallus domesticus*)	5	U	FD	2	w	7	mo	SM	F	PHY	IRRI	FE		22.4	73
128	Robbins and Baker, 1980	2266	Chicken (*Gallus domesticus*)	3	U	FD	8	d	8	d	JV	M	PHY	FDCV	WO		26.4	73
129	Jensen and Maurice, 1979	2166	Chicken (*Gallus domesticus*)	2	U	FD	4	w	1	d	JV	NR	PHY	FDCV	WO		36.6	73
130	Robbins and Baker, 1980	2267	Chicken (*Gallus domesticus*)	2	U	FD	12	d	8	d	JV	NR	PHY	FDCV	WO		50.1	73
131	Robbins and Baker, 1980	2266	Chicken (*Gallus domesticus*)	2	U	FD	8	d	8	d	JV	M	PHY	FDCV	WO		55.2	73
132	Robbins and Baker, 1980	2267	Chicken (*Gallus domesticus*)	2	U	FD	8	d	8	d	JV	NR	PHY	FDCV	WO		57.2	73
133	Robbins and Baker, 1980	2267	Chicken (*Gallus domesticus*)	2	U	FD	12	d	8	d	JV	NR	PHY	FDCV	WO		59.0	73
			Pathology (PTH)															
134	Guenthner et al, 1978	2114	Turkey (*Melagris gallopavo*)	2	U	FD	24	w	1	d	JV	M	HIS	GHIS	HE	2.97		73
135	Hoda and Maha, 1995	2007	Chicken (*Gallus domesticus*)	3	U	FD	6	w	1	d	JV	M	ORW	SMIX	AT	3.61	7.21	80
136	Chiou et al, 1999	2048	Chicken (*Gallus domesticus*)	4	U	FD	3	w	3	w	JV	NR	HIS	GHIS	DT	5.73	14.3	80
137	Hoda and Maha, 1995	2007	Chicken (*Gallus domesticus*)	3	U	FD	6	w	1	d	JV	NR	ORW	SMIX	LI	6.28		67
138	Jensen et al, 1991	2163	Chicken (*Gallus domesticus*)	4	U	FD	3	w	1	d	JV	M	HIS	GLSN	MH	8.40	16.8	79
139	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	HIS	GHIS	GZ	12.3	24.7	78
140	Pearce et al, 1983	2294	Chicken (*Gallus domesticus*)	4	U	FD	5	d	27	w	JV	F	ORW	SMIX	LI	12.3	24.7	78
141	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	5	U	FD	4	w	1	d	JV	NR	HIS	GHIS	GZ	14.3	28.7	78
142	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	NR	HIS	GHIS	GZ	14.3	28.7	78
143	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	5	U	FD	4	w	1	d	JV	NR	HIS	GHIS	GZ	14.3	28.7	78
144	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	HIS	GHIS	GZ	14.3	28.7	78
145	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	HIS	GHIS	GZ	14.3	28.7	78
146	Wideman et al, 1996	2325	Chicken (*Gallus domesticus*)	5	M	FD	2	w	1	d	JV	M	HIS	GHIS	PR	15.7	21.2	78
147	Pearce et al, 1983	2294	Chicken (*Gallus domesticus*)	5	U	FD	12	d	26	w	SM	F	ORW	SMIX	LI	15.8	31.6	79
148	Jensen and Maurice, 1978	2165	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	HIS	USTR	GZ	17.8	35.5	79
149	Stevenson et al, 1983	6170	Chicken (*Gallus domesticus*)	4	U	FD	5	d	27	w	SM	F	ORW	SMIX	LI	18.0	28.0	76
150	Wood and Worden, 1973	36216	Duck (*Anas platyrhynchos*)	2	U	FD	16	d	2	d	JV	B	ITX	GITX	WO	18.1		72
151	Jackson et al, 1979	2160	Chicken (*Gallus domesticus*)	5	U	FD	232	d	17	w	SM	F	ORW	ORWT	LI	23.2	29.9	80
152	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	ORW	ORWT	LI	23.7	29.7	80
153	Stevenson and Jackson 1980	2292	Chicken (*Gallus domesticus*)	5	U	FD	6	d	24	w	SM	F	ORW	SMIX	LI	27.2	54.4	79
154	Chiou et al 1997	2050	Chicken (*Gallus domesticus*)	5	M	FD	4	w	28	w	SM	F	HIS	GHIS	LI	27.9	35.3	85
155	Stevenson et al, 1983	6170	Chicken (*Gallus domesticus*)	4	U	GV	5	d	27	w	SM	F	ORW	SMIX	LI	34.0	65.4	79
156	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	ORW	SMIX	GZ	35.3	44.1	80
157	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	ORW	ORWT	GZ	40.0	50.0	80
158	Ledoux et al, 1987	2194	Chicken (*Gallus domesticus*)	3	UX	FD	21	d	1	d	JV	F	ORW	SMIX	LI	45.4		78
159	Jackson, 1977	2157	Chicken (*Gallus domesticus*)	6	U	FD	35	d	NR	NR	SM	F	ORW	ORWT	LI	49.9	54.8	80
160	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	5	M	DR	14	d	4	d	JV	NR	HIS	GLSN	WO	51.6	258	78
161	Van Vleet et al, 1981	80	Duck (*Anas platyrhynchos*)	2	U	FD	28	d	1	d	JV	M	HIS	NCRO	GZ	201		72
162	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	4	M	FD	35	d	3	d	JV	NR	HIS	GLSN	LI	297		70
163	Shivanandappa et al, 1983	3727	Chicken (*Gallus domesticus*)	6	U	OR	3	w	25	w	JV	M	PTH	ORWT	LI	637		66
164	Hoda and Maha, 1995	2007	Chicken (*Gallus domesticus*)	3	U	FD	6	w	1	d	JV	M	ORW	SMIX	AT		1.02	74
165	Wood and Worden, 1973	36216	Chicken (*Gallus domesticus*)	2	U	FD	21	d	2	d	JV	B	ORW	ORWT	LI		3.55	72
166	King, 1975	2177	Duck (*Anas platyrhynchos*)	2	U	FD	56	d	8	d	JV	B	ORW	SMIX	IN		4.15	72
167	King, 1972	2178	Chicken (*Gallus domesticus*)	2	U	FD	9	w	1	d	JV	B	ORW	SMIX	IN		4.65	72
168	Jackson et al, 1979	2160	Chicken (*Gallus domesticus*)	5	U	FD	336	d	17	w	SM	F	ORW	ORWT	LI		5.11	74
169	Jensen and Maurice, 1978	2164	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	ORW	SMIX	LI		7.87	67
170	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	ORW	ORWT	GZ		8.58	74
171	Wideman et al, 1996	2325	Chicken (*Gallus domesticus*)	4	U	FD	2	w	1	d	JV	M	HIS	GHIS	PR		13.3	72
172	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	2	U	FD	4	w	1	d	JV	NR	HIS	GHIS	GZ		14.3	72
173	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	HIS	GHIS	GZ		14.3	72
174	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	HIS	GHIS	GZ		14.3	72
175	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	HIS	GHIS	GZ		14.3	72
176	Jensen and Maurice, 1978	2164	Chicken (*Gallus domesticus*)	2	U	FD	4	w	1	d	JV	NR	HIS	GHIS	GZ		16.6	67
177	Latymer and Coates, 1981	2191	Chicken (*Gallus domesticus*)	2	U	FD	24	d	1	d	JV	B	ORW	ORWT	LI		21.3	73
178	Robbins and Baker, 1980	2267	Chicken (*Gallus domesticus*)	3	U	FD	14	d	8	d	JV	NR	HIS	GHIS	GZ		21.3	73
179	Stevenson and Jackson, 1980	2293	Chicken (*Gallus domesticus*)	4	U	FD	8	w	24	w	SM	F	ORW	SMIX	LI		22.6	73
180	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	SM	F	ORW	ORWT	KI		23.9	79
181	Smith, 1969	2284	Chicken (*Gallus domesticus*)	4	U	FD	25	d	1	d	JV	M	ORW	ORWT	LI		30.3	73
182	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	SM	F	ORW	ORWT	KI		30.4	79

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
183	Christmas and Harms, 1979	2052	Turkey (*Melagris gallopavo*)	3	U	FD	21	d	1	d	JV	B	HIS	USTR	GZ		31.4	74
184	Jensen and Maurice, 1978	2165	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	ORW	SMIX	GZ		34.9	73
185	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	SM	F	ORW	ORWT	KI		35.2	79
186	Jensen and Maurice, 1979	2166	Chicken (*Gallus domesticus*)	2	U	FD	4	w	1	d	JV	NR	ORW	SMIX	SP		36.6	73
187	Van Vleet et al, 1981	80	Duck (*Anas platyrhynchos*)	2	U	FD	15	d	1	d	JV	M	HIS	NCRO	GZ		201	72
188	Shivanandappa et al, 1983	3727	Chicken (*Gallus domesticus*)	5	U	OR	3	w	25	w	JV	M	ORW	ORWT	LI		536	75
			Reproduction (REP)															
189	Ankari et al, 1998	2006	Chicken (*Gallus domesticus*)	4	U	FD	84	d	25	w	LB	F	REP	EGPN	WO	4.05	12.1	80
190	Harms and Buresh, 1986	2117	Chicken (*Gallus domesticus*)	3	U	FD	6	w	64	w	LB	F	REP	EGPN	WO	13.9	19.5	85
191	Jackson and Stevenson, 1981	2158	Chicken (*Gallus domesticus*)	6	U	FD	280	d	18	w	LB	F	EGG	EGWT	EG	15.6	23.3	86
192	Stevenson et al, 1983	6170	Chicken (*Gallus domesticus*)	4	U	GV	5	d	27	w	LB	F	REP	PROG	WO	16.7	34.0	89
193	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	LB	F	REP	EGPN	WO	17.0	25.5	86
194	Stevenson et al, 1983	6170	Chicken (*Gallus domesticus*)	4	U	FD	5	d	27	w	LB	F	REP	PROG	WO	18.0	28.0	86
195	Jackson and Stevenson, 1981	2158	Chicken (*Gallus domesticus*)	6	U	FD	280	d	18	w	LB	F	EGG	EGWT	EG	19.4	29.0	86
196	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	LB	F	REP	EGPN	WO	20.5	30.7	86
197	Jackson et al, 1979	2160	Chicken (*Gallus domesticus*)	5	U	FD	336	d	17	w	LB	F	REP	EGPN	WO	21.6		71
198	Griminger, 1977	2112	Chicken (*Gallus domesticus*)	5	U	FD	2	w	7	mo	LB	F	EGG	ESTH	EG	22.4	44.8	85
199	Pearce et al, 1983	2294	Chicken (*Gallus domesticus*)	5	U	FD	12	d	26	w	LB	F	REP	EGPN	WO	22.5	45.0	85
200	Jackson et al, 1979	2160	Chicken (*Gallus domesticus*)	5	U	FD	232	d	17	w	LB	F	REP	EGPN	WO	23.2	29.9	86
201	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	LB	F	REP	EGPN	WO	23.9		76
202	Stevenson and Jackson, 1980	2292	Chicken (*Gallus domesticus*)	5	U	FD	6	d	24	w	LB	F	REP	EGPN	WO	27.2	54.4	85
203	Chiou et al, 1997	2050	Chicken (*Gallus domesticus*)	5	M	FD	4	w	28	w	LB	F	REP	EGPN	WO	27.5	40.6	91
204	Jackson, 1977	2157	Chicken (*Gallus domesticus*)	6	U	FD	35	d	NR	NR	LB	F	REP	PROG	WO	29.1	47.5	86
205	Jackson and Stevenson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	LB	F	REP	EGPN	WO	30.4		76
206	Chiou et al, 1998	2049	Chicken (*Gallus domesticus*)	4	U	FD	4	w	38	w	LB	F	REP	EGPN	WO	33.4	40.1	86
207	Jackson and Stevenson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	LB	F	REP	EGPN	WO	35.2		76
208	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	LB	F	REP	ORWT	OV	40.0	50.0	86
209	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	LB	F	REP	EGPN	WO	43.3		71
210	Shivanandappa et al, 1983	3727	Chicken (*Gallus domesticus*)	6	U	OR	3	w	25	w	JV	M	REP	SPCV	TE	239	318	87
211	Kadirvel and Kothandaraman, 1978	11876	Chicken (*Gallus domesticus*)	2	U	FD	28	w	12	w	LB	F	EGG	EGWT	WO		19.7	80
212	Stevenson and Jackson, 1980	2293	Chicken (*Gallus domesticus*)	4	U	FD	8	w	24	w	LB	F	REP	EGPN	WO		22.6	79
213	Shivanandappa et al, 1983	3727	Chicken (*Gallus domesticus*)	5	U	OR	3	w	25	w	JV	M	REP	SPCV	TE		536	81
			Growth (GRO)															
214	Hoda and Maha, 1995	2007	Chicken (*Gallus domesticus*)	3	U	FD	6	w	1	d	JV	M	GRO	BDWT	WO	1.92		78
215	Kashani et al, 1986	2171	Turkey (*Melagris gallopavo*)	4	U	FD	8	w	1	d	JV	M	GRO	BDWT	WO	2.34	4.68	83
216	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	2	U	FD	42	d	1	d	JV	M	GRO	BDWT	WO	2.70		76
217	Hill, 1974	1369	Chicken (*Gallus domesticus*)	2	U	FD	2	w	1	d	JV	B	GRO	BDWT	WO	2.75		76
218	Guenthner et al, 1978	2114	Turkey (*Melagris gallopavo*)	2	U	FD	24	w	1	d	JV	M	GRO	BDWT	WO	2.97		68
219	McGhee et al, 1965	14453	Chicken (*Gallus domesticus*)	5	U	FD	4	w	NR	NR	JV	NR	GRO	BDWT	WO	3.83	7.67	83
220	King, 1975	2177	Duck (*Anas platyrhynchos*)	2	U	FD	56	d	8	d	JV	B	GRO	BDWT	WO	4.15		76
221	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	M	GRO	BDWT	WO	4.43		76
222	King, 1972	2178	Chicken (*Gallus domesticus*)	2	U	FD	9	w	1	d	JV	B	GRO	BDWT	WO	4.65		67
223	Kayongo-Male and Palmer, 1998	5149	Turkey (*Melagris gallopavo*)	3	U	FD	4	w	NR	NR	JV	NR	GRO	BDWT	WO	4.75		68
224	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	2	U	FD	42	d	1	d	JV	M	GRO	BDWT	WO	5.43		76
225	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	3	U	FD	42	d	1	d	JV	M	GRO	BDWT	WO	5.56		76
226	Waibel et al, 1964	14405	Turkey (*Melagris gallopavo*)	3	U	FD	3	w	7	d	JV	NR	GRO	BDWT	WO	5.82	46.6	75
227	Hoda and Maha, 1995	2007	Chicken (*Gallus domesticus*)	3	U	FD	6	w	1	d	JV	NR	GRO	BDWT	WO	6.28		78
228	Hoda and Maha, 1995	2007	Chicken (*Gallus domesticus*)	3	U	FD	6	w	1	d	JV	NR	GRO	BDWT	WO	7.55		78
229	Hill, 1974	92	Chicken (*Gallus domesticus*)	2	U	FD	2	w	1	d	JV	B	GRO	BDWT	WI	7.63		76
230	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	2	U	FD	42	d	1	d	JV	M	GRO	BDWT	WO	8.19		76
231	Ko et al, 1985	2181	Chicken (*Gallus domesticus*)	4	U	FD	3	w	3	d	JV	M	GRO	BDWT	WO	8.40		69
232	Ekperigin and Vohra, 1981	6474	Chicken (*Gallus domesticus*)	4	U	FD	7	d	6	d	JV	NR	GRO	BDWT	WO	8.59	42.9	80
233	Ekperigin and Vohra, 1981	6474	Chicken (*Gallus domesticus*)	3	U	FD	7	d	7	d	JV	NR	GRO	BDWT	WO	8.59	42.9	80
234	Gill et al, 1995	2107	Chicken (*Gallus domesticus*)	4	U	FD	3	w	4	w	JV	M	GRO	BDWT	WO	9.52	19.0	84
235	Skrivan et al, 2000	25969	Chicken (*Gallus domesticus*)	2	M	FD	38	d	1	d	JV	B	GRO	BDWT	WO	9.72		82
236	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	5	M	DR	14	d	4	d	JV	NR	GRO	BDWT	WO	10.2	51.6	82
237	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	3	U	FD	42	d	1	d	JV	M	GRO	BDWT	WO	11.1		76
238	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	2	U	FD	42	d	21	d	JV	M	GRO	BDWT	WO	11.5		67
239	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	5	U	FD	35	d	1	d	JV	M	GRO	BDWT	WO	11.9		76
240	Nam et al, 1984	2226	Chicken (*Gallus domesticus*)	3	U	FD	4	w	3	d	JV	NR	GRO	BDWT	WO	12.2	24.3	83
241	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	2	M	DR	14	d	4	d	JV	NR	GRO	BDWT	WO	12.6		78
242	Chiou et al, 1999	2048	Chicken (*Gallus domesticus*)	4	U	FD	3	w	3	w	JV	NR	GRO	BDWT	WO	13.3	26.6	84

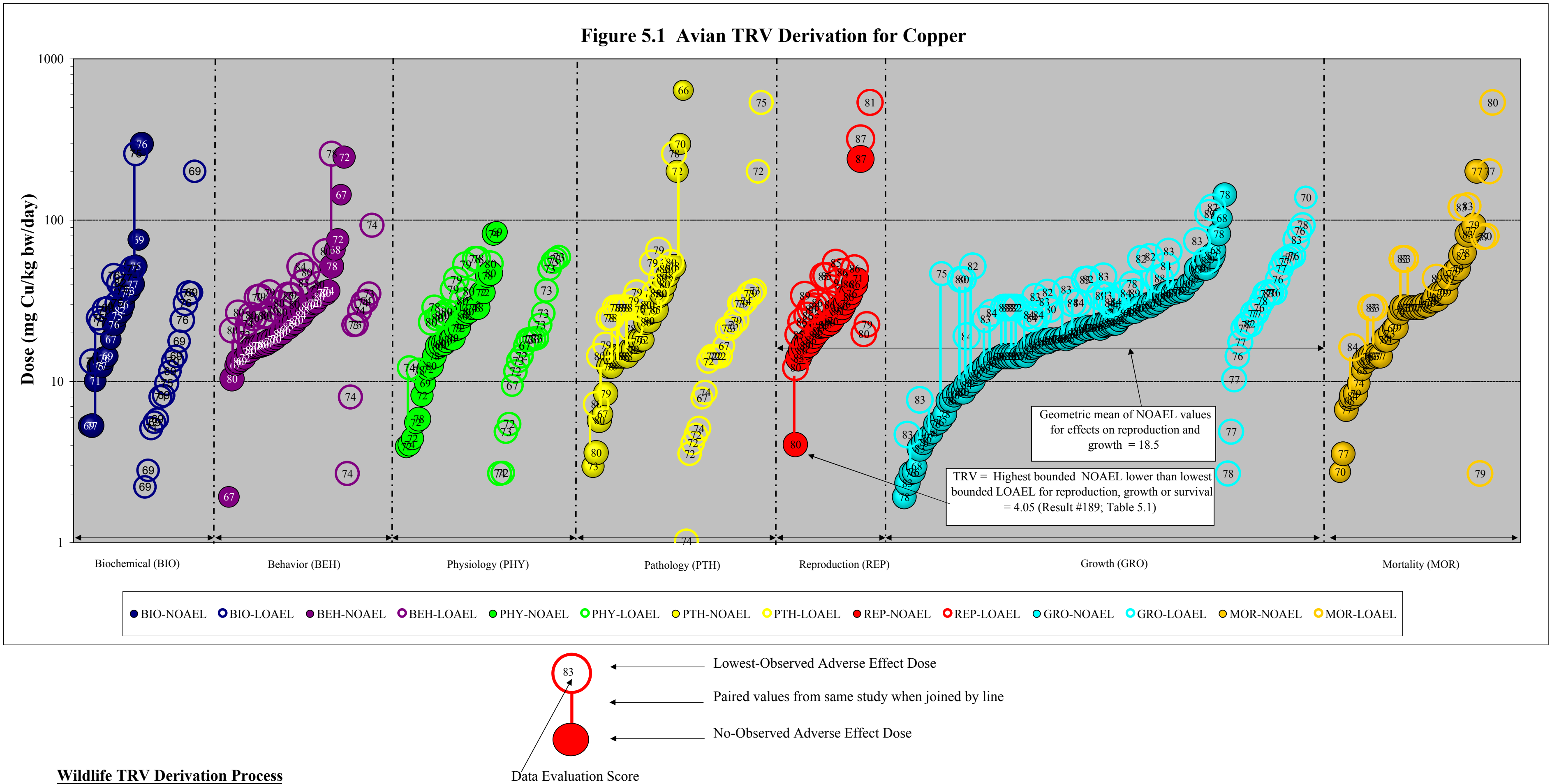
Result #	Reference	Ref No.	Test Organism	# of Conc/ Doses	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Effect Type	Effect Measure	Response Site	NOAEL Dose* (mg/kg bw/day)	LOAEL Dose* (mg/kg bw/day)	Total
243	Jenkins et al, 1970	2162	Chicken (*Gallus domesticus*)	2	M	FD	6	w	1	d	JV	B	GRO	BDWT	WO	13.4		73
244	Marron et al, 2001	25968	Chicken (*Gallus domesticus*)	2	U	FD	21	d	7	d	JV	M	GRO	BDWT	WO	14.2		68
245	Hill, 1990	5734	Chicken (*Gallus domesticus*)	5	U	FD	19	d	1	d	JV	F	GRO	BDWT	WO	14.2		76
246	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	14.3	28.7	82
247	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	5	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	14.3	28.7	82
248	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	14.3	28.7	82
249	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	5	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	14.3	28.7	82
250	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	14.3	28.7	82
251	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	2	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	14.3		67
252	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	2	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	14.3		67
253	Bakalli et al, 1995	3717	Chicken (*Gallus domesticus*)	2	U	FD	41	d	1	d	JV	M	GRO	BDWT	WO	14.3		76
254	Funk and Baker, 1991	2099	Chicken (*Gallus domesticus*)	3	U	FD	14	d	8	d	JV	M	GRO	BDWT	WO	15.7	25.8	84
255	Miles et al, 1998	2221	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	B	GRO	BDWT	WO	16.5	24.7	84
256	Stevenson and Jackson, 1980	2292	Chicken (*Gallus domesticus*)	5	U	FD	6	d	24	w	SM	F	GRO	BDWT	WO	16.7	33.4	83
257	Miles et al, 1998	2221	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	B	GRO	BDWT	WO	17.2	25.8	84
258	Pesti and Bakalli, 1996	2244	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	M	GRO	BDWT	WO	17.5		76
259	Smith, 1969	2284	Chicken (*Gallus domesticus*)	4	U	FD	25	d	1	d	JV	M	GRO	BDWT	WO	17.8	31.1	83
260	Wang et al,1987	2319	Chicken (*Gallus domesticus*)	4	U	FD	3	w	1	d	JV	M	GRO	BDWT	WO	17.8	35.5	82
261	Stevenson et al, 1983	6170	Chicken (*Gallus domesticus*)	4	U	FD	5	d	27	w	SM	F	GRO	BDWT	WO	18.0	28.0	80
262	Jensen and Maurice, 1978	2164	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	NR	GRO	BDWT	WO	18.2		68
263	Ward et al, 1995	6788	Turkey (*Melagris gallopavo*)	2	M	FD	10	d	5	d	JV	M	GRO	BDWT	WO	18.3		74
264	Jensen and Maurice, 1978	2164	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	NR	GRO	BDWT	WO	18.3		68
265	Jensen and Maurice, 1978	2164	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	NR	GRO	BDWT	WO	18.4		68
266	Jensen and Maurice, 1978	2166	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	18.5	37.1	83
267	Jensen and Maurice, 1978	2164	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	NR	GRO	BDWT	WO	18.6		68
268	Funk and Baker, 1991	2099	Chicken (*Gallus domesticus*)	5	U	FD	14	d	8	d	JV	M	GRO	BDWT	WO	19.6	30.5	84
269	Kadirvel and Kothandaraman, 1978	11876	Chicken (*Gallus domesticus*)	2	U	FD	28	w	12	w	SM	F	GRO	BDWT	WO	19.7		69
270	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	GRO	BDWT	WO	20.5	30.7	84
271	Pimentel et al, 1992	5617	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	B	GRO	BDWT	WO	20.9		68
272	Robbins and Baker, 1980	2267	Chicken (*Gallus domesticus*)	3	U	FD	14	d	8	d	JV	NR	GRO	BDWT	WO	21.3	42.7	83
273	Ekperigin and Vohra, 1981	6474	Chicken (*Gallus domesticus*)	5	U	FD	7	d	9	d	JV	NR	GRO	BDWT	WO	21.5	42.9	82
274	Ekperigin and Vohra, 1981	6474	Chicken (*Gallus domesticus*)	2	U	FD	8	d	9	d	JV	NR	GRO	BDWT	WO	21.5		76
275	Jackson et al, 1979	2160	Chicken (*Gallus domesticus*)	5	U	FD	336	d	17	w	SM	F	GRO	BDWT	WO	21.6		68
276	Wideman et al, 1996	2325	Chicken (*Gallus domesticus*)	5	M	FD	2	w	1	d	JV	M	GRO	BDWT	WO	21.7		76
277	Miles et al, 1998	2221	Chicken (*Gallus domesticus*)	4	M	FD	21	d	1	d	JV	B	GRO	BDWT	WO	21.9	34.0	89
278	Griminger, 1977	2112	Chicken (*Gallus domesticus*)	5	U	FD	2	w	7	mo	SM	F	GRO	BDWT	WO	22.4	44.8	83
279	Kassim and Suwanpradit, 1996	2172	Chicken (*Gallus domesticus*)	4	U	FD	3	w	1	d	JV	M	GRO	BDWT	WO	22.7	34.1	83
280	Jackson and Stevenson, 1981	2158	Chicken (*Gallus domesticus*)	6	U	FD	280	d	18	w	SM	F	GRO	BDWT	WO	23.0	30.7	84
281	Jackson et al, 1979	2160	Chicken (*Gallus domesticus*)	5	U	FD	232	d	17	w	SM	F	GRO	BDWT	WO	23.2	29.9	84
282	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	GRO	BDWT	WO	23.3	31.0	84
283	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	SM	F	GRO	BDWT	WO	23.9		74
284	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	24.7		67
285	Jackson and Stevenson, 1981	2158	Chicken (*Gallus domesticus*)	6	U	FD	280	d	18	w	SM	F	GRO	BDWT	WO	26.4	35.2	84
286	Ward et al, 1995	6788	Turkey (*Melagris gallopavo*)	2	M	DR	10	d	5	d	JV	M	GRO	BDWT	WO	26.6		69
287	Ledoux et al, 1989	5812	Chicken (*Gallus domesticus*)	4	U	FD	3	w	1	d	JV	M	GRO	BDWT	WO	26.9	40.4	78
288	Chiou et al, 1997	2050	Chicken (*Gallus domesticus*)	5	M	FD	28	d	28	w	SM	F	GRO	BDWT	WO	27.9	35.3	89
289	Hill, 1989	7091	Chicken (*Gallus domesticus*)	4	U	FD	19	d	NR	NR	JV	NR	GRO	BDWT	WO	28.4		70
290	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	28.7	57.4	82
291	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	28.7		67
292	Miles et al, 1998	2221	Chicken (*Gallus domesticus*)	4	M	FD	21	d	1	d	JV	B	GRO	BDWT	WO	29.5		83
293	Vohra and Kratzer, 1968	14404	Turkey (*Melagris gallopavo*)	3	U	FD	21	d	NR	NR	JV	B	GRO	BDWT	WO	29.7	59.3	82
294	Hill, 1990	5734	Chicken (*Gallus domesticus*)	4	U	FD	19	d	1	d	JV	F	GRO	BDWT	WO	30.4		76
295	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	SM	F	GRO	BDWT	WO	30.7		74
296	Mehring and Brumbaugh, 1960	22	Chicken (*Gallus domesticus*)	5	M	FD	10	w	1	d	JV	B	GRO	BDWT	WO	33.0	43.3	88
297	Jensen et al, 1991	2163	Chicken (*Gallus domesticus*)	4	U	FD	3	w	1	d	JV	M	GRO	BDWT	WO	34.1		68
298	Harms and Buresh, 1986	2118	Turkey (*Melagris gallopavo*)	3	U	FD	21	d	1	d	JV	B	GRO	BDWT	WO	34.6	51.9	84
299	Funk and Baker, 1991	2099	Chicken (*Gallus domesticus*)	5	U	FD	14	d	8	d	JV	M	GRO	BDWT	WO	35.2	63.9	83
300	Bafundo et al, 1984	2517	Chicken (*Gallus domesticus*)	2	U	FD	14	d	8	d	JV	M	GRO	BDWT	WO	35.5		67
301	Hill, 1990	5734	Chicken (*Gallus domesticus*)	2	U	FD	19	d	1	d	JV	F	GRO	BDWT	WO	35.5		76
302	Funk and Baker, 1991	2099	Chicken (*Gallus domesticus*)	3	U	FD	14	d	8	d	JV	M	GRO	BDWT	WO	36.3		78
303	Jensen and Maurice, 1979	2166	Chicken (*Gallus domesticus*)	2	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO	36.6		77
304	Davis et al, 1996	1278	Chicken (*Gallus domesticus*)	2	U	FD	21	d	14	d	JV	M	GRO	BDWT	WO	37.1		69

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
305	Chiou et al, 1998	2049	Chicken (*Gallus domesticus*)	4	U	FD	4	w	38	w	SM	F	GRO	BDWT	WO	40.1		69
306	Southern and Baker, 1983	6368	Chicken (*Gallus domesticus*)	2	U	FD	14	d	8	d	JV	M	GRO	BDWT	WO	41.0		68
307	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	GRO	BDWT	WO	43.3		69
308	Kassim and Suwanpradit, 1996	2172	Chicken (*Gallus domesticus*)	4	U	FD	3	w	3	w	JV	M	GRO	BDWT	WO	49.5	74.2	83
309	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	GRO	BDWT	WO	50.0		69
310	Vohra and Kratzer, 1968	14404	Turkey (*Melagris gallopavo*)	3	U	FD	21	d	NR	NR	JV	B	GRO	BDWT	WO	50.1		76
311	Jackson, 1977	2157	Chicken (*Gallus domesticus*)	6	U	FD	35	d	1	yr	SM	F	GRO	BDWT	WO	50.9	55.9	84
312	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	4	M	FD	35	d	3	d	JV	NR	GRO	BDWT	WO	56.8	109	89
313	Vohra and Kratzer, 1968	14404	Turkey (*Melagris gallopavo*)	5	U	FD	21	d	NR	NR	JV	B	GRO	BDWT	WO	60.0	120	82
314	Stevenson et al, 1983	6170	Chicken (*Gallus domesticus*)	4	U	GV	5	d	27	w	SM	F	GRO	BDWT	WO	65.4		68
315	Yannakopoulos et al., 1990	2333	Japanese quail (*Coturnix japonica*)	4	U	FD	34	d	7	d	JV	B	GRO	BDWT	WO	82.0		78
316	Leeson and Summers, 1982	2196	Chicken (*Gallus domesticus*)	4	U	FD	21	d	1	d	JV	M	GRO	BDWT	WO	103		68
317	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	2	M	FD	35	d	3	d	JV	NR	GRO	BDWT	WO	143		78
318	Ko et al, 1985	2181	Chicken (*Gallus domesticus*)	4	U	FD	3	w	3	d	JV	M	GRO	BDWT	WO		2.69	78
319	Kashani et al, 1986	2171	Turkey (*Melagris gallopavo*)	2	U	FD	8	w	1	d	JV	M	GRO	BDWT	WO		4.88	77
320	Harms and Eberst, 1974	9234	Turkey (*Melagris gallopavo*)	2	U	FD	3	w	1	d	JV	NR	GRO	GGRO	WO		10.3	77
321	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO		14.3	76
322	Jensen and Maurice, 1978	2165	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO		17.5	77
323	Latymer and Coates, 1981	2191	Chicken (*Gallus domesticus*)	2	U	FD	24	d	1	d	JV	B	GRO	BDWT	WO		21.3	77
324	Stevenson and Jackson, 1980	2293	Chicken (*Gallus domesticus*)	4	U	FD	8	w	24	w	SM	F	GRO	BDWT	WO		22.6	77
325	Ledoux et al, 1987	2194	Chicken (*Gallus domesticus*)	3	UX	FD	21	d	1	d	JV	F	GRO	BDWT	WO		22.7	82
326	Robbins and Baker, 1980	2266	Chicken (*Gallus domesticus*)	3	U	FD	8	d	8	d	JV	M	GRO	BDWT	WO		26.4	77
327	Robbins and Baker, 1980	2266	Chicken (*Gallus domesticus*)	3	U	FD	8	d	8	d	JV	M	GRO	BDWT	WO		26.4	77
328	Hill, 1974	1369	Chicken (*Gallus domesticus*)	2	U	FD	5	w	1	d	JV	B	GRO	BDWT	WO		28.7	76
329	Christmas and Harms, 1979	2052	Turkey (*Melagris gallopavo*)	3	U	FD	21	d	1	d	JV	B	GRO	BDWT	WO		31.4	78
330	Jensen and Maurice, 1978	2165	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	GRO	BDWT	WO		34.9	77
331	Stevenson and Jackson, 1981	2291	Chicken (*Gallus domesticus*)	2	M	FD	6	w	24	w	SM	F	GRO	BDWT	WO		35.2	83
332	Ekperigin and Vohra, 1981	2084	Chicken (*Gallus domesticus*)	3	U	FD	1	w	12	d	JV	B	GRO	BDWT	WO		35.5	76
333	Wang et al, 1987	2319	Chicken (*Gallus domesticus*)	2	U	FD	3	w	1	d	JV	M	GRO	BDWT	WO		35.5	76
334	Hill, 1974	92	Chicken (*Gallus domesticus*)	6	U	FD	2	w	1	d	JV	B	GRO	BDWT	WO		42.9	76
335	Robbins and Baker, 1980	2267	Chicken (*Gallus domesticus*)	2	U	FD	12	d	8	d	JV	NR	GRO	BDWT	WO		50.1	77
336	Robbins and Baker, 1980	2266	Chicken (*Gallus domesticus*)	2	U	FD	8	d	8	d	JV	M	GRO	BDWT	WO		55.2	77
337	Robbins and Baker, 1980	2267	Chicken (*Gallus domesticus*)	2	U	FD	8	d	8	d	JV	NR	GRO	BDWT	WO		57.2	77
338	Robbins and Baker, 1980	2267	Chicken (*Gallus domesticus*)	2	U	FD	12	d	8	d	JV	NR	GRO	BDWT	WO		59.0	77
339	Vohra and Kratzer, 1968	14404	Turkey (*Melagris gallopavo*)	4	U	FD	21	d	NR	NR	JV	B	GRO	BDWT	WO		60.0	76
340	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	2	M	FD	35	d	3	d	JV	NR	GRO	BDWT	WO		75.5	83
341	Hill, 1979	1370	Chicken (*Gallus domesticus*)	2	U	FD	2	w	1	d	JV	NR	GRO	BDWT	WO		85.9	76
342	Jensen, 1975	1403	Chicken (*Gallus domesticus*)	2	U	FD	14	d	1	d	JV	NR	GRO	BDWT	WO		92.9	78
343	Hill, 1980	395	Chicken (*Gallus domesticus*)	2	U	FD	1	w	1	d	JV	F	GRO	BDWT	WO		138	70
Survival (MOR)																		
344	Hill, 1974	1369	Chicken (*Gallus domesticus*)	2	U	FD	2	w	NR	NR	JV	B	MOR	MORT	WO	2.75		70
345	Wood and Worden, 1973	36216	Chicken (*Gallus domesticus*)	2	U	FD	49	d	2	d	JV	B	MOR	MORT	WO	3.55		77
346	Wood and Worden, 1973	36216	Duck (*Anas platyrhynchos*)	2	U	FD	49	d	2	d	JV	B	MOR	MORT	WO	6.69		77
347	Hill, 1974	92	Chicken (*Gallus domesticus*)	2	U	FD	5	w	1	d	JV	B	MOR	MORT	WO	7.63		68
348	McGhee et al, 1965	14453	Chicken (*Gallus domesticus*)	5	U	FD	4	w	NR	NR	JV	NR	MOR	MORT	WO	8.14	16.3	84
349	Ko et al, 1985	2181	Chicken (*Gallus domesticus*)	4	U	FD	3	w	3	d	JV	M	MOR	MORT	WO	8.40		79
350	Skrivan et al, 2000	25969	Chicken (*Gallus domesticus*)	2	M	FD	38	d	1	d	JV	B	MOR	MORT	WO	9.72		74
351	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	MOR	MORT	WO	11.7		68
352	Jenkins et al, 1970	2162	Chicken (*Gallus domesticus*)	2	M	FD	6	w	1	d	JV	B	MOR	MORT	WO	13.4		83
353	Marron et al, 2001	25968	Chicken (*Gallus domesticus*)	2	U	FD	21	d	7	d	JV	M	MOR	MORT	WO	14.2		78
354	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	5	U	FD	4	w	1	d	JV	NR	MOR	MORT	WO	14.3	28.7	83
355	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	MOR	MORT	WO	14.3	28.7	83
356	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	2	U	FD	4	w	1	d	JV	NR	MOR	MORT	WO	14.3		77
357	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	2	U	FD	4	w	1	d	JV	NR	MOR	MORT	WO	14.3		77
358	Wood and Worden, 1973	36216	Duck (*Anas platyrhynchos*)	2	U	FD	16	d	2	d	JV	B	MOR	MORT	WO	18.1		77
359	Ward et al, 1995	6788	Turkey (*Melagris gallopavo*)	2	M	FD	10	d	5	d	JV	M	MOR	MORT	WO	18.3		84
360	Ankari et al, 1998	2006	Chicken (*Gallus domesticus*)	4	U	FD	84	d	25	w	SM	F	MOR	MORT	WO	19.9		73
361	Latymer and Coates, 1981	2191	Chicken (*Gallus domesticus*)	2	U	FD	24	d	1	d	JV	B	MOR	MORT	WO	21.3		69
362	Jackson et al, 1979	2160	Chicken (*Gallus domesticus*)	5	U	FD	336	d	17	w	SM	F	MOR	MORT	WO	21.6		79
363	Ward et al, 1995	6788	Turkey (*Melagris gallopavo*)	2	M	DR	10	d	5	d	JV	M	MOR	MORT	WO	26.6		79
364	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	4	U	FD	4	w	1	d	JV	NR	MOR	MORT	WO	28.7	57.4	83
365	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	5	U	FD	4	w	1	d	JV	NR	MOR	MORT	WO	28.7	57.4	83

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
366	Hill, 1974	1369	Chicken (*Gallus domesticus*)	2	U	FD	5	w	1	d	JV	M	MOR	MORT	WO	28.7		70
367	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	MOR	MORT	WO	28.7		77
368	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	MOR	MORT	WO	28.7		77
369	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	MOR	MORT	WO	28.7		77
370	Poupoulis and Jensen, 1976	2250	Chicken (*Gallus domesticus*)	3	U	FD	4	w	1	d	JV	NR	MOR	MORT	WO	28.7		77
371	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	MOR	MORT	WO	29.7		79
372	Miles et al, 1998	2221	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	B	MOR	MORT	WO	29.7		79
373	Miles et al, 1998	2221	Chicken (*Gallus domesticus*)	4	U	FD	42	d	1	d	JV	B	MOR	MORT	WO	30.8		70
374	Jackson and Stevenson, 1981	2158	Chicken (*Gallus domesticus*)	6	U	FD	280	d	18	w	SM	F	MOR	MORT	WO	31.6		79
375	Mehring and Brumbaugh, 1960	22	Chicken (*Gallus domesticus*)	5	M	FD	10	w	1	d	JV	B	MOR	MORT	WO	33.0	43.3	89
376	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	MOR	MORT	WO	35.2		79
377	Jackson and Stevenson, 1981	2158	Chicken (*Gallus domesticus*)	6	U	FD	280	d	18	w	SM	F	MOR	MORT	WO	35.4		79
378	Jackson et al, 1979	2160	Chicken (*Gallus domesticus*)	5	U	FD	232	d	17	w	SM	F	MOR	MORT	WO	35.5		79
379	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	MOR	MORT	WO	43.3		79
380	Waibel et al, 1964	14405	Turkey (*Melagris gallopavo*)	3	U	FD	3	w	7	d	JV	NR	MOR	SURV	WO	46.6		72
381	Christmas and Harms, 1979	2052	Turkey (*Melagris gallopavo*)	3	U	FD	21	d	1	d	JV	B	MOR	MORT	WO	48.3		79
382	Jackson and Stevenson, 1981	2159	Chicken (*Gallus domesticus*)	6	U	FD	336	d	26	w	SM	F	MOR	MORT	WO	50.0		79
383	Vohra and Kratzer, 1968	14404	Turkey (*Melagris gallopavo*)	5	U	FD	21	d	NR	NR	JV	B	MOR	MORT	WO	60.0	120	83
384	Jackson, 1977	2157	Chicken (*Gallus domesticus*)	6	U	FD	35	d	NR	NR	SM	F	MOR	MORT	WO	62.7		78
385	Hill, 1974	92	Chicken (*Gallus domesticus*)	6	U	FD	5	w	1	d	JV	F	MOR	MORT	WO	81.6	122	83
386	Hill, 1979	1370	Chicken (*Gallus domesticus*)	2	U	FD	2	w	1	d	JV	B	MOR	MORT	WO	85.9		77
387	Jensen, 1975	1403	Chicken (*Gallus domesticus*)	2	U	FD	14	d	1	d	JV	NR	MOR	MORT	WO	92.9		79
388	Van Vleet et al, 1981	80	Duck (*Anas platyrhynchos*)	2	U	FD	15	d	1	d	JV	M	MOR	MORT	WO	201		77
389	Ko et al, 1985	2181	Chicken (*Gallus domesticus*)	4	U	FD	3	w	3	d	JV	M	MOR	MORT	WO		2.69	79
390	Foster, 1999	18769	Duck (*Anas platyrhynchos*)	2	M	DR	4	d	4	d	JV	NR	MOR	MORT	WO		78.5	77
391	Shivanandappa et al, 1983	3727	Chicken (*Gallus domesticus*)	6	U	OR	3	w	25	w	JV	M	MOR	MORT	WO		79.6	80
392	Van Vleet et al, 1981	80	Duck (*Anas platyrhynchos*)	2	U	FD	15	d	1	d	JV	M	MOR	MORT	WO		201	77
393	Shivanandappa et al, 1983	3727	Chicken (*Gallus domesticus*)	5	U	OR	4	d	25	w	JV	M	MOR	MORT	WO		536	80

AATT = alanine aminotransferase; AD = adipose tissue; ASAT = aspartate aminotransferase; AT = alimentary tract; B = both; BDWT = body weight changes; BEH = behavior; BIO = biochemical; BL = blood; BT = breast; bw = body weight; CHM = chemical changes; CHOL = cholesterol; CRKI = creatine kinase; d = day; DR = drinking water; DT = digestive tract; EG = egg; EGG = egg; EGPN = eggs per nest; EGWT = egg weight; ENZ = enyzme level changes; ESTH = eggshell thickness; F = female; FCNS = food consumption; FD = food; FDB = feeding behavior; FDCV = food conversion efficiency; FE = feathers; FEFF = feeding efficiency; FFTA = free fatty acids; GCHM = general biochemical changes; GGRO = general growth; GHIS = general histology; GITX = general intoxication; GLCN = glycine; GLPX = glutathione peroxidase; GLSN = gross lesions; GLUC = glucose; GOTR = glutamic-oxaloacetic transaminase; GPHY = general pysiology changes; GRO = growth; GV = gavage; GZ = gizzard; HE = heart; HEMT = general hematology; HIS = histological changes; HMGL = hemoglobin; IN = intestinal tract; IRRI = skin irritation; ITX = intoxication; JV = juvenile; kg = kilograms; KI = kidney; LADH = lactate dehydrogenase; LB = egg-laying bird; LD = lipid; LI = liver; LIPD = lipid; LOAEL = lowest observed adverse effect level; mg = mil M = measured; MH = mouth; MOR = effects on mortality and survival; MORT = mortality; NCRO = necrosis; NOAEL = No Observed Advese Effect Level; NR = Not reported; OR = other oral; ORW = organ weight changes; ORWT = organ weight changes; OV = ovaries; PHPH = pH; PHY = physiology; PL = plasma; PR = proventriculus; PROG = progeny counts/numbers; PROT = prothrombin time; PTH = pathology; REP = reproduction; SGOT = serum glutamate oxalo aetate transaminase; SK = skin; SM = sexually mature; SMIX = weight relative to body weight; SP = spleen; SPCV = sperm cell viability; SR = serum; SURV = survival; TE = testes; U = unmeasured; URIC = uric acid; USTR = ultrastructural changes; UX = measured but values not reported; w = weeks; WCON = water consumption; WI = wings; WO = whole organism; yr = year.

*NOAEL and LOAEL values that are equal and from the same reference represent different experimental designs. These are designated with different Phase numbers in Appendix 5.1.



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 at least three NOAEL results available within the growth and reproduction effect groups for calculation of a geometric mean.

3) The geometric mean is equal to 18.5 mg copper/kg bw/d and is higher than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.

3) The avian wildlife TRV for copper is equal to 4.05 mg copper/kg bw/day which is the highest NOAEL value lower than the lowest bound LOAEL value for effects on 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 Copper

Surrogate Receptor Group	TRV for Copper (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 Copper in Biota Type (i)[2,3] (B_i) (mg/kg dw)	Eco-SSL (mg/kg dw)[4]
Avian herbivore (dove)	4.05	0.190	0.139	$\ln(B_i) = 0.394 * \ln(Soil_j) + 0.688$ where i = plants	76
Avian ground insectivore (woodcock)	4.05	0.214	0.164	$B_i = 0.515 * Soil_j$ where i = earthworms	28
Avian carnivore (hawk)	4.05	0.0353	0.057	$\ln(B_i) = 0.1444 * \ln(Soil_j) + 2.042$ where i = mammals	1600

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

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 3,365 papers with possible toxicity data for copper for either avian or mammalian species. Of these studies, 3,175 were rejected for use as described in Section 7.5. Of the remaining papers, 97 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)
Copper
Page 1 of 5

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	Cerklewski and Forbes, 1977	2625	Rat (*Rattus norvegicus*)	2	U	FD	1	w	NR	NR	JV	M	CHM	HMGL	UR	1.53		71
2	Uthus, 2001	36349	Rat (*Rattus norvegicus*)	2	U	FD	62	d	NR	NR	JV	M	CHM	HMGL	BL	2.07		70
3	Amer, et al, 1973	10086	Cattle (*Bos taurus*)	3	M	FD	4	w	3	d	JV	M	ENZ	GENZ	BL	2.71	5.09	80
4	Miranda et al, 1981	36240	Rat (*Rattus norvegicus*)	2	M	FD	5	w	NR	NR	JV	M	ENZ	ASAT	PL	3.60		74
5	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	FD	13	w	6	w	JV	B	ENZ	AATT	BL	6.02	12.0	77
6	Irie, 1990	21243	Pig (*Sus scrofa*)	3	U	FD	8	w	4	mo	JV	NR	CHM	FFTA	WO	6.07		70
7	Thacker, 1991	2304	Pig (*Sus scrofa*)	2	U	FD	7	d	NR	NR	GE	F	CHM	PRTL	MK	6.51		70
8	Kline et al, 1971	20975	Pig (*Sus scrofa*)	4	M	FD	88	d	69	d	JV	NR	CHM	HMGL	BL	7.63		66
9	Kornegay et al, 1986	2182	Pig (*Sus scrofa*)	3	U	FD	25	d	NR	NR	JV	B	CHM	HMGL	BL	8.59	17.2	71
10	Brandt, 1983	2033	Mink (*Mustela vision*)	3	M	FD	4	mo	90	d	JV	M	CHM	HMGL	PL	10.2	19.6	81
11	Suttle and Mills, 1966	3757	Pig (*Sus scrofa*)	3	U	FD	34	d	NR	NR	JV	F	ENZ	ASAT	SR	11.9	20.3	77
12	Smith et al, 1975	3756	Horse - Shetland pony (*Equus caballus*)	4	M	FD	84	d	NR	NR	JV	NR	CHM	PCLV	BL	13.8		67
13	Moffitt and Murphy, 1973	12718	Rat (*Rattus norvegicus*)	4	U	DR	15	d	NR	NR	JV	B	ENZ	AHDX	LI	17.1	51.2	71
14	Bassuny, 1991	2020	Rabbit (*Oryctolagus cuniculus*)	5	U	FD	7	w	35	d	JV	M	CHM	PRTL	BL		0.758	71
15	Solaiman et al, 2001	36748	Goat (*Capra hircus*)	3	U	GV	9	w	7-8	mo	JV	F	ENZ	GGTR	PL		1.47	73
16	Kakela et al, 1999	36231	Mink (*Mustela vision*)	2	U	FD	28	d	6	mo	JV	F	CHM	VTMA	PL		4.01	70
17	Kakela and Hyvarinen, 1999	36248	Mink (*Mustela vision*)	2	U	FD	28	d	6	mo	JV	F	CHM	FFTA	LD		4.01	70
18	Adam et al, 1977	3752	Goat (*Capra hircus*)	4	U	GV	144	d	12	mo	AD	B	CHM	GLYC	LI		5.36	73
19	DeGoey et al, 1971	2064	Pig (*Sus scrofa*)	2	U	FD	98	d	NR	mo	JV	NR	CHM	HMGL	BL		7.46	71
20	Gipp et al, 1973	14396	Pig (*Sus scrofa*)	2	U	FD	12	w	NR	NR	JV	F	CHM	HMGL	BL		7.66	70
21	Myres and Bowland, 1973	12809	Pig (*Sus scrofa*)	2	U	FD	10	w	70	d	JV	B	CHM	FFTA	LD		7.84	71
22	Ritchie et al, 1963	14402	Pig (*Sus scrofa*)	2	U	FD	15	w	7	w	JV	NR	CHM	HMGL	WO		8.08	70
23	Onifade and Abu, 1998	2237	Rabbit (*Oryctolagus cuniculus*)	4	U	FD	70	d	7	w	JV	NR	CHM	TWBC	BL		9.47	70
24	Gipp et al, 1974	14397	Pig (*Sus scrofa*)	2	U	FD	35	d	3	w	JV	B	CHM	HMGL	BL		9.93	71
25	Radecki et al, 1992	2255	Pig (*Sus scrofa*)	2	U	FD	14	d	21	d	JV	B	ENZ	G6PD	GT		12.0	70
26	DeGoey et al, 1971	2064	Pig (*Sus scrofa*)	2	U	FD	23	d	NR	mo	JV	NR	CHM	HMGL	BL		15.5	70
27	Rana and Kumar, 1980	2256	Rat (*Rattus norvegicus*)	2	U	GV	20	d	90	d	JV	M	CHM	RBCE	BL		39.8	77
28	Kumar et al, 1987	2186	Rat (*Rattus norvegicus*)	2	U	GV	45	d	90	d	JV	M	CHM	PRTL	KI		39.8	77
29	Gautam et al, 2001	36346	Rat (*Rattus norvegicus*)	2	U	FD	2	w	NR	NR	JV	NR	CHM	CALC	LI		39.8	74
30	DeVries et al, 1986	10891	Rat (*Rattus norvegicus*)	2	U	DR	11	mo	3	w	JV	F	HRM	GHRM	BR		45.8	66
31	Aburto et al, 2001	25964	Rat (*Rattus norvegicus*)	2	U	FD	6	mo	10	w	JV	M	CHM	GCHM	LI		48.7	70
32	Pribyl et al, 1980	23825	Rat (*Rattus norvegicus*)	2	U	FD	4	d	NR	NR	JV	M	ENZ	GENZ	SR		63.5	70
33	Rana and Verma, 1997	36247	Rat (*Rattus norvegicus*)	2	U	FD	30	d	NR	NR	JV	M	CHM	GLTH	LI		75.0	79
34	Tatum et al, 2000	36389	Rat (*Rattus norvegicus*)	2	U	FD	6	w	NR	NR	JV	F	ENZ	GENZ	PL		75.7	70
35	Rana et al, 1985	13236	Rat (*Rattus norvegicus*)	2	U	GV	30	d	90	d	JV	M	CHM	GLYC	LI		100	77
36	Fuentealba et al, 2000	36364	Rat (*Rattus norvegicus*)	2	U	FD	12	w	21	d	JV	B	ENZ	AATT	LI		122	69
37	Fuentealba et al, 2000	36364	Rat (*Rattus norvegicus*)	2	U	FD	18	w	NR	NR	GE	F	ENZ	AATT	LI		132	69
38	Fuentealba et al, 1993	2097	Rat (*Rattus norvegicus*)	2	U	FD	1	w	NR	mo	JV	M	CHM	GBCM	LI		135	69
39	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	4	U	FD	92	d	6	w	JV	M	ENZ	AATT	BL		146	69
40	Haywood and Comerford, 1980	2123	Rat (*Rattus norvegicus*)	2	U	FD	1	w	NR	mo	JV	M	ENZ	AATT	BL		178	69
41	Zhang et al, 2000	36355	Rat (*Rattus norvegicus*)	2	U	GV	8	w	8	w	JV	B	ENZ	GENZ	SR		357	79
42	Pettersen, et al, 2002	36374	Mouse (*Mus musculus*)	3	U	FD	3	w	4	w	JV	B	CHM	NACO	HE		494	70
43	Gooneratne and Howell, 1980	36200	Sheep (*Ovis aries*)	2	U	DR	66	d	9-12	mo	JV	M	ENZ	GLPX	LI		1820	69
44	Sansinanea et al, 1996	36234	Sheep (*Ovis aries*)	2	U	OR	14	w	12	mo	JV	F	CHM	GLUC	SR		7140	77
Behavior (BEH)																		
45	Miranda et al, 1981	36240	Rat (*Rattus norvegicus*)	2	M	FD	5	w	NR	NR	JV	M	FDB	FCNS	WO	3.60		75
46	Anugwa et al, 1984	2010	Rabbit (*Oryctolagus cuniculus*)	3	M	FD	8	w	8	w	JV	B	FDB	FCNS	WO	3.64	6.67	85
47	Bassuny, 1991	2020	Rabbit (*Oryctolagus cuniculus*)	5	U	FD	7	w	35	d	JV	M	FDB	FCNS	WO	4.25		74
48	Ward, et al, 1991	1888	Pig (*Sus scrofa*)	2	M	FD	144	d	31	d	JV	B	FDB	FDNG	WO	4.37		70
49	Allcroft et al, 1961	14387	Pig (*Sus scrofa*)	4	M	FD	4	w	8-10	w	JV	B	FDB	FCNS	WO	5.60	9.34	84
50	Gershbein et alm 1983	136	Rat (*Rattus norvegicus*)	2	U	FD	80	d	44	d	JV	M	BEH	NMVM	WO	5.89		66
51	Thacker, 1991	2304	Pig (*Sus scrofa*)	2	U	FD	35	d	NR	NR	LC	F	FDB	FCNS	WO	6.69		74
52	Apgar et al, 1995	25922	Pig (*Sus scrofa*)	4	M	FD	5	w	31	d	JV	B	FDB	FCNS	WO	6.90		70
53	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	2	M	FD	28	d	29	d	JV	B	FDB	FCNS	WO	7.37		70
54	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	2	M	FD	28	d	29	d	JV	B	FDB	FCNS	WO	7.37		70
55	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	2	M	FD	28	d	30	d	JV	B	FDB	FCNS	WO	8.21		70
56	Allcroft et al, 1961	14387	Pig (*Sus scrofa*)	4	M	FD	19	w	8-10	w	JV	B	FDB	FCNS	WO	8.43		69
57	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	3	M	FD	28	d	29	d	JV	B	FDB	FCNS	WO	8.50		70
58	Cromwell et al 1989	2061	Pig (*Sus scrofa*)	5	U	FD	33	d	28	d	JV	B	FDB	FCNS	WO	8.67	13.0	80
59	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	4	M	FD	28	d	30	d	JV	B	FDB	FCNS	WO	8.68		70
60	Cromwell et al 1989	2061	Pig (*Sus scrofa*)	4	U	FD	28	d	28	d	JV	B	FDB	FCNS	WO	10.0	19.9	80

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
61	Edmonds and Baker, 1986	2075	Pig (*Sus scrofa*)	3	U	FD	28	d	4	w	JV	NR	FDB	FCNS	WO	10.3	26.9	80
62	Apgar and Kornegay, 1996	25928	Pig (*Sus scrofa*)	2	M	FD	14	d	NR	NR	JV	M	FDB	FCNS	WO	16.5		73
63	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	DR	15	d	6	w	JV	B	FDB	WCON	WO	17.2	51.7	75
64	Grobner et al, 1986	2113	Rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	d	28	d	JV	NR	FDB	FCNS	WO	27.7	45.7	85
65	Bush et al., 1995	2043	Mink (*Mustela vision*)	3	M	FD	132	d	10	w	JV	B	FDB	FCNS	WO	33.4		69
66	Hebert, 1993	2126	Mouse (*Mus musculus*)	6	U	DR	15	d	6	w	JV	B	FDB	WCON	WO	33.8	101	75
67	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	FD	13	w	6	w	JV	B	FDB	FCNS	WO	49.7	99.4	80
68	Grobner et al, 1986	2113	Rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	d	28	d	JV	NR	FDB	FCNS	WO	59.0		70
69	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	FD	7	d	6	w	JV	B	FDB	FCNS	WO	179	359	80
70	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	5	U	DR	2	w	6	w	JV	M	FDB	WCON	WO	259	400	74
71	Hebert et al, 1993	2127	Mouse (*Mus musculus*)	5	U	DR	2	w	6	w	JV	M	FDB	WCON	WO	589	1365	74
72	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	6	U	FD	15	d	6	w	JV	M	FDB	FCNS	WO	2050	3360	79
73	Hebert et al, 1993	2127	Mouse (*Mus musculus*)	6	U	FD	15	d	6	w	JV	B	FDB	FCNS	WO	12500	18700	79
74	Ortolani et al, 2003	36759	Sheep (*Ovis aries*)	2	U	DR	14	d	6	mo	JV	M	FDB	FCNS	WO		3.00	72
75	Freundt and Ibrahim, 1990	2640	Rat (*Rattus norvegicus*)	2	U	DR	91	d	NR	NR	JV	F	FDB	WCON	WO		5.78	68
76	DeGoey et al, 1971	2064	Pig (*Sus scrofa*)	2	U	FD	98	d	NR	NR	JV	NR	FDB	FCNS	WO		7.46	74
77	Onifade and Abu, 1998	2237	Rabbit (*Oryctolagus cuniculus*)	4	U	FD	70	d	7	w	JV	NR	FDB	FCNS	WO		9.47	73
78	Boyden, 1938	14653	Rat (*Rattus norvegicus*)	5	U	FD	4	w	28	d	JV	B	FDB	FCNS	WO		23.5	73
79	Komulainen, 1983	12079	Rat (*Rattus norvegicus*)	4	U	DR	3	w	4	w	JV	M	FDB	WCON	WO		28.0	72
									Physiology (PHY)									
80	Bailey et al, 2001	25941	Cattle (*Bos taurus*)	3	M	FD	112	d	NR	NR	JV	NR	PHY	FDCV	WO	1.33		69
81	Arthur, 1965	2012	Guinea pig (*Cavia porcellus*)	3	U	FD	8	w	NR	NR	JV	B	PHY	GPHY	HA	1.48		73
82	Omole et al, 1976	43456	Pig (*Sus scrofa*)	3	U	FD	127	d	NR	NR	NR	B	PHY	FDCV	WO	2.77	4.43	76
83	Solaiman et al, 2001	36748	Goat (*Capra hircus*)	3	U	GV	9	w	7-8	mo	JV	F	PHY	FDCV	WO	3.14		69
84	Anugwa et al, 1984	2010	Rabbit (*Oryctolagus cuniculus*)	3	M	FD	8	w	8	w	JV	B	PHY	DIFD	WO	3.64	6.67	85
85	Ward et al, 1991	1888	Pig (*Sus scrofa*)	2	M	FD	144	d	31	d	JV	B	PHY	FDCV	WO	4.37		70
86	Apgar et al, 1995	25922	Pig (*Sus scrofa*)	4	M	FD	5	w	31	d	JV	B	PHY	FDCV	WO	6.90		70
87	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	2	M	FD	28	d	29	d	JV	B	PHY	FDCV	WO	7.37		70
88	Kline et al, 1971	20975	Pig (*Sus scrofa*)	4	M	FD	88	d	69	d	JV	NR	PHY	FDCV	WO	7.63		69
89	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	2	M	FD	28	d	30	d	JV	B	PHY	FDCV	WO	8.21		70
90	Braude and Ryder, 1973	2034	Pig (*Sus scrofa*)	4	M	FD	112	d	9	w	JV	NR	PHY	FDCV	WO	8.29		69
91	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	3	M	FD	28	d	29	d	JV	B	PHY	FDCV	WO	8.50		70
92	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	4	M	FD	28	d	30	d	JV	B	PHY	FDCV	WO	8.68		70
93	Cromwell et al, 1989	2061	Pig (*Sus scrofa*)	4	U	FD	28	d	28	d	JV	B	PHY	FDCV	WO	8.89	17.8	80
94	Grobner et al, 1986	2113	Rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	d	28	d	JV	NR	PHY	FDCV	WO	9.45	23.6	85
95	Edmonds and Baker, 1986	2075	Pig (*Sus scrofa*)	3	U	FD	28	d	4	w	JV	NR	PHY	FDCV	WO	10.3	26.9	80
96	Grobner et al, 1986	2113	Rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	d	28	d	JV	NR	PHY	FDCV	WO	33.6	59.0	85
97	Keen et al, 1982	11928	Rat (*Rattus norvegicus*)	4	U	FD	7	w	NR	NR	JV	F	PHY	GPHY	PL	189		66
98	Bassuny, 1991	2020	Rabbit (*Oryctolagus cuniculus*)	5	U	FD	7	w	35	d	JV	M	PHY	FDCV	WO		0.758	74
99	Cromwell et al, 1989	2061	Pig (*Sus scrofa*)	5	U	FD	33	d	28	d	JV	B	PHY	FDCV	WO		4.10	74
100	Cromwell et al, 1989	2061	Pig (*Sus scrofa*)	3	U	FD	28	d	28	d	JV	B	PHY	FDCV	WO		4.89	74
101	DeGoey et al, 1971	2064	Pig (*Sus scrofa*)	2	U	FD	23	d	NR	mo	JV	NR	PHY	IRRI	SK		15.5	73
102	Rana and Kumar, 1980	2256	Rat (*Rattus norvegicus*)	2	U	GV	20	d	90	d	JV	M	PHY	IRRI	FO		39.8	80
									Pathology (PTH)									
103	Uthus, 2001	36349	Rat (*Rattus norvegicus*)	2	U	FD	62	d	NR	NR	JV	M	ORW	ORWT	KI	2.07		73
104	Miranda et al, 1981	36240	Rat (*Rattus norvegicus*)	2	M	FD	5	w	NR	NR	JV	M	ORW	SMIX	LI	3.60		79
105	Humann-Ziehank et al, 2001	36762	Sheep (*Ovis aries*)	2	U	FD	84	d	1	yr	AD	M	ITX	GITX	WO	3.70		70
106	Ward et al, 1991	1888	Pig (*Sus scrofa*)	2	M	FD	144	d	31	d	JV	B	HIS	GHIS	GT	4.37		70
107	Adam et al, 1977	3752	Goat (*Capra hircus*)	4	U	GV	144	d	12	mo	AD	B	HIS	GHIS	LI	5.36	10.7	82
108	Hebert, 1993	2126	Mouse (*Mus musculus*)	6	U	DR	15	d	6	w	JV	F	ORW	ORWT	TS	5.53	18.4	73
109	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	FD	13	w	6	w	JV	F	HIS	GLSN	KI	6.01	12.0	80
110	Thacker, 1991	2304	Pig (*Sus scrofa*)	2	U	FD	7	d	NR	NR	GE	F	GRS	BDWT	WO	6.51		72
111	Anugwa et al, 1984	2010	Rabbit (*Oryctolagus cuniculus*)	3	M	FD	8	w	8	w	JV	B	ORW	SMIX	LI	6.67		70
112	Ritchie et al, 1963	14402	Pig (*Sus scrofa*)	2	U	FD	15	w	7	w	JV	NR	ORW	ORWT	LI	8.08		69
113	Onifade and Abu, 1998	2237	Rabbit (*Oryctolagus cuniculus*)	4	U	FD	70	d	7	w	JV	NR	ORW	SMIX	BR	9.47	18.9	79
114	Howell et al, 1991	36230	Sheep (*Ovis aries*)	2	U	GV	19	w	6-9	mo	JV	M	HIS	CTYP	LI	14.3		73
115	Prince et al, 1979	2253	Pig (*Sus scrofa*)	2	U	FD	63	d	53	d	JV	NR	ITX	GITX	WO	16.5		73
116	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	DR	15	d	6	w	JV	B	ITX	GITX	WO	17.2	51.6	75
117	Bush et al, 1995	2043	Mink (*Mustela vision*)	3	M	FD	132	d	10	w	JV	B	HIS	NCRO	LI	33.4		78
118	Kumar et al, 1987	2186	Rat (*Rattus norvegicus*)	2	U	GV	45	d	90	d	JV	M	ORW	ORWT	KI	39.8		76
119	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	FD	15	d	6	w	JV	B	ORW	ORWT	LI	40.9	81.8	80
120	DeVries et al, 1986	10891	Rat (*Rattus norvegicus*)	2	U	DR	11	mo	3	w	JV	F	ORW	ORWT	LI	45.8		69

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

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
121	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	5	U	FD	92	d	6	w	JV	M	HIS	HYPL	SH	70.4	142	79
122	Hebert, 1993	2126	Mouse (*Mus musculus*)	6	U	FD	13	w	6	w	JV	B	ORW	ORWT	LI	82.8	166	80
123	Keen et al, 1982	11928	Rat (*Rattus norvegicus*)	4	U	FD	7	w	NR	NR	JV	F	HIS	GHIS	MT	91.7	183	79
124	Hebert, 1993	2126	Mouse (*Mus musculus*)	6	U	FD	15	d	6	w	JV	M	ORW	ORWT	LI	97.2	194	80
125	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	6	U	FD	15	d	6	w	JV	B	HIS	HYPL	SH	197	385	79
126	Dodds-Smith et al, 1992	2069	Common shrew (*Sorex araneus*)	2	U	FD	12	w	NR	NR	JV	B	ORW	ORWT	KI	251		69
127	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	5	U	DR	2	w	6	w	JV	B	ITX	GITX	WO	259	400	74
128	Haywood, 1985	2121	Rat (*Rattus norvegicus*)	5	U	FD	1	w	NR	NR	JV	M	HIS	NCRO	LI	274	365	73
129	Hebert et al, 1993	2127	Mouse (*Mus musculus*)	5	U	DR	2	w	6	w	JV	B	ITX	GITX	WO	1430	3400	74
130	Hebert et al, 1993	2127	Mouse (*Mus musculus*)	5	U	FD	92	d	6	w	JV	B	ITX	GITX	WO	48300		73
131	Grobner et al, 1986	2113	Rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	d	28	d	JV	NR	ORW	ORWT	DT		3.40	79
132	Howell et al, 1974	2148	Sheep (*Ovis aries*)	3	U	GV	37	w	6-12	mo	JV	B	HIS	GHIS	BR		5.09	80
133	Gopinath et al, 1974	36202	Sheep (*Ovis aries*)	2	U	DR	10	w	6	mo	JV	F	HIS	GHIS	KI		5.09	72
134	King, 1975	2179	Rabbit (*Oryctolagus cuniculus*)	2	U	FD	6	w	5	w	JV	B	ORW	SMIX	IN		5.43	72
135	Ishmael et al, 1971	2155	Sheep (*Ovis aries*)	2	U	OR	88	d	6	mo	JV	F	ORW	SMIX	LI		7.57	70
136	King, 1975	2179	Rabbit (*Oryctolagus cuniculus*)	2	U	FD	6	w	5	w	JV	B	ORW	SMIX	IN		10.9	72
137	Radecki et al, 1992	2255	Pig (*Sus scrofa*)	2	U	FD	14	d	21	d	JV	B	HIS	GHIS	GT		12.0	73
138	DeGoey et al, 1971	2064	Pig (*Sus scrofa*)	2	U	FD	23	d	NR	mo	JV	NR	HIS	NCRO	LI		15.5	73
139	Boyden, 1938	14653	Rat (*Rattus norvegicus*)	5	U	FD	4	w	28	d	JV	B	ORW	ORWT	SP		23.5	73
140	Rana and Kumar, 1980	2256	Rat (*Rattus norvegicus*)	2	U	GV	20	d	90	d	JV	M	HIS	NCRO	LI		39.8	80
141	Rana and Kumar, 1985	2257	Rat (*Rattus norvegicus*)	2	U	GV	20	d	90	d	AD	M	HIS	GHIS	LI		39.8	80
142	Aburto et al, 2001	25964	Rat (*Rattus norvegicus*)	2	U	FD	12	mo	10	w	JV	M	HIS	GHIS	LI		48.7	73
143	Chesta et al, 1989	2047	Guinea pig (*Cavia porcellus*)	2	U	DR	45	d	NR	NR	GE	F	HIS	GHIS	LI		73.7	67
144	Rana et al, 1985	13236	Rat (*Rattus norvegicus*)	2	U	GV	30	d	90	d	JV	M	ORW	SMIX	LI		100	80
145	Fuentealba et al, 2000	36364	Rat (*Rattus norvegicus*)	2	U	FD	12	w	21	d	JV	B	HIS	NCRO	LI		122	72
146	Fuentealba et al, 2000	36364	Rat (*Rattus norvegicus*)	2	U	FD	18	w	NR	NR	GE	F	HIS	NCRO	LI		132	72
147	Fuentealba et al, 1989	2095	Rat (*Rattus norvegicus*)	2	U	FD	4	w	6	w	JV	M	HIS	USTR	LI		135	66
148	Fuentealba et al, 1989	2096	Rat (*Rattus norvegicus*)	2	U	FD	16	w	NR	mo	JV	M	HIS	HYPL	BI		135	66
149	Fuentealba et al, 1993	2097	Rat (*Rattus norvegicus*)	2	U	FD	10	w	NR	mo	JV	M	HIS	HYPL	BI		135	72
150	Fuentealba et al, 1989	2098	Rat (*Rattus norvegicus*)	2	U	FD	3	w	6	w	JV	M	HIS	GHIS	KI		135	66
151	Fuentealba and Haywood, 1988	2094	Rat (*Rattus norvegicus*)	2	U	FD	1	w	6	w	JV	M	HIS	GHIS	LI		135	66
152	Haywood, 1980	2122	Rat (*Rattus norvegicus*)	2	U	FD	15	w	NR	mo	JV	M	HIS	HYPL	BI		157	72
153	Haywood et al, 1985	2125	Rat (*Rattus norvegicus*)	2	U	FD	5	w	NR	mo	AD	M	HIS	NCRO	KI		233	66
154	Haywood and Loughran, 1985	2124	Rat (*Rattus norvegicus*)	5	U	FD	6	w	NR	mo	JV	M	HIS	NCRO	LI		285	73
155	Gooneratne and Howell, 1980	36200	Sheep (*Ovis aries*)	2	U	DR	63	d	6-9	mo	JV	M	HIS	GHIS	MU		1817	72
			Reproduction (REP)															
156	Aulerich et al, 1982	2013	Mink (*Mustela vision*)	5	U	FD	357	d	NR	mo	JV	F	REP	PROG	WO	3.40	6.79	85
157	Thacker, 1991	2304	Pig (*Sus scrofa*)	2	U	FD	7	d	NR	NR	GE	F	REP	PROG	WO	6.51		79
158	Webster, 1979	823	Mouse (*Mus musculus*)	4	U	FD	19	d	4	mo	GE	F	REP	PRWT	WO	50.7		79
159	Lecyk, 1980	2193	Mouse (*Mus musculus*)	7	U	FD	49	d	NR	NR	GE	B	REP	PROG	WO	90.9	136	84
160	Lecyk, 1980	2193	Mouse (*Mus musculus*)	7	U	FD	49	d	NR	NR	GE	B	REP	PROG	WO	90.9	136	84
161	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	FD	13	w	6	w	JV	M	REP	SPCL	SM	107		80
162	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	4	U	FD	92	d	6	w	JV	M	REP	SPCL	SM	304		70
163	Hebert, 1993	2126	Mouse (*Mus musculus*)	6	U	FD	13	w	6	w	JV	M	REP	SPCL	SM	358		76
164	Hebert et al, 1993	2127	Mouse (*Mus musculus*)	4	U	FD	92	d	6	w	JV	M	REP	SPCL	SM	48300		70
165	Cromwell et al, 1993	2062	Pig (*Sus scrofa*)	2	U	FD	783	d	10	mo	GE	F	REP	RSUC	WO		5.51	80
166	Bataineh et al, 1998	1717	Rat (*Rattus norvegicus*)	2	U	DR	12	w	NR	NR	AD	M	REP	TEWT	TE		41.2	67
			Growth (GRO)															
167	Engle and Spears, 2001	25940	Cattle (*Bos taurus*)	2	U	FD	239	d	NR	NR	JV	M	GRO	BDWT	WO	0.812		69
168	Engle et al, 2000	25935	Cattle (*Bos taurus*)	2	U	FD	154	d	NR	NR	JV	M	GRO	BDWT	WO	0.852		69
169	Bailey et al, 2001	25941	Cattle (*Bos taurus*)	3	M	FD	112	d	NR	NR	JV	NR	GRO	BDWT	WO	1.33		73
170	Arthur, 1965	2012	Guinea pig (*Cavia porcellus*)	3	U	FD	8	w	NR	NR	JV	B	GRO	BDWT	WO	1.48		70
171	Uthus, 2001	36349	Rat (*Rattus norvegicus*)	2	U	FD	62	d	NR	NR	JV	M	GRO	BDWT	WO	2.07		77
172	Miranda et al, 1981	36240	Rat (*Rattus norvegicus*)	2	M	FD	5	w	NR	NR	JV	M	GRO	BDWT	WO	3.60		81
173	Bassuny, 1991	2020	Rabbit (*Oryctolagus cuniculus*)	5	U	FD	7	w	35	d	JV	M	GRO	BDWT	WO	4.25		78
174	Ward et al, 1991	1888	Pig (*Sus scrofa*)	2	M	FD	144	d	31	d	JV	B	GRO	BDWT	WO	4.37		74
175	King, 1975	2179	Rabbit (*Oryctolagus cuniculus*)	2	U	FD	8	w	5	w	JV	B	GRO	BDWT	WO	5.43		76
176	Cromwell et al, 1993	2062	Pig (*Sus scrofa*)	2	U	FD	783	d	10.3	mo	GE	F	GRO	BDWT	WO	5.51		69
177	Allcroft et al, 1961	14387	Pig (*Sus scrofa*)	4	M	FD	4	w	8-10	w	JV	B	GRO	BDWT	WO	5.60	9.34	88
178	Gershbein et al, 1983	136	Rat (*Rattus norvegicus*)	2	U	FD	80	d	44	d	JV	M	GRO	BDWT	WO	5.89		68
179	Anugwa et al, 1984	2010	Rabbit (*Oryctolagus cuniculus*)	3	M	FD	8	w	8	w	JV	B	GRO	BDWT	WO	6.67		74
180	Apgar et al, 1995	25922	Pig (*Sus scrofa*)	4	M	FD	5	w	31	d	JV	B	GRO	BDWT	WO	6.90		74

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
181	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	4	U	FD	28	d	26-32	d	JV	B	GRO	BDWT	WO	7.19		69
182	Omole, 1977	12977	Rabbit (*Oryctolagus cuniculus*)	4	U	FD	8	w	6	w	JV	B	GRO	BDWT	WO	7.34		69
183	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	2	U	FD	28	d	26-32	d	JV	B	GRO	BDWT	WO	7.36		69
184	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	2	M	FD	28	d	29	d	JV	B	GRO	BDWT	WO	7.37		74
185	Kline et al, 1971	20975	Pig (*Sus scrofa*)	4	M	FD	88	d	69	d	JV	NR	GRO	BDWT	WO	7.63		73
186	Gipp et al, 1973	14396	Pig (*Sus scrofa*)	2	U	FD	12	w	NR	NR	JV	F	GRO	BDWT	WO	7.66		68
187	Cromwell et al, 1989	2061	Pig (*Sus scrofa*)	3	U	FD	28	d	28	d	JV	B	GRO	BDWT	WO	7.68		69
188	Luo and Dove, 1996	25929	Pig (*Sus scrofa*)	2	U	FD	15	d	26	d	JV	M	GRO	BDWT	WO	7.72		69
189	Myres and Bowland, 1973	12809	Pig (*Sus scrofa*)	2	U	FD	10	w	70	d	JV	B	GRO	BDWT	WO	7.84		69
190	Ritchie et al, 1963	14402	Pig (*Sus scrofa*)	2	U	FD	15	w	7	w	JV	NR	GRO	BDWT	WO	8.08		68
191	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	2	M	FD	28	d	30	d	JV	B	GRO	BDWT	WO	8.21		74
192	Braude and Ryder, 1973	2034	Pig (*Sus scrofa*)	4	M	FD	112	d	9	w	JV	NR	GRO	BDWT	WO	8.29		73
193	Allcroft et al, 1961	14387	Pig (*Sus scrofa*)	4	M	FD	19	w	8-10	w	JV	B	GRO	BDWT	WO	8.43		73
194	Prince et al 1979	2253	Pig (*Sus scrofa*)	2	U	FD	59	d	64	d	JV	NR	GRO	BDWT	WO	8.44		68
195	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	3	M	FD	28	d	29	d	JV	B	GRO	BDWT	WO	8.50		74
196	Cromwell et al, 1998	25930	Pig (*Sus scrofa*)	4	M	FD	28	d	30	d	JV	B	GRO	BDWT	WO	8.68		74
197	Cromwell et al 1989	2061	Pig (*Sus scrofa*)	3	U	FD	28	d	28	d	JV	B	GRO	BDWT	WO	9.60		69
198	Gipp et al, 1974	14397	Pig (*Sus scrofa*)	2	U	FD	35	d	3	w	JV	B	GRO	BDWT	WO	9.93		69
199	Brandt, 1983	2033	Mink (*Mustela vision*)	3	M	FD	4	mo	90	d	JV	M	GRO	BDWT	WO	10.2	19.6	88
200	Edmonds and Baker, 1986	2075	Pig (*Sus scrofa*)	3	U	FD	28	d	4	w	JV	NR	GRO	BDWT	WO	10.3	26.9	84
201	Radecki et al, 1992	2255	Pig (*Sus scrofa*)	2	U	FD	14	d	21	d	JV	B	GRO	BDWT	WO	12.0		68
202	Aulerich et al, 1982	2013	Mink (*Mustela vision*)	5	U	FD	20	w	NR	mo	JV	B	GRO	BDWT	WO	12.4		68
203	Felsman et al, 1973	3760	Cattle (*Bos taurus*)	4	U	FD	98	d	6	w	JV	M	GRO	BDWT	WO	12.7		68
204	Smith et al, 1975	3756	Horse - Shetland pony (*Equus caballus*)	4	M	FD	84	d	NR	NR	JV	NR	GRO	BDWT	WO	13.8		74
205	Suttle and Mills, 1966	3757	Pig (*Sus scrofa*)	3	U	FD	14	d	NR	NR	JV	F	GRO	BDWT	WO	16.2	27.6	84
206	Cromwell et al, 1989	2061	Pig (*Sus scrofa*)	5	U	FD	33	d	28	d	JV	B	GRO	BDWT	WO	16.4		69
207	Apgar and Kornegay, 1996	25928	Pig (*Sus scrofa*)	2	M	FD	14	d	NR	NR	JV	M	GRO	BDWT	WO	16.5		77
208	Cromwell et al, 1989	2061	Pig (*Sus scrofa*)	4	U	FD	28	d	28	d	JV	B	GRO	BDWT	WO	16.7		69
209	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	DR	15	d	6	w	JV	B	GRO	BDWT	WO	17.2	51.6	79
210	Lalich et al, 1965	2189	Rat (*Rattus norvegicus*)	2	U	FD	42	d	NR	NR	JV	M	GRO	BDWT	WO	17.5		68
211	Cromwell et al, 1989	2061	Pig (*Sus scrofa*)	4	U	FD	28	d	28	d	JV	B	GRO	BDWT	WO	17.8		69
212	Felsman et al, 1973	3760	Cattle (*Bos taurus*)	4	U	FD	98	d	6	w	JV	M	GRO	BDWT	WO	22.9		68
213	Grobner et al, 1986	2113	Rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	d	28	d	JV	NR	GRO	BDWT	WO	27.7	45.7	89
214	Onifade and Abu, 1998	2237	Rabbit (*Oryctolagus cuniculus*)	4	U	FD	70	d	7	w	JV	NR	GRO	BDWT	WO	28.4		77
215	Bush et al, 1995	2043	Mink (*Mustela vision*)	3	M	FD	132	d	10	w	JV	B	GRO	BDWT	WO	33.4		82
216	Hebert, 1993	2126	Mouse (*Mus musculus*)	6	U	DR	8	d	6	w	JV	B	GRO	BDWT	WO	33.8	101	78
217	King, 1975	2179	Rabbit (*Oryctolagus cuniculus*)	2	U	FD	6	w	5	w	JV	B	GRO	BDWT	WO	37.1		67
218	White et al, 1985	2324	Rat (*Rattus norvegicus*)	2	U	FD	50	d	21	d	JV	M	GRO	BDWT	WO	43.1		68
219	DeVries et al, 1986	10891	Rat (*Rattus norvegicus*)	2	U	DR	11	mo	3	w	JV	F	GRO	BDWT	WO	45.8		73
220	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	FD	13	w	6	w	JV	B	GRO	BDWT	WO	49.8	99.6	84
221	Komulainen, 1983	12079	Rat (*Rattus norvegicus*)	4	U	DR	1	w	4	w	JV	M	GRO	BDWT	WO	50.0	64.0	82
222	Grobner et al, 1986	2113	Rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	d	28	d	JV	NR	GRO	BDWT	WO	59.0		74
223	Myers et al, 1993	2225	Rat (*Rattus norvegicus*)	2	U	DR	6	w	NR	mo	JV	M	GRO	BDWT	WO	73.4		67
224	Tatum et al, 2000	36389	Rat (*Rattus norvegicus*)	2	U	FD	6	w	NR	NR	JV	F	GRO	BDWT	WO	75.7		68
225	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	FD	15	d	6	w	JV	B	GRO	BDWT	WO	82.5	165	84
226	Keen et al, 1982	11928	Rat (*Rattus norvegicus*)	4	U	FD	7	w	NR	NR	JV	F	GRO	BDWT	WO	91.7	183	83
227	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	6	U	FD	92	d	6	w	JV	M	GRO	BDWT	WO	146	293	83
228	Hebert, 1993	2126	Mouse (*Mus musculus*)	6	U	FD	13	w	6	w	JV	B	GRO	BDWT	WO	179	358	84
229	Dodds-Smith et al, 1992	440	Common shrew (*Sorex araneus*)	2	U	FD	12	w	NR	NR	JV	B	GRO	BDWT	WO	229		77
230	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	5	U	DR	2	w	6	w	JV	M	GRO	BDWT	WO	259	400	78
231	Pettersen et al, 2002	36374	Mouse (*Mus musculus*)	3	U	FD	3	w	4	w	JV	B	GRO	BDWT	WO	494	988	83
232	Hebert, 1993	2126	Mouse (*Mus musculus*)	6	U	FD	15	d	6	w	JV	B	GRO	BDWT	WO	690		69
233	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	6	U	FD	15	d	6	w	JV	M	GRO	BDWT	WO	812	1740	83
234	Hebert et al, 1993	2127	Mouse (*Mus musculus*)	5	U	DR	2	w	6	w	JV	M	GRO	BDWT	WO	1430	3400	78
235	Hebert et al, 1993	2127	Mouse (*Mus musculus*)	6	U	FD	92	d	6	w	JV	M	GRO	BDWT	WO	2110	4670	83
236	Hebert et al, 1993	2127	Mouse (*Mus musculus*)	6	U	FD	15	d	6	w	JV	F	GRO	BDWT	WO	19500	47500	83
237	Solaiman et al, 2001	36748	Goat (*Capra hircus*)	3	U	GV	9	w	7-8	mo	JV	F	GRO	BDWT	WO		1.47	80
238	Ortolani et al, 2003	36759	Sheep (*Ovis aries*)	2	U	DR	35	d	6	mo	JV	M	GRO	BDWT	WO		3.00	76
239	Freundt and Ibrahim, 1990	2640	Rat (*Rattus norvegicus*)	2	U	DR	91	d	NR	NR	JV	F	GRO	BDWT	WO		5.78	72
240	DeGoey et al, 1971	2064	Pig (*Sus scrofa*)	2	U	FD	98	d	NR	NR	JV	B	GRO	BDWT	WO		7.46	78
241	DeGoey et al, 1971	2064	Pig (*Sus scrofa*)	2	U	FD	23	d	NR	NR	JV	NR	MPH	MUSC	MU		15.5	77
242	Boyden, 1938	14653	Rat (*Rattus norvegicus*)	5	U	FD	4	w	28	d	JV	B	GRO	BDWT	WO		23.5	77

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

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
243	Rana and Kumar, 1980	2256	Rat (*Rattus norvegicus*)	2	U	GV	20	d	90	d	JV	M	GRO	BDWT	WO		39.8	84
244	Kumar et al, 1987	2186	Rat (*Rattus norvegicus*)	2	U	GV	45	d	90	d	JV	M	GRO	BDWT	WO		39.8	84
245	Llewellyn et al, 1985	2203	Rat (*Rattus norvegicus*)	2	U	FD	21	w	NR	NR	JV	M	GRO	BDWT	WO		106	71
246	Fuentealba et al, 2000	36364	Rat (*Rattus norvegicus*)	2	U	FD	12	w	21	d	JV	B	GRO	BDWT	WO		122	76
247	Haywood, 1985	2121	Rat (*Rattus norvegicus*)	5	U	FD	15	w	NR	NR	JV	M	GRO	BDWT	WO		274	71
248	Haywood and Loughran, 1985	2124	Rat (*Rattus norvegicus*)	5	U	FD	6	w	NR	mo	JV	M	GRO	BDWT	WO		285	77
			Survival (MOR)															
249	Bassuny, 1991	2020	Rabbit (*Oryctolagus cuniculus*)	5	U	FD	7	w	35	d	JV	M	MOR	MORT	WO	4.25		79
250	Cromwell et al, 1993	2062	Pig (*Sus scrofa*)	2	U	FD	783	d	10.3	mo	GE	F	MOR	MORT	WO	5.51		70
251	Allcroft et al, 1961	14387	Pig (*Sus scrofa*)	4	M	FD	4	w	8-10	w	JV	B	MOR	MORT	WO	5.60	9.34	89
252	Brandt, 1983	2033	Mink (*Mustela vision*)	3	M	FD	4	mo	90	d	JV	M	MOR	MORT	WO	10.2	19.6	89
253	Jenkins, 1989	48117	Cattle (*Bos taurus*)	5	U	FD	6	w	3	d	JV	M	MOR	MORT	WO	16.3	32.5	77
254	Boyden, 1938	14653	Rat (*Rattus norvegicus*)	5	U	FD	1	w	28	d	JV	B	MOR	MORT	WO	23.3	35.0	84
255	Edmonds and Baker, 1986	2075	Pig (*Sus scrofa*)	3	U	FD	28	d	4	w	JV	NR	MOR	MORT	WO	25.9		79
256	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	DR	15	d	6	w	JV	B	MOR	MORT	WO	33.3	111	78
257	Bush et al, 1995	2043	Mink (*Mustela vision*)	3	M	FD	132	d	10	w	JV	B	MOR	MORT	WO	33.4		83
258	Hebert, 1993	2126	Mouse (*Mus musculus*)	6	U	DR	15	d	6	w	JV	F	MOR	MORT	WO	33.8	101	80
259	Grobner et al, 1986	2113	Rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	d	28	d	JV	NR	MOR	MORT	WO	45.5		75
260	Grobner et al, 1986	2113	Rabbit (*Oryctolagus cuniculus*)	6	M	FD	28	d	28	d	JV	NR	MOR	MORT	WO	59.0		75
261	Keen et al, 1982	11928	Rat (*Rattus norvegicus*)	4	U	FD	7	w	NR	NR	JV	F	MOR	MORT	WO	91.7	183	84
262	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	FD	13	w	6	w	JV	B	MOR	MORT	WO	107		79
263	Dodds-Smith et al, 1992	440	Common shrew (*Sorex araneus*)	2	U	FD	12	w	NR	NR	JV	B	MOR	MORT	WO	229		78
264	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	5	U	DR	2	w	6	w	JV	M	MOR	MORT	WO	259	400	79
265	Hebert, 1993	2126	Rat (*Rattus norvegicus*)	6	U	FD	15	d	6	w	JV	B	MOR	MORT	WO	307		79
266	Haywood, 1985	2121	Rat (*Rattus norvegicus*)	5	U	FD	2	w	NR	NR	JV	M	MOR	MORT	WO	457	548	78
267	Hebert, 1993	2126	Mouse (*Mus musculus*)	6	U	FD	15	d	6	w	JV	B	MOR	MORT	WO	690		70
268	Hebert, 1993	2126	Mouse (*Mus musculus*)	6	U	FD	13	w	6	w	JV	B	MOR	MORT	WO	760		79
269	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	6	U	FD	92	d	6	w	JV	B	MOR	MORT	WO	798		78
270	Hebert et al, 1993	2127	Mouse (*Mus musculus*)	5	U	DR	2	w	6	w	JV	B	MOR	MORT	WO	1430	3400	79
271	Hebert et al, 1993	2127	Rat (*Rattus norvegicus*)	6	U	FD	15	d	6	w	JV	M	MOR	MORT	WO	4160		78
272	Hebert et al, 1993	2127	Mouse (*Mus musculus*)	6	U	FD	15	d	6	w	JV	B	MOR	MORT	WO	47500		78
273	Hebert et al, 1993	2127	Mouse (*Mus musculus*)	6	U	FD	92	d	6	w	JV	B	MOR	MORT	WO	48300		78
274	Gopinath et al, 1974	36202	Sheep (*Ovis aries*)	2	U	DR	10	w	6	mo	JV	F	MOR	MORT	WO		5.09	77
275	Ishmael et al, 1971	2155	Sheep (*Ovis aries*)	2	U	OR	31	d	6	mo	JV	F	MOR	MORT	WO		7.57	75
276	Ritchie et al, 1963	14402	Pig (*Sus scrofa*)	2	U	FD	15	w	7	w	JV	NR	MOR	MORT	WO		8.08	78
277	DeGoey et al, 1971	2064	Pig (*Sus scrofa*)	2	U	FD	23	d	NR	NR	JV	NR	MOR	MORT	WO		15.5	78
278	McNatt et al, 1971	2216	Rat (*Rattus norvegicus*)	2	U	DR	3	w	4-11	mo	JV	M	MOR	MORT	WO		114	68

AATT = alanine aminotransferase; AD = adult; AHDX = aniline hydroxylase; ASAT = aspartate aminotransferase; B = both; BDWT = body weight changes; BEH = behavior; BI = bile; BIO = biochemical; BL = blood; BLPR = blood pressure; BR = brain; bw = body weight; CALC = calcium; CHM = chemical changes; CTYP = percent cell type; d = day; DIFD = digestibility of food; DR = Drinking water; DT - digestive tract; ENZ = enyzme level changes; F = female; FCNS = food consumption; FD = food; FDB = feeding behavior; FDCV = food conversion efficiency; FDNG = feeding behavior; FFTA = fatty acids, free; FO = foot; G6PD = glucose-6-phosphate dehydrogenase; GBCM = general biochemical changes; GE = gestation; GENZ = general enzyme changes; GGTR = (gamma) Y-glutamyltransferase; GHIS = general histology; GHRM = general hormone; GITX = general intoxication; GLPX = glutathione peroxidase; GLTH = glutathione; GLUC = glucose; GLYC = glycogen; GPHY = general pysiology changes; GRO = growth; GRS = gross body weight changes; GT = gastrointestinal tract; GV = gavage; HA = hair; HE = heart; HIS = histological changes; HMGL = hemoglobin; HRM = hormone changes; HYPL = hyperplasia; IN = intestinal tract; IRRI = skin irritation; ITX = intoxication; JV = juvenile; kg = kilograms; KI = kidney; LC = lactation; LD = lipid; LI = liver; LOAEL = lowest observed adverse effect level; mg = milligrams; mo = months; M = male; M = measured; MK = milk, lactating females; MOR = effects on mortality and survival; MORT = mortality; MPH = morphology; MT = multiple; MU = muscle; MUSC = muscle changes; NACO = sodium; NOAEL = No Observed Advese Effect Level; NCRO = necrosis; NR = Not reported; NMVM = number of movements; OR = other oral; ORW = organ weight changes; ORWT = organ weight changes; PCLV = packed cell volume; PHY = physiology; PL = plasma; PROG = progeny numbers/counts; PRTL = protein, total; PRWT = progeny weight; PTH = pathology; RBCE = red blood cell count; REP = reproduction; RSUC = sperm cell counts; SH = stomach; SK = skin; SM = sexually mature; SMIX = weight relative to body weight; SP = spleen; SPCL = sperm cell counts; SR = serum; SURV = survival; TE = testes; TEWT = testes weight; TS = thymus; TWBC = white blood cell count, total; U = unmeasured; UR = urine; USTR = ultrastructural changes; VTMA = vitamin A; w = weeks; WCON = water consumption; WO = whole organism; yr = year.

*NOAEL and LOAEL values that are equal and from the same reference represent different experimental designs. These are designated with different Phase numbers in Appendix 6.1.

Within the reviewed papers there are 278 results for biochemical (BIO), behavior (BEH), physiology (PHY), 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 25 mg copper/kg bw/day. However, this value is higher than the lowest bounded LOAEL for reproduction, growth, or mortality results. Therefore, the TRV is equal to the highest bounded NOAEL below the lowest bounded LOAEL for reproduction, growth, or survival, and is equal to 5.60 mg copper/kg bw/day.

6.2 Estimation of Dose and Calculation of the Eco-SSL

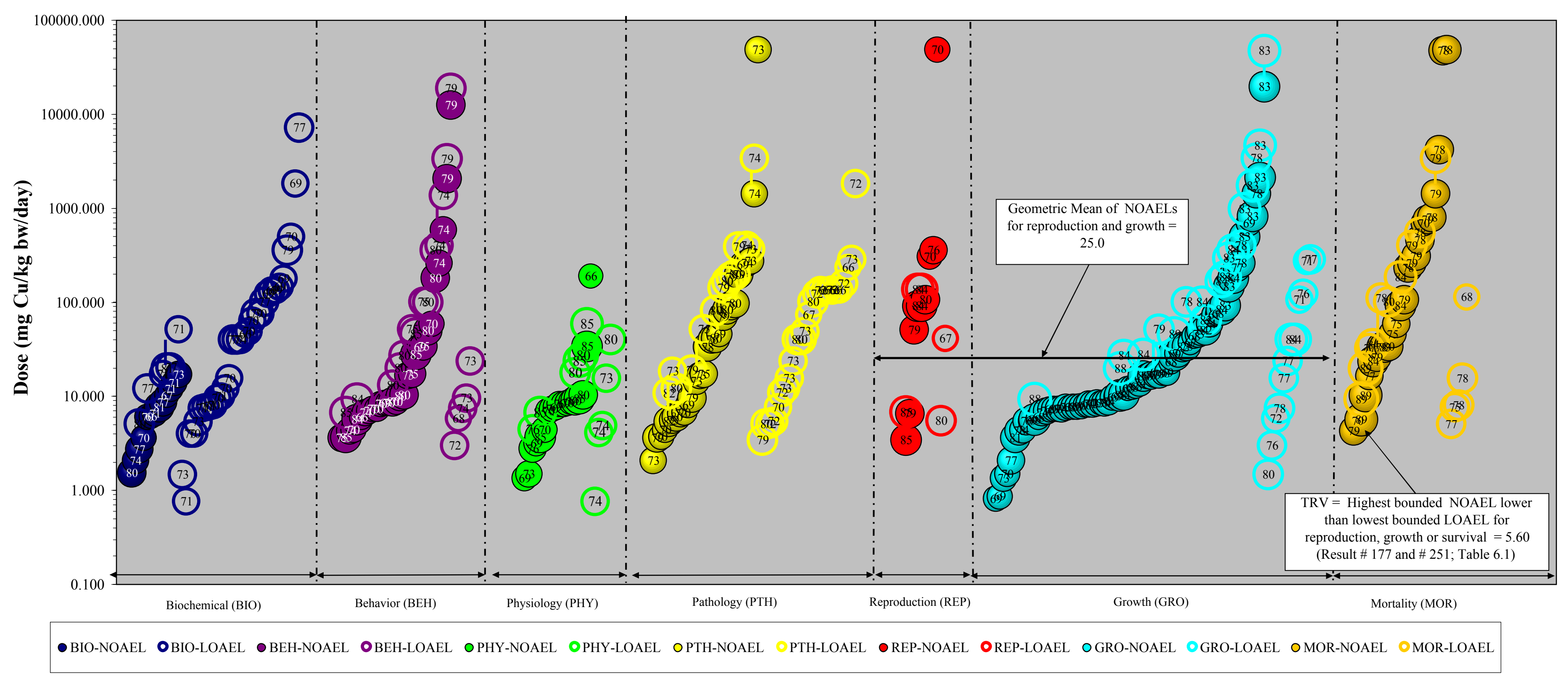
Three separate Eco-SSL values were calculated for mammalian wildlife, one for each of three surrogate receptor groups representing different trophic levels. The mammalian Eco-SSLs derived for copper were calculated according to the Eco-SSL guidance (U.S. EPA, 2003; Attachment 4-5) and are summarized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

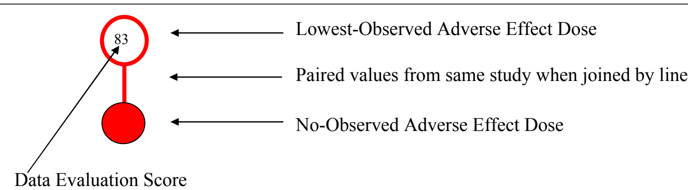
Table 6.2 Calculation of the Mammalian Eco-SSLs for Copper

Surrogate Receptor Group	TRV for Copper (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 Copper in Biota Type (i)[2,3] (B_i) (mg/kg dw)	Eco-SSL *(mg/kg dw)*[4]
Mammalian herbivore (vole)	5.60	0.0875	0.032	$\ln(B_i) = 0.394 * \ln(Soil_j) + 0.688$ where i = plants	1100
Mammalian ground insectivore (shrew)	5.60	0.209	0.030	$B_i = 0.515 * Soil_j$ where i = earthworms	49
Mammalian carnivore (weasel)	5.60	0.130	0.043	$\ln(B_i) = 0.1444 * \ln(Soil_j) + 2.042$ where i = mammals	560

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

Figure 6.1 Mammalian TRV Derivation for Copper





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.

3) The geometric mean is equal to 25.0 mg copper/kg bw/d and is higher than the lowest bounded LOAEL for results within the reproduction, growth, and survival (MOR) effect groups.

4) The mammalian wildlife TRV for copper is equal to 5.60 mg copper/kg bw/day which is the highest NOAEL value lower than the lowest LOAEL value for reproduction and growth.

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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.

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Diss adriamycin cardiotoxicity and essential trace metal homeostasis in the in vivo rat heart (doxorubicin, cardiomyopathy, manganese, iron). *901491 ORDER NO: AAD85-26534*

Not Avail amino acid metal complexes using hydrolyzed protein as the amino acid source and methods re same. *U.S.* 11 pp.

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Unrel antiviral, antibacterial, antifungal agents containing polysaccharide antimicrobial metal salts and their compositions. *Jpn. Kokai Tokkyo Koho* : 7 pp.

Mix aqueous feed additive comprising lactic acid, organic acid and chelated trace elements. *PCT Int. Appl.* 15 pp.

Diss arsenic: an analytical procedure to determine its total content in biological samples and signs of its deprivation in rats and chicks. *788794 ORDER NO: AAD82-20750*

Diss the biochemistry of transition metals: copper, vanadium, and iron. *738101 ORDER NO: AAD81-03507*

FL	birds and fowls fodder additive prescription and its prepn. *Faming Zhuanli Shenqing Gongkai Shuomingshu* : 10 pp.
FL	1985. a case of copper poisoning in calves. *TIJDSCHR DIERGENEESKD.* 10(10): 405-406.
Diss	characterization, fate and environmental risk assessment of microbial, elemental and toxic components of fractionated broiler litter during storage and reutilization. *01295605 ORDER NO: AAD93-16361*
Not Avail	1969.*Contemporary Agriculture, Volume 16, Number 4, 1968. SFCSI-AGR(TT-68-50058/4)*
Diss	content and evolution of cadmium, cobalt, chromium, copper, nickel, lead, and zinc in soils of l'horta and ribera baixa regions (valencia) (spain) original title: contenido y evolucion de cadmio, cobalto, cromo, cobre, niquel, plomo, cinc en suelos de las comarcas de l'horta y la baixa (valencia). *01269400 ORDER NO: NOT AVAILABLE FROM UNIVERSITY MICROFILMS INT'L.*
Diss	copper absorption from the small intestine of the chicken (gallus domesticus) (metallothionein, estrogen). *845064 ORDER NO: AAD84-12711*
Nut def	1983. copper deficiency and developmental emphysema. *Nutrition Reviews* 41(10): 318-20.
Diss	crystallographic studies of transport proteins and ligands (thiobacillus ferrooxidans, didelphins virginiana, multiplewavelength anomalous dispersion). *01695894 ORDER NO: AAD99-23629*
Diss	development of a cloning system for gene expression in pasteurella multocida|. *01295811 ORDER NO: AAD93-16820*
Diss	diabetes teratogenicity: role of altered mineral metabolism. *1070710 ORDER NO: AAD89-10542*
Diss	ecology and toxicology of arsenic in contaminated grassland. *0996661 ORDER NO: NOT AVAILABLE FROM UNIVERSITY MICROFILMS INT'L.*
Diss	ecophysiology of the common cockle (cerastoderma edule l.) in southampton water, with particular reference to pollution (england). *1092481 ORDER NO: AADDX-87466*
Diss	the effect of chromium depletion and streptozotocin-induced diabetes in pregnancy. *01593456 ORDER NO: AAD97-30469*
Diss	the effect of zinc deficiency on immune function. *01173644 ORDER NO: AAD91-18419*
Diss	effects of cellulase from trichoderma viride on wheat bran utilization and the minerals influenced by cell wall components in broiler diets|. *858634 ORDER NO: AAD84-21622*
Diss	effects of dietary fatty acids, polyunsaturated/saturated ratios, and fat levels on growth and mineral deposition in young male rats (fatty acids). *01156306 ORDER NO: AAD91-05922*
Diss	effects of dietary glycine and copper on metabolic symptoms induced by a methionine toxicity in the chick. *774569 ORDER NO: AAD82-07283*
Diss	the effects of dietary sodium zeolite a on growth and mineral utilization of chickens. *01295923 ORDER NO: AAD93-17007*
Diss	elastin metabolism in avian lung and aorta: effects of selected nutritional factors. *771828 ORDER*

NO: AAD82-05013

Mix electrolyte feed supplement for poultry hatchlings. *U.S.S.R. From: Izobreteniya 1992* (7): 14.

Diss etiology and physiology of chemical-induced tibial dyschondroplasia in broiler chickens|. *01124219 ORDER NO: AAD90-27533*

Diss etude de l'evolution des systemes antioxydants au cours du developpement de l'insuffisance cardiaque experimentale chez le rat original title: study of antioxidant systems during the development of experimental cardiac failure in rat (mrna, ischemia, superoxide dismutase, manganese, copper-zinc). *01476944 ORDER NO: AADAA-IC484409*

Diss an examination of the development and maintenance of the deafferented olfactory cortex. *1053096 ORDER NO: AAD82-12323*

Diss experimental copper deficiency in the golden hamster and in healthy adult men. *800202 ORDER NO: AAD83-01960*

Diss expression of antioxidant enzymes in copper deficient rat brain, heart, and liver. *01452581 ORDER NO: AADAA-I9543281*

Diss factors affecting copper utilization (bioavailability). *01409018 ORDER NO: AADAA-I9512287*

Diss factors affecting the toxicity and metabolism of organic arsenicals (roxarsone, copper, cysteine). *1003496 ORDER NO: AAD85-02122*

Diss functional assessment of manganese status (superoxide dismutase, biliary excretion). *01447018 ORDER NO: AADAA-I9527297*

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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 ligature, 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, *Bacillus thuringiensis*, 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)	*In vitro* 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 histosoils (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 Efct)	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 then 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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Eco-SSL
Ecological Soil Screening Levels

Appendix 5-1

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

February 2007

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Ref			Exposure																					Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	**Ref N.**	**Reference**	**Chemical Form**	**MW%**	**Test Species**	**Phase #**	**# of Conc/ Doses**	**Conc/ Doses**	**Conc/Dose Units**	**Wet Weight Reported?**	**Percent Moisture**	**Application Frequency**	**Method of Analyses**	**Route of Exposure**	**Exposure Duration**	**Duration Units**	**Age**	**Age Units**	**Lifestage**	**Sex**	**Control Type**	**Test Location**	**Endpoint Number**	**General Effect Group**	**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 Concentrations**	**Chemical form**	**Dose Quantification**	**Endpoint**	**Dose Range**	**Statistical Power**	**Exposure Duration**	**Test Conditions**	**Total**
Biochemical																																														
1	6530	Rangachar and Jayprakash, 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/100	mg/kg diet	N	N	ADL	U	FD	105	d	10	w	JV	M	C	COM	1	BIO	CHM	HMGL	BL	100		N	1.3	N	0.0690	5.31		10	10	5	10	5	1	4	10	10	4	69
2	2048	Chiou et al, 1999	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/100/250/500	mg/kg diet	N	N	NR	U	FD	3	w	3	w	JV	NR	C	DOM	4	BIO	ENZ	CRKI	BL	100	250	Y	1.945	Y	0.1144	5.32	13.3	10	10	5	10	7	1	10	10	10	4	77
3	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	7	2	0/52.4	mg/L	N	N	DLY	M	DR	14	d	4	d	JV	NR	C	COM	3	BIO	CHM	GLUC	BL	52.4		Y	0.2594	Y	0.04981	10.1		10	5	10	10	7	1	4	10	10	4	71
4	2294	Pearce et al 1983	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/250/500/1000	mg/kg diet	N	N	ADL	U	FD	5	d	27	w	JV	F	C	NR	2	BIO	CHM	LIPD	BL	250	500	N	1.6	N	0.07903	12.3	24.7	10	10	5	10	5	1	10	10	10	4	75
5	2160	Jackson, et. al., 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/23.5/43.84/56.47/60.43	mg/org/d	N	N	ADL	U	FD	224	d	17	w	SM	F	C	NR	6	BIO	CHM	LIPD	LI	23.5	43.84	Y	1.886	Y	0.11348	12.5	23.2	10	10	5	10	7	1	10	10	10	4	77
6	2294	Pearce et al 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/250/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	6	d	26	w	SM	F	C	NR	4	BIO	CHM	LIPD	LI	250	500	N	1.6	Y	0.089	13.9	27.8	10	10	5	10	6	1	10	10	10	4	76
7	36263	Poupoulis and Jensen, 1976	Copper	100	Chicken (*Gallus domesticus*)	1	5	0/125/250/500/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	M	C	COM	1	BIO	CHM	FFTA	LD	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	4	5	1	10	10	10	4	69
8	6788	Ward et al, 1995	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	2	0/6.34	mg/org/d	N	N	ADL	M	FD	10	d	5	d	JV	M	C	DOM	4	BIO	CHM	HMGL	BL	6.34		Y	0.3465	Y	0.035	18.3		10	10	10	10	7	1	4	1	10	4	67
9	2293	Stevenson and Jackson 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	8	w	24	w	SM	F	C	NR	4	BIO	CHM	LIPD	LI	500	1000	N	1.6	Y	0.07229	22.6	45.2	10	10	5	10	6	1	10	10	10	4	76
10	2049	Chiou et al, 1998	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/400/500/600	mg/kg diet	N	N	ADL	U	FD	1	w	38	w	SM	F	C	COM	4	BIO	ENZ	LADH	SR	500	600	N	1.464	N	0.07459	25.5	30.6	10	10	5	10	5	1	10	10	10	4	75
11	2050	Chiou et al, 1997	Copper (II) sulfate	100	Chicken (*Gallus domesticus*)	1	5	0/195/405/598/758	ug/g diet	N	N	ADL	M	FD	4	w	28	w	SM	F	C	COM	7	BIO	ENZ	ASAT	SR	405	598	Y	1.427	Y	0.097	27.5	40.6	10	10	10	10	7	1	10	10	10	4	82
12	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	SM	F	C	NR	6	BIO	CHM	LIPD	LI	600	750	Y	1.54	N	0.07709	30.0	37.5	10	10	5	10	6	1	10	10	10	4	76
13	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	7	BIO	CHM	LIPD	LI	600	750	Y	1.41	Y	0.08286	35.3	44.1	10	10	5	10	7	1	10	10	10	4	77
14	2194	Ledoux, et.al. 1987	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/400/800	mg/kg diet	N	N	ADL	UX	FD	21	d	1	d	JV	F	C	NR	5	BIO	ENZ	GOTR	SR	800		N	0.564	Y	0.0256	36.3		10	10	10	10	6	1	4	8	10	4	73
15	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	7	BIO	CHM	LIPD	LI	600	750	Y	1.77	Y	0.118	40.0	50.0	10	10	5	10	7	1	10	10	10	4	77
16	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	6	5	0/2.1/9.9/50.15/250.85	mg/L	N	N	DLY	M	DR	14	d	4	d	JV	NR	C	COM	3	BIO	CHM	URIC	BL	50.2	250.9	Y	0.2379	Y	0.245	51.6	258	10	5	10	10	7	1	8	10	10	4	75
17	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	2	2	0/503.4	mg/kg diet	N	N	DLY	M	FD	35	d	3	d	JV	NR	C	COM	3	BIO	CHM	HEMT	BL	503.4		Y	0.8668	Y	0.13002	75.5		10	10	10	10	7	1	4	3	10	4	69
18	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	1	4	0/218.5/420/1024	mg/kg diet	N	N	DLY	M	FD	35	d	3	d	JV	NR	C	COM	3	BIO	CHM	GLUC	SR	1024		Y	0.7181	Y	0.208	297		10	10	10	10	7	1	4	10	10	4	76
19	2244	Pesti and Bakalli 1996	Cupric citrate	100	Chicken (*Gallus domesticus*)	6	4	0/50/75/100	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	3	BIO	CHM	CHOL	BT		50	N	2.19	N	0.09695		2.21	10	10	5	10	5	1	4	10	10	4	69
20	2244	Pesti and Bakalli 1996	Cupric citrate	100	Chicken (*Gallus domesticus*)	4	3	0/63/125	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	3	BIO	CHM	CHOL	BT		63	N	2.155	N	0.09594		2.80	10	10	5	10	5	1	4	10	10	4	69
21	2160	Jackson, et. al., 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/10.39/21.31/31.52/39.91	mg/org/d	N	N	ADL	U	FD	336	d	17	w	SM	F	C	NR	5	BIO	CHM	LIPD	LI		10.39	Y	2.032	Y	0.104		5.11	10	10	5	10	7	1	4	10	10	4	71
22	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	5	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	2	BIO	CHM	CHOL	BT		125	N	2.148	N	0.09574		5.57	10	10	5	10	5	1	4	10	10	4	69
23	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	21	d	1	d	JV	M	C	COM	3	BIO	CHM	CHOL	PL		125	N	1.884	N	0.0879		5.83	10	10	5	10	5	1	4	10	10	4	69
24	2107	Gill et al, 1995	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	4	0/0.05/0.1/0.5	% in diet	N	N	DLY	U	FD	2	w	4	w	JV	M	C	DOM	3	BIO	ENZ	SGOT	SR		0.05	Y	0.348	Y	0.01397		7.99	10	10	5	10	7	1	4	10	10	4	71
25	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	7	2	0/187	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	3	BIO	CHM	CHOL	BT		187	N	2.26	N	0.09896		8.19	10	10	5	10	5	1	4	10	10	4	69
26	25969	Skrivan et al, 2000	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/208	mg/kg diet	N	N	ADL	M	FD	38	d	1	d	JV	M	C	COM	3	BIO	CHM	CHOL	AD		208	Y	1.876	N	0.08766		9.72	10	10	10	10	6	1	4	10	10	4	75
27	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/250	mg/kg diet	N	N	ADL	U	FD	42	d	21	d	JV	M	C	COM	3	BIO	CHM	CHOL	BT		250	N	1.963	N	0.09028		11.5	10	10	5	10	5	1	4	10	10	4	69
28	2226	Nam et al 1984	Copper carbonate	51.43	Chicken (*Gallus domesticus*)	1	3	0/0.05/0.10	% in diet	N	N	ADL	U	FD	4	w	3	d	JV	NR	C	COM	3	BIO	CHM	GBCM	NR		0.05	N	1.042	Y	0.0543		13.4	10	10	5	10	6	1	4	10	10	4	70
29	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	9	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	BIO	CHM	PHPH	GZ		250	N	1.042	N	0.05978		14.3	10	10	5	10	5	1	4	10	10	4	69
30	3717	Bakalli et al, 1995	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	20	d	1	d	JV	M	C	COM	3	BIO	CHM	CHOL	PL		250	N	0.564	N	0.04009		17.8	10	10	5	10	5	1	4	10	10	4	69
31	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/440	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	SM	F	C	NR	6	BIO	ENZ	AATT	SR		440	Y	1.4	Y	0.07614		23.9	10	10	10	10	7	1	4	10	10	4	76
32	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/920	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	JV	F	C	NR	6	BIO	ENZ	AATT	SR		920	Y	1.41	Y	0.04667		30.4	10	10	10	10	7	1	4	10	10	4	76
33	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	2	0/1830	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	JV	F	C	NR	5	BIO	ENZ	AATT	SR		1830	Y	1.41	Y	0.02714		35.2	10	10	10	10	7	1	4	10	10	4	76
34	2084	Ekperigin and Vohra 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/500/1000	mg/kg diet	N	N	DLY	U	FD	4	w	12	d	JV	NR	C	NR	2	BIO	CHM	GLCN	LI		500	N	0.564	N	0.04009		35.5	10	10	5	10	5	1	4	10	10	4	69
35	80	Van Vleet et al, 1981	Copper sulfate	100	Duck (*Anas platyrhynchos*)	2	2	0/1500	mg/kg diet	N	N	ADL	U	FD	15	d	1	d	JV	M	C	COM	3	BIO	ENZ	GLPX	BL		1500	N	0.092	N	0.01231		201	10	10	5	10	5	1	4	10	10	4	69
Behavior																																														
36	2007	Hoda and Maha, 1995	Copper sulfate	25	Chicken (*Gallus domesticus*)	3	3	0/75/150	mg/kg diet	N	N	ADL	U	FD	6	w	1	d	JV	NR	C	LAB	2	BEH	FDB	FCNS	WO	150		Y	1.1273	Y	0.05786	1.92		10	10	5	10	7	4	4	3	10	4	67
37	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	4	BEH	FDB	FCNS	WO	150	300	Y	1.68	Y	0.11625	10.4	20.8	10	10	5	10	7	4	10	10	10	4	80
38	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	7	2	0/52.4	mg/L	N	N	DLY	M	DR	14	d	4	d	JV	NR	C	COM	2	BEH	FDB	WCON	WO	52.4		Y	0.2594	Y	0.06226	12.6		10	5	10	10	7	4	4	3	10	4	67
39	2048	Chiou et al, 1999	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/100/250/500	mg/kg diet	N	N	NR	U	FD	3	w	3	w	JV	NR	C	DOM	2	BEH	FDB	FCNS	WO	250	500	Y	1.945	Y	0.1135	13.3	26.6	10	10	5	10	7	4	10	10	10	4	80
40	2162	Jenkins et al, 1970	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/229	mg/kg diet	N	N	ADL	M	FD	6	w	1	d	JV	B	C	COM	3	BEH	FDB	FCNS	WO	229		Y	0.986	N	0.05767	13.4		10	10	10	10	6	4	4	1	10	4	69
41	2117	Harms and Buresh 1986	Copper sulfate - anhydrous	100	Chicken (*Gallus domesticus*)	1	3	0/22.3/31.2	mg/org/d	N	N	DLY	U	FD	6	w	64	w	SM	F	C	NR	1	BEH	FDB	FCNS	WO	22.3	31.2	N	1.6	Y	0.0999	13.9	19.5	10	10	5	10	6	4	4	10	3	4	72
42	5812	Ledoux et al, 1989	Copper acetate monohydrate	100	Chicken (*Gallus domesticus*)	1	4	0/100/200/300	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	M	C	DOM	1	BEH	FDB	FCNS	WO	200	300	N	0.564	Y	0.0428	15.2	22.8	10	10	5	5	6	4	10	10	10	4	74
43	2099	Funk and Baker 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	3	0/5/8.23	mg/org/d	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	2	BEH	FDB	FCNS	WO	5	8.23	Y	0.319	Y	0.025	15.7	25.8	10	10	5	10	7	4	10	10	10	4	80
44	2221	Miles et al 1998	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	4	0/200/400/600	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	B	C	NR	1	BEH	FDB	FCNS	WO	400	600	Y	1.986	Y	0.08176	16.5	24.7	10	10	5	10	7	4	10	10	10	4	80
45	2294	Pearce et al 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/250/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	48	d	26	w	SM	F	C	NR	1	BEH	FDB	FCNS	WO	250	500	N	1.6	Y	0.106	16.6	33.1	10	10	5	10	6	4	10	10	10	4	79
46	2292	Stevenson and Jackson 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/250/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	6	d	24	w	SM	F	C	NR	1	BEH	FDB	FCNS	WO	250	500	N	1.6	Y	0.107	16.7	33.4	10	10	5	10	6	4	10	10	10	4	79
47	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	7	BEH	FDB	FCNS	WO	300	450	Y	2.03	Y	0.11491	17.0	25.5	10	10	5	10	7	4	10	10	10	4	80
48	2221	Miles et al 1998	Tribasic copper chloride	100	Chicken (*Gallus domesticus*)	4	4	0/200/400/600	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	B	C	NR	1	BEH	FDB	FCNS	WO	400	600	Y	1.966	Y	0.08452	17.2	25.8	10	10	5	10	7	4	10	10	10	4	80
49	2165	Jensen and Maurice 1978	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	BEH	FDB	FEFF	WO	250	500	Y	0.564	N	0.04009	17.8	35.5	10	10	5	10	6	4	10	10	10	4	79
50	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	SM	F	C	NR	7	BEH	FDB	FCNS	WO	300	450	Y	1.62	Y	0.0968	17.9	26.9	10	10	5	10	7	4	10	10	10	4	80
51	6170	Stevenson et al, 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/25.8/40.0/45.0	mg/org/d	N	N	ADL	U	FD	5	d	27	w	SM	F	C	COM	3	BEH	FDB	FCNS	WO	25.8	40	Y	1.43	Y	0.103	18.0	28.0	10	10	5	10	7	4	10	10	10	4	80
52	6788	Ward et al, 1995	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	2	0/6.34	mg/org/d	N	N	ADL	M	FD	10	d	5	d	JV	M	C	DOM	2	BEH	FDB	WCON	WO	6.34		Y	0.3465	Y	0.035	18.3		10	10	10	10	7	4	4	1	10	4	70
53	2099	Funk and Baker 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/2.49/4.71/7.33/8.42	mg/org/d	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	1	BEH	FDB	FCNS	WO	4.71	7.33	Y	0.24	Y	0.0183	19.6	30.5	10	10	5	10	7	4	10	10	10	4	80
54	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	SM	F	C	NR	6	BEH	FDB	FCNS	WO	450	600	Y	1.91	Y	0.0853	20.1	26.8	10	10	5	10	7	4	10	10	10	4	80

Ref			Exposure																					Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	Endpoint Number	General Effect Group	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 Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
55	5617	Pimentel et al, 1992	Copper	100	Chicken (*Gallus domesticus*)	1	2	0/211.6	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	B	C	COM	2	BEH	FDB	FCNS	WO	211.6		Y	0.1103	Y	0.0109	20.9		10	10	5	4	7	4	4	8	10	4	66
56	2221	Miles et al 1998	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/175/341/529	mg/kg diet	N	N	ADL	M	FD	21	d	1	d	JV	B	C	NR	1	BEH	FDB	FCNS	WO	341	529	Y	0.568	Y	0.03652	21.9	34.0	10	10	10	10	7	4	10	10	10	4	85
57	2172	Kassim and Suwanpradit, 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	M	C	COM	2	BEH	FDB	FCNS	WO	250	375	N	0.564	Y	0.05127	22.7	34.1	10	10	5	10	6	4	10	10	10	4	79
58	2160	Jackson, et. al., 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/23.5/43.84/56.47/60.43	mg/org/d	N	N	ADL	U	FD	224	d	17	w	SM	F	C	NR	3	BEH	FDB	FCNS	WO	43.84	56.47	Y	1.886	Y	0.10957	23.2	29.9	10	10	5	10	7	4	10	10	10	4	80
59	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/440	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	SM	F	C	NR	3	BEH	FDB	FCNS	WO	440		Y	1.4	Y	0.07619	23.9		10	10	10	10	7	4	4	1	10	4	70
60	2194	Ledoux, et.al. 1987	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/400/800	mg/kg diet	N	N	ADL	UX	FD	21	d	1	d	JV	F	C	NR	2	BEH	FDB	FCNS	WO	400	800	N	0.564	Y	0.0363	25.7	51.5	10	10	10	10	6	4	10	10	10	4	84
61	2050	Chiou et al, 1997	Copper (II) sulfate	100	Chicken (*Gallus domesticus*)	1	5	0/195/405/598/758	ug/g diet	N	N	ADL	M	FD	4	w	28	w	SM	F	C	COM	1	BEH	FDB	FCNS	WO	405	598	Y	1.427	Y	0.097	27.5	40.6	10	10	10	10	7	4	10	10	10	4	85
62	2157	Jackson, 1977	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/0.01486/0.02857/0.04828/0.07886/0.08657	g/org/d	N	N	ADL	U	FD	35	d	NR	NR	SM	F	C	NR	3	BEH	FDB	FCNS	WO	0.0483	0.079	Y	1.66	Y	0.1009	29.1	47.5	10	10	5	10	7	4	10	10	10	4	80
63	2221	Miles et al 1998	Tribasic copper chloride	100	Chicken (*Gallus domesticus*)	2	4	0/161/305/468	mg/kg diet	N	N	ADL	M	FD	21	d	1	d	JV	B	C	NR	1	BEH	FDB	FCNS	WO	468		Y	0.619	Y	0.03905	29.5		10	10	10	10	7	4	4	10	10	4	79
64	5734	Hill, 1990	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/100/200/400	mg/kg diet	N	N	ADL	U	FD	19	d	1	d	JV	F	C	DOM	2	BEH	FDB	FCNS	WO	400		N	0.564	N	0.04291	30.4		10	10	5	10	5	4	4	10	10	4	72
65	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/920	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	JV	F	C	NR	2	BEH	FDB	FCNS	WO	920		Y	1.41	Y	0.04667	30.4		10	10	10	10	7	4	4	1	10	4	70
66	2049	Chiou et al, 1998	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/400/500/600	mg/kg diet	N	N	ADL	U	FD	4	w	38	w	SM	F	C	COM	1	BEH	FDB	FCNS	WO	500	600	Y	1.464	Y	0.0978	33.4	40.1	10	10	5	10	7	4	10	10	10	4	80
67	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	2	0/1830	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	JV	F	C	NR	2	BEH	FDB	FCNS	WO	1830		Y	1.41	Y	0.02714	35.2		10	10	10	10	7	4	4	1	10	4	70
68	2099	Funk and Baker 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/2.67/5.22/10.36/18.79	mg/org/d	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	1	BEH	FDB	FCNS	WO	10.36	18.79	Y	0.294	Y	0.0235	35.2	63.9	10	10	5	10	7	4	10	10	10	4	80
69	2099	Funk and Baker 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	3	0/5.78/11.51	mg/org/d	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	2	BEH	FDB	FCNS	WO	11.51		Y	0.317	Y	0.02886	36.3		10	10	5	10	7	4	4	10	10	4	74
70	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	6	5	0/2.1/9.9/50.15/250.85	mg/L	N	N	DLY	M	DR	14	d	4	d	JV	NR	C	COM	2	BEH	FDB	WCON	WO	50.2	250.9	Y	0.2379	Y	0.245	51.6	258	10	5	10	10	7	4	8	10	10	4	78
71	6170	Stevenson et al, 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/25.5/52.0/100.0	mg/d	N	N	DLY	U	GV	5	d	27	w	SM	F	C	COM	3	BEH	FDB	FCNS	WO	100		Y	1.53	Y	0.1	65.4		10	8	10	10	7	4	4	1	10	4	68
72	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	2	2	0/503.4	mg/kg diet	N	N	DLY	M	FD	35	d	3	d	JV	NR	C	COM	2	BEH	FDB	FCNS	WO	503.4		Y	0.8668	Y	0.13002	75.5		10	10	10	10	7	4	4	3	10	4	72
73	18769	Foster, 1999	Cupric acetate monohydrate	100	Duck (*Anas platyrhynchos*)	3	2	0/1024.8	mg/kg diet	N	N	DLY	M	FD	35	d	3	d	JV	NR	C	COM	2	BEH	FDB	FCNS	WO	1024.8		Y	0.9584	Y	0.13418	143		10	10	10	5	7	4	4	3	10	4	67
74	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	1	4	0/218.5/420/1024	mg/kg diet	N	N	DLY	M	FD	35	d	3	d	JV	NR	C	COM	2	BEH	FDB	FCNS	WO	1024		Y	0.7181	Y	0.17234	246		10	10	10	10	7	4	4	3	10	4	72
75	2181	Ko et al, 1985	Copper carbonate	100	Chicken (*Gallus domesticus*)	2	4	0/42/76/98	mg/kg diet	N	N	ADL	U	FD	3	w	3	d	JV	M	C	COM	3	BEH	FDB	FCNS	WO		42	Y	0.2039	Y	0.01304		2.69	10	10	5	10	7	4	4	10	10	4	74
76	2107	Gill et al, 1995	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	4	0/0.05/0.1/0.5	% in diet	N	N	DLY	U	FD	4	w	4	w	JV	M	C	DOM	2	BEH	FDB	FCNS	WO		0.05	Y	0.348	Y	0.01397		7.99	10	10	5	10	7	4	4	10	10	4	74
77	2112	Griminger 1977	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	5	0/0.1/0.2/0.3/0.4	% in diet	N	N	DLY	U	FD	2	w	7	mo	SM	F	C	NR	2	BEH	FDB	FCNS	WO		0.1	N	1.6	Y	0.09		22.4	10	10	5	10	6	4	4	10	10	4	73
78	2293	Stevenson and Jackson 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	8	w	24	w	SM	F	C	NR	2	BEH	FDB	FCNS	WO		500	N	1.6	Y	0.07229		22.6	10	10	5	10	6	4	4	10	10	4	73
79	2333	Yannakopoulos et al., 1990	copper sulfate pentahydrate	100	Japanese quail (*Coturnix japonica*)	1	4	0/200/400/600	mg/kg diet	N	N	ADL	U	FD	34	d	7	d	JV	B	C	NR	2	BEH	FDB	FCNS	WO		200	Y	0.1865	Y	0.0256		27.5	10	10	5	10	7	4	4	10	10	4	74
80	2118	Harms and Buresh 1987	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	3	0/500/750	mg/kg diet	N	N	DLY	U	FD	21	d	1	d	JV	B	C	NR	2	BEH	FDB	FCNS	WO		500	Y	0.3615	Y	0.02225		30.8	10	10	5	10	7	4	4	10	10	4	74
81	2052	Christmas and Harms, 1979	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	3	0/500/750	mg/kg diet	N	N	ADL	U	FD	21	d	1	d	JV	B	C	DOM	2	BEH	FDB	FCNS	WO		500	Y	0.365	Y	0.0229		31.4	10	10	5	10	7	4	4	10	10	4	74
82	2165	Jensen and Maurice 1978	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	3	0/500/750	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	BEH	FDB	FEFF	WO		500	Y	0.592	N	0.04137		34.9	10	10	5	10	6	4	4	10	10	4	73
83	1403	Jensen, 1975	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/1000	mg/kg diet	N	N	ADL	U	FD	14	d	1	d	JV	M	C	NR	3	BEH	FDB	FCNS	WO		1000	Y	0.141	Y	0.0131		92.9	10	10	5	10	7	4	4	10	10	4	74
Physiology																																														
84	2259	Rangachar and Hegde 1975	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	3	0/100/200	mg/kg diet	N	N	DLY	U	FD	120	d	1	d	JV	F	C	COM	1	PHY	PHY	PROT	PL	200		N	1.6	N	0.07903	3.93		10	10	5	10	5	4	4	10	10	4	72
85	2006	Ankari et al, 1998	Copper	100	Chicken (*Gallus domesticus*)	1	4	0/50/150/250	mg/kg diet	N	N	ADL	U	FD	84	d	25	w	SM	F	C	DOM	6	PHY	PHY	FDCV	WO	50	150	Y	1.5161	Y	0.12278	4.05	12.1	10	10	5	4	7	4	10	10	10	4	74
86	2244	Pesti and Bakalli 1996	Cupric citrate	100	Chicken (*Gallus domesticus*)	6	4	0/50/75/100	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO	100		N	2.19	N	0.09695	4.43		10	10	5	10	5	4	4	10	10	4	72
87	2244	Pesti and Bakalli 1996	Cupric citrate	100	Chicken (*Gallus domesticus*)	4	3	0/63/125	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO	125		N	2.155	N	0.09594	5.56		10	10	5	10	5	4	4	10	10	4	72
88	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO	125	250	N	1.884	N	0.0879	5.83	11.7	10	10	5	10	5	4	10	10	10	4	78
89	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	7	2	0/187	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO	187		N	2.26	N	0.09896	8.19		10	10	5	10	5	4	4	10	10	4	72
90	25969	Skrivan et al, 2000	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/208	mg/kg diet	N	N	ADL	M	FD	39	d	1	d	JV	B	C	COM	4	PHY	PHY	FDCV	WO	208		Y	1.876	N	0.08766	9.72		10	10	10	10	6	4	4	1	10	4	69
91	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	5	0/63/125/185/250	mg/kg diet	N	N	ADL	U	FD	35	d	1	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO	250		N	1.789	N	0.08499	11.9		10	10	5	10	5	4	4	10	10	4	72
92	2160	Jackson, et. al., 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/23.5/43.84/56.47/60.43	mg/org/d	N	N	ADL	U	FD	224	d	17	w	SM	F	C	NR	7	PHY	PHY	FDCV	WO	23.5	43.84	Y	1.886	Y	0.11348	12.5	23.2	10	10	5	10	7	4	10	10	10	4	80
93	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	6	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	4	10	10	10	4	78
94	2221	Miles et al 1998	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	4	0/200/400/600	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	B	C	NR	4	PHY	PHY	FDCV	WO	400	600	Y	1.986	Y	0.08176	16.5	24.7	10	10	5	10	7	4	10	10	10	4	80
95	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	4	PHY	PHY	FDCV	WO	300	450	Y	2.03	Y	0.11491	17.0	25.5	10	10	5	10	7	4	10	10	10	4	80
96	2221	Miles et al 1998	Tribasic copper chloride	100	Chicken (*Gallus domesticus*)	4	4	0/200/400/600	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	B	C	NR	4	PHY	PHY	FDCV	WO	400	600	Y	1.966	Y	0.08452	17.2	25.8	10	10	5	10	7	4	10	10	10	4	80
97	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	SM	F	C	NR	7	PHY	PHY	FDCV	WO	300	450	Y	1.62	Y	0.0968	17.9	26.9	10	10	5	10	7	4	10	10	10	4	80
98	6788	Ward et al, 1995	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	2	0/6.34	mg/org/d	N	N	ADL	M	FD	10	d	5	d	JV	M	C	DOM	3	PHY	PHY	FDCV	WO	6.34		Y	0.3465	Y	0.0351	18.3		10	10	10	10	7	4	4	1	10	4	70
99	2166	Jensen and Maurice 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/250/500/750	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO	250	500	Y	0.5	N	0.03706	18.5	37.1	10	10	5	10	6	4	10	10	10	4	79
100	2267	Robbins and Baker 1980	Copper sulfate	100	Chicken (*Gallus domesticus*)	3	3	0/250/500	mg/kg diet	N	N	DLY	U	FD	14	d	8	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO	250	500	Y	0.334	N	0.0285	21.3	42.7	10	10	5	10	6	4	10	10	10	4	79
101	6474	Ekperigin and Vohra 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/250	mg/kg diet	N	N	NR	U	FD	8	d	7	d	JV	NR	C	DOM	2	PHY	PHY	FDCV	WO	250		N	0.328	N	0.0282	21.5		10	10	5	10	5	4	4	10	10	4	72
102	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	SM	F	C	NR	5	PHY	PHY	FDCV	WO	600	750	Y	1.78	Y	0.0751	25.3	31.6	10	10	5	10	7	4	10	10	10	4	80
103	2266	Robbins and Baker, 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/250/500	mg/kg diet	N	N	NR	U	FD	8	d	8	d	JV	M	C	NR	2	PHY	PHY	FDCV	WO	250	500	Y	0.181	N	0.01913	26.4	52.8	10	10	5	10	6	4	10	10	10	4	79
104	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	w	26	w	SM	F	C	NR	5	PHY	PHY	FDCV	WO	450	600	Y	1.55	Y	0.09361	27.2	36.2	10	10	5	10	7	4	10	10	10	4	80
105	2048	Chiou et al, 1999	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/100/250/500	mg/kg diet	N	N	NR	U	FD	3	w	3	w	JV	NR	C	DOM	5	PHY	PHY	FDCV	WO	500		Y	1.819	Y	0.1035	28.4		10	10	5	10	7	4	4	10	10	4	74
106	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/125/250/500/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO	500	1000	N	1.042	N	0.05978	28.7	57.4	10	10	5	10	5	4	10	10	10	4	78
107	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	7	4	0/250/500/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO	500	1000	N	1.042	N	0.05978	28.7	57.4	10	10	5	10	5	4	10	10	10	4	78
108	2319	Wang et al 1987	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO	500		N	0.564	N	0.04009	35.5		10	10	5	10	5	4	4	10	10	4	72
109	2319	Wang et al 1987	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/125/250/500	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO	500		N	0.564	N	0.04009	35.5		10	10	5	10	5	4	4	10	10	4	72

Ref			Exposure																					Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	Endpoint Number	General Effect Group	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 Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
110	2194	Ledoux, et.al. 1987	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/400/800	mg/kg diet	N	N	ADL	UX	FD	21	d	1	d	JV	F	C	NR	3	PHY	PHY	FDCV	WO	800		N	0.564	Y	0.032	45.4		10	10	10	10	6	4	4	10	10	4	78
111	2099	Funk and Baker 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/2.49/4.71/7.33/8.42	mg/org/d	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	3	PHY	PHY	FDCV	WO	7.33	8.42	Y	0.157	Y	0.0105	46.7	53.6	10	10	5	10	7	4	10	10	10	4	80
112	2333	Yannakopoulos et al., 1990	copper sulfate pentahydrate	100	Japanese quail (*Coturnix japonica*)	1	4	0/200/400/600	mg/kg diet	N	N	ADL	U	FD	34	d	7	d	JV	B	C	NR	4	PHY	PHY	FDCV	WO	600		Y	0.1764	Y	0.0241	82.0		10	10	5	10	7	4	4	10	10	4	74
113	22	Mehring et al, 1960	Copper oxide	100	Chicken (*Gallus domesticus*)	1	5	0/403/570/749/1180	mg/kg diet	N	N	NR	M	FD	10	w	1	d	JV	B	C	NR	3	PHY	PHY	FDCV	WO	1180		Y	0.5556	N	0.0397	84.3		10	10	10	10	6	4	4	1	10	4	69
114	2181	Ko et al, 1985	Copper carbonate	100	Chicken (*Gallus domesticus*)	2	4	0/42/76/98	mg/kg diet	N	N	ADL	U	FD	3	w	3	d	JV	M	C	COM	4	PHY	PHY	FDCV	WO		42	Y	0.2039	Y	0.01304		2.69	10	10	5	10	7	4	4	10	10	4	74
115	2244	Pesti and Bakalli 1996	Cupric citrate	100	Chicken (*Gallus domesticus*)	8	2	0/63	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO		63	N	2.393	N	0.10271		2.70	10	10	5	10	5	4	4	10	10	4	72
116	2171	Kashani et al., 1986	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	2	0/120	mg/kg diet	N	N	ADL	U	FD	8	w	1	d	JV	M	C	NR	2	PHY	PHY	FDCV	WO		120	Y	2.8	N	0.11377		4.88	10	10	5	10	6	4	4	10	10	4	73
117	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	9	2	0/125	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO		125	N	2.309	N	0.10035		5.43	10	10	5	10	5	4	4	10	10	4	72
118	2164	Jensen and Maurice 1978	Copper	100	Chicken (*Gallus domesticus*)	3	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	NR	C	NR	3	PHY	PHY	GPHY	WO		125	Y	0.476	N	0.0359		9.43	10	10	5	4	6	4	4	10	10	4	67
119	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/250	mg/kg diet	N	N	ADL	U	FD	42	d	21	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO		250	N	1.963	N	0.09028		11.5	10	10	5	10	5	4	4	10	10	4	72
120	2226	Nam et al 1984	Copper carbonate	51.43	Chicken (*Gallus domesticus*)	1	3	0/0.05/0.10	% in diet	N	N	ADL	U	FD	4	w	3	d	JV	NR	C	COM	4	PHY	PHY	FDCV	WO		0.05	N	1.042	Y	0.0543		13.4	10	10	5	10	6	4	4	10	10	4	73
121	3717	Bakalli et al, 1995	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	41	d	1	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO		250	N	1.042	N	0.05978		14.3	10	10	5	10	5	4	4	10	10	4	72
122	2164	Jensen and Maurice 1978	Copper	100	Chicken (*Gallus domesticus*)	1	2	0/240	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	PHY	PHY	IRRI	FE		240	Y	0.606	N	0.04201		16.6	10	10	5	4	6	4	4	10	10	4	67
123	2164	Jensen and Maurice 1978	Copper carbonate	100	Chicken (*Gallus domesticus*)	7	2	0/250	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	NR	C	NR	3	PHY	PHY	GPHY	DT		250	Y	0.53	N	0.0385		18.2	10	10	5	10	6	4	4	10	10	4	73
124	2164	Jensen and Maurice 1978	Copper chloride	100	Chicken (*Gallus domesticus*)	5	2	0/250	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	NR	C	NR	3	PHY	PHY	GPHY	DT		250	Y	0.516	N	0.03783		18.3	10	10	5	10	6	4	4	10	10	4	73
125	2164	Jensen and Maurice 1978	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	2	0/250	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	NR	C	NR	3	PHY	PHY	GPHY	DT		250	Y	0.513	N	0.03769		18.4	10	10	5	10	6	4	4	10	10	4	73
126	2164	Jensen and Maurice 1978	Copper oxide	100	Chicken (*Gallus domesticus*)	6	2	0/250	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	NR	C	NR	3	PHY	PHY	GPHY	DT		250	Y	0.496	N	0.03687		18.6	10	10	5	10	6	4	4	10	10	4	73
127	2112	Griminger 1977	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	5	0/0.1/0.2/0.3/0.4	% in diet	N	N	DLY	U	FD	2	w	7	mo	SM	F	C	NR	3	PHY	PHY	IRRI	FE		0.1	N	1.6	Y	0.09		22.4	10	10	5	10	6	4	4	10	10	4	73
128	2266	Robbins and Baker, 1980	Copper carbonate	100	Chicken (*Gallus domesticus*)	3	3	0/250/500	mg/kg diet	N	N	NR	U	FD	8	d	8	d	JV	M	C	NR	2	PHY	PHY	FDCV	WO		250	Y	0.181	N	0.01913		26.4	10	10	5	10	6	4	4	10	10	4	73
129	2166	Jensen and Maurice 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PHY	PHY	FDCV	WO		500	Y	0.519	N	0.03797		36.6	10	10	5	10	6	4	4	10	10	4	73
130	2267	Robbins and Baker 1980	Copper sulfate	100	Chicken (*Gallus domesticus*)	2	2	0/500	mg/kg diet	N	N	DLY	U	FD	12	d	8	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO		500	Y	0.211	N	0.02114		50.1	10	10	5	10	6	4	4	10	10	4	73
131	2266	Robbins and Baker, 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/500	mg/kg diet	N	N	NR	U	FD	8	d	8	d	JV	M	C	NR	2	PHY	PHY	FDCV	WO		500	Y	0.16	N	0.01765		55.2	10	10	5	10	6	4	4	10	10	4	73
132	2267	Robbins and Baker 1980	Copper sulfate	100	Chicken (*Gallus domesticus*)	4	2	0/500	mg/kg diet	N	N	DLY	U	FD	8	d	8	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO		500	Y	0.144	N	0.01648		57.2	10	10	5	10	6	4	4	10	10	4	73
133	2267	Robbins and Baker 1980	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	DLY	U	FD	12	d	8	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO		500	Y	0.132	N	0.01557		59.0	10	10	5	10	6	4	4	10	10	4	73
Pathology																																														
134	2114	Guenthner et al, 1978	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	2	0/120	mg/kg diet	N	N	ADL	U	FD	24	w	1	d	JV	M	C	DOM	3	PTH	HIS	GHIS	HE	120		Y	11.61	N	0.28716	2.97		10	10	5	10	6	4	4	10	10	4	73
135	2007	Hoda and Maha, 1995	Copper carbonate	100	Chicken (*Gallus domesticus*)	1	3	0/75/150	mg/kg diet	N	N	ADL	U	FD	6	w	1	d	JV	M	C	LAB	4	PTH	ORW	SMIX	AT	75	150	Y	1.2861	Y	0.06186	3.61	7.21	10	10	5	10	7	4	10	10	10	4	80
136	2048	Chiou et al, 1999	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/100/250/500	mg/kg diet	N	N	NR	U	FD	3	w	3	w	JV	NR	C	DOM	3	PTH	HIS	GHIS	DT	100	250	Y	1.997	Y	0.1144	5.73	14.3	10	10	5	10	7	4	10	10	10	4	80
137	2007	Hoda and Maha, 1995	Copper oxide	80	Chicken (*Gallus domesticus*)	2	3	0/75/150	mg/kg diet	N	N	ADL	U	FD	6	w	1	d	JV	NR	C	LAB	4	PTH	ORW	SMIX	LI	150		Y	1.0887	Y	0.05698	6.28		10	10	5	10	7	4	4	3	10	4	67
138	2163	Jensen et al, 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/120/240/480	mg/kg diet	N	N	NR	U	FD	3	w	1	d	JV	M	C	COM	3	PTH	HIS	GLSN	XX	120	240	Y	0.589	N	0.04124	8.40	16.8	10	10	5	10	6	4	10	10	10	4	79
139	2250	Poupoulis and Jensen 1976	Copper chloride dihydrate	100	Chicken (*Gallus domesticus*)	11	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ	250	500	N	1.6	N	0.07903	12.3	24.7	10	10	5	10	5	4	10	10	10	4	78
140	2294	Pearce et al 1983	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/250/500/1000	mg/kg diet	N	N	ADL	U	FD	5	d	27	w	JV	F	C	NR	1	PTH	ORW	SMIX	LI	250	500	N	1.6	N	0.07903	12.3	24.7	10	10	5	10	5	4	10	10	10	4	78
141	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/250/500/750/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	4	10	10	10	4	78
142	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	7	4	0/250/500/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	4	10	10	10	4	78
143	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/125/250/500/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	4	10	10	10	4	78
144	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	9	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	4	10	10	10	4	78
145	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	5	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	4	10	10	10	4	78
146	2325	Wideman et al 1996	Copper	100	Chicken (*Gallus domesticus*)	1	5	0/118/191/259/264	mg/kg diet	N	N	ADL	M	FD	2	w	1	d	JV	M	C	NR	1	PTH	HIS	GHIS	PR	191	259	Y	0.374	N	0.03068	15.7	21.2	10	10	10	4	6	4	10	10	10	4	78
147	2294	Pearce et al 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/250/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	12	d	26	w	SM	F	C	NR	3	PTH	ORW	SMIX	LI	250	500	N	1.6	Y	0.101	15.8	31.6	10	10	5	10	6	4	10	10	10	4	79
148	2165	Jensen and Maurice 1978	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PTH	HIS	USTR	GZ	250	500	Y	0.564	N	0.04009	17.8	35.5	10	10	5	10	6	4	10	10	10	4	79
149	6170	Stevenson et al, 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/25.8/40.0/45.0	mg/org/d	N	N	ADL	U	FD	5	d	27	w	SM	F	C	COM	4	PTH	ORW	SMIX	LI	25.8	40	Y	1.43	Y	0.103	18.0	28.0	10	10	5	10	7	4	10	10	10	4	80
150	36216	Wood and Worden, 1973	Copper sulfate	100	Duck (*Anas platyrhynchos*)	3	2	0/135	mg/kg diet	N	N	ADL	U	FD	16	d	2	d	JV	B	C	COM	1	PTH	ITX	GITX	WO	135		N	0.092	N	0.01231	18.1		10	10	5	10	5	4	4	10	10	4	72
151	2160	Jackson, et. al., 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/23.5/43.84/56.47/60.43	mg/org/d	N	N	ADL	U	FD	232	d	17	w	SM	F	C	NR	5	PTH	ORW	ORWT	LI	43.84	56.47	Y	1.886	Y	0.10957	23.2	29.9	10	10	5	10	7	4	10	10	10	4	80
152	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	6	PTH	ORW	ORWT	LI	600	750	Y	1.82	Y	0.072	23.7	29.7	10	10	5	10	7	4	10	10	10	4	80
153	2292	Stevenson and Jackson 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/250/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	6	d	24	w	SM	F	C	NR	5	PTH	ORW	SMIX	LI	500	1000	N	1.6	Y	0.087	27.2	54.4	10	10	5	10	6	4	10	10	10	4	79
154	2050	Chiou et al, 1997	Copper (II) sulfate	100	Chicken (*Gallus domesticus*)	1	5	0/195/405/598/758	ug/g diet	N	N	ADL	M	FD	4	w	28	w	SM	F	C	COM	5	PTH	HIS	GHIS	LI	598	758	Y	1.395	Y	0.065	27.9	35.3	10	10	10	10	7	4	10	10	10	4	85
155	6170	Stevenson et al, 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/25.5/52.0/100.0	mg/org/d	N	N	DLY	U	GV	5	d	27	w	SM	F	C	COM	4	PTH	ORW	SMIX	LI	52	100	Y	1.53	Y	0.104	34.0	65.4	10	8	10	10	7	4	10	10	10	4	83
156	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	6	PTH	ORW	SMIX	GZ	600	750	Y	1.41	Y	0.08286	35.3	44.1	10	10	5	10	7	4	10	10	10	4	80
157	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	6	PTH	ORW	ORWT	GZ	600	750	Y	1.77	Y	0.118	40.0	50.0	10	10	5	10	7	4	10	10	10	4	80
158	2194	Ledoux, et.al. 1987	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/400/800	mg/kg diet	N	N	ADL	UX	FD	21	d	1	d	JV	F	C	NR	4	PTH	ORW	SMIX	LI	800		N	0.564	Y	0.032	45.4		10	10	10	10	6	4	4	10	10	4	78
159	2157	Jackson, 1977	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/0.01486/0.02857/0.04828/0.07886/0.08657	g/org/d	N	N	ADL	U	FD	35	d	NR	NR	SM	F	C	NR	5	PTH	ORW	ORWT	LI	0.0789	0.087	Y	1.58	Y	0.082	49.9	54.8	10	10	5	10	7	4	10	10	10	4	80
160	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	6	5	0/2.1/9.9/50.15/250.85	mg/L	N	N	DLY	M	DR	14	d	4	d	JV	NR	C	COM	4	PTH	HIS	GLSN	WO	50.2	250.9	Y	0.2379	Y	0.245	51.6	258	10	5	10	10	7	4	8	10	10	4	78
161	80	Van Vleet et al, 1981	Copper sulfate	100	Duck (*Anas platyrhynchos*)	2	2	0/1500	mg/kg diet	N	N	ADL	U	FD	28	d	1	d	JV	M	C	COM	2	PTH	HIS	NCRO	GZ	1500		N	0.092	N	0.01231	201		10	10	5	10	5	4	4	10	10	4	72
162	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	1	4	0/218.5/420/1024	mg/kg diet	N	N	DLY	M	FD	35	d	3	d	JV	NR	C	COM	4	PTH	HIS	GLSN	LI	1024		Y	0.7181	Y	0.208	297		10	10	10	10	7	4	4	1	10	4	70
163	3727	Shivanandappa et al., 1983	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	6	0/200/600/800/1200/1600	mg/kg bw	N	N	DLY	U	OR	3	w	25	w	JV	M	V	NR	4	PTH	ORW	ORWT	LI	1600		Y	1.7	N	0.08221	637		10	8	5	10	10	4	4	1	10	4	66
164	2007	Hoda and Maha, 1995	Copper sulfate	25	Chicken (*Gallus domesticus*)	3	3	0/75/150	mg/kg diet	N	N	ADL	U	FD	6	w	1	d	JV	M	C	LAB	4	PTH	ORW	SMIX	AT		75	Y	1.0704	Y	0.05833		1.02	10	10	5	10	7	4	4	10	10	4	74

Ref			Exposure																					Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	Endpoint Number	General Effect Group	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 Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
165	36216	Wood and Worden, 1973	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/50	mg/kg diet	N	N	ADL	U	FD	21	d	2	d	JV	B	C	COM	1	PTH	ORW	ORWT	LI		50	N	0.564	N	0.04009		3.55	10	10	5	10	5	4	4	10	10	4	72
166	2177	King, 1975	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	1	2	0/100	mg/kg diet	N	N	ADL	U	FD	56	d	8	d	JV	B	C	COM	2	PTH	ORW	SMIX	IN		100	N	2.644	N	0.1096		4.15	10	10	5	10	5	4	4	10	10	4	72
167	2178	King, 1972	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/100	mg/kg diet	N	N	ADL	U	FD	9	w	1	d	JV	B	C	COM	2	PTH	ORW	SMIX	IN		100	N	1.8966	N	0.08828		4.65	10	10	5	10	5	4	4	10	10	4	72
168	2160	Jackson, et. al., 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/10.39/21.31/31.52/39.91	mg/org/d	N	N	ADL	U	FD	336	d	17	w	SM	F	C	NR	6	PTH	ORW	ORWT	LI		10.39	Y	2.032	Y	0.104		5.11	10	10	5	10	7	4	4	10	10	4	74
169	2164	Jensen and Maurice 1978	copper	100	Chicken (*Gallus domesticus*)	2	3	0/120/240	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	ORW	SMIX	LI		120	Y	0.709	N	0.04653		7.87	10	10	5	4	6	4	4	10	10	4	67
170	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	3	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	7	PTH	ORW	ORWT	GZ		150	Y	2.23	Y	0.12753		8.58	10	10	5	10	7	4	4	10	10	4	74
171	2325	Wideman et al 1996	Copper (II) sulfate	100	Chicken (*Gallus domesticus*)	2	4	0/250/500/750	mg/kg diet	N	N	ADL	U	FD	2	w	1	d	JV	M	C	NR	1	PTH	HIS	GHIS	PR		250	N	1.3	N	0.06904		13.3	10	10	5	10	5	4	4	10	10	4	72
172	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	2	0/250	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ		250	N	1.042	N	0.05978		14.3	10	10	5	10	5	4	4	10	10	4	72
173	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	8	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ		250	N	1.042	N	0.05978		14.3	10	10	5	10	5	4	4	10	10	4	72
174	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	6	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ		250	N	1.042	N	0.05978		14.3	10	10	5	10	5	4	4	10	10	4	72
175	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	10	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ		250	N	1.042	N	0.05978		14.3	10	10	5	10	5	4	4	10	10	4	72
176	2164	Jensen and Maurice 1978	Copper	100	Chicken (*Gallus domesticus*)	1	2	0/240	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ		240	Y	0.606	N	0.04201		16.6	10	10	5	4	6	4	4	10	10	4	67
177	2191	Latymer and Coates, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	24	d	1	d	JV	B	V	COM	4	PTH	ORW	ORWT	LI		250	Y	0.335	N	0.02856		21.3	10	10	5	10	6	4	4	10	10	4	73
178	2267	Robbins and Baker 1980	Copper sulfate	100	Chicken (*Gallus domesticus*)	3	3	0/250/500	mg/kg diet	N	N	DLY	U	FD	14	d	8	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ		250	Y	0.334	N	0.0285		21.3	10	10	5	10	6	4	4	10	10	4	73
179	2293	Stevenson and Jackson 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	8	w	24	w	SM	F	C	NR	5	PTH	ORW	SMIX	LI		500	N	1.6	Y	0.07229		22.6	10	10	5	10	6	4	4	10	10	4	73
180	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/440	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	SM	F	C	NR	5	PTH	ORW	ORWT	KI		440	Y	1.4	Y	0.07619		23.9	10	10	10	10	7	4	4	10	10	4	79
181	2284	Smith 1969	Cupric sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/100/200/350	mg/kg diet	N	N	ADL	U	FD	25	d	1	d	JV	M	C	COM	3	PTH	ORW	ORWT	LI		350	Y	0.32	N	0.02772		30.3	10	10	5	10	6	4	4	10	10	4	73
182	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/920	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	JV	F	C	NR	5	PTH	ORW	ORWT	KI		920	Y	1.41	Y	0.04667		30.4	10	10	10	10	7	4	4	10	10	4	79
183	2052	Christmas and Harms, 1979	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	3	0/500/750	mg/kg diet	N	N	ADL	U	FD	21	d	1	d	JV	B	C	DOM	4	PTH	HIS	USTR	GZ		500	Y	0.365	Y	0.0229		31.4	10	10	5	10	7	4	4	10	10	4	74
184	2165	Jensen and Maurice 1978	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	3	0/500/750	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	ORW	SMIX	GZ		500	Y	0.592	N	0.04137		34.9	10	10	5	10	6	4	4	10	10	4	73
185	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	2	0/1830	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	JV	F	C	NR	4	PTH	ORW	ORWT	KI		1830	Y	1.41	Y	0.02714		35.2	10	10	10	10	7	4	4	10	10	4	79
186	2166	Jensen and Maurice 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PTH	ORW	SMIX	SP		500	Y	0.519	N	0.03797		36.6	10	10	5	10	6	4	4	10	10	4	73
187	80	Van Vleet et al, 1981	Copper sulfate	100	Duck (*Anas platyrhynchos*)	1	2	0/1500	mg/kg diet	N	N	ADL	U	FD	15	d	1	d	JV	M	C	COM	1	PTH	HIS	NCRO	GZ		1500	N	0.092	N	0.01231		201	10	10	5	10	5	4	4	10	10	4	72
188	3727	Shivanandappa et al., 1983	Copper oxychloride	59.51	Chicken (*Gallus domesticus*)	2	5	0/900/1200/1500/1800	mg/kg bw	N	N	DLY	U	OR	3	w	25	w	JV	M	V	NR	2	PTH	ORW	ORWT	LI		900	Y	1.7	N	0.08221		536	10	8	5	10	10	4	4	10	10	4	75
Reproduction																																														
189	2006	Ankari et al, 1998	Copper	100	Chicken (*Gallus domesticus*)	1	4	0/50/150/250	mg/kg diet	N	N	ADL	U	FD	84	d	25	w	LB	F	C	DOM	1	REP	REP	EGPN	WO	50	150	Y	1.5161	Y	0.12278	4.05	12.1	10	10	5	4	7	10	10	10	10	4	80
190	2117	Harms and Buresh 1986	Copper sulfate - anhydrous	100	Chicken (*Gallus domesticus*)	1	3	0/22.3/31.2	mg/org/d	N	N	DLY	U	FD	6	w	64	w	LB	F	C	NR	1	REP	REP	EGPN	WO	22.3	31.2	N	1.6	Y	0.0999	13.9	19.5	10	10	5	10	6	10	10	10	10	4	85
191	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	LB	F	C	NR	3	REP	EGG	EGWT	EG	300	450	Y	2.16	Y	0.112	15.6	23.3	10	10	5	10	7	10	10	10	10	4	86
192	6170	Stevenson et al, 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/25.5/52.0/100.0	mg/org/d	N	N	DLY	U	GV	5	d	27	w	LB	F	C	COM	2	REP	REP	PROG	WO	25.5	52	Y	1.53	Y	0.104	16.7	34.0	10	8	10	10	7	10	10	10	10	4	89
193	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	LB	F	C	NR	3	REP	REP	EGPN	WO	300	450	Y	2.03	Y	0.11491	17.0	25.5	10	10	5	10	7	10	10	10	10	4	86
194	6170	Stevenson et al, 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/25.8/40.0/45.0	mg/org/d	N	N	ADL	U	FD	5	d	27	w	LB	F	C	COM	2	REP	REP	PROG	WO	25.8	40	Y	1.43	Y	0.103	18.0	28.0	10	10	5	10	7	10	10	10	10	4	86
195	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	LB	F	C	NR	3	REP	EGG	EGWT	EG	300	450	Y	1.5	Y	0.0968	19.4	29.0	10	10	5	10	7	10	10	10	10	4	86
196	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	LB	F	C	NR	3	REP	REP	EGPN	WO	300	450	Y	1.6	Y	0.10908	20.5	30.7	10	10	5	10	7	10	10	10	10	4	86
197	2160	Jackson, et. al., 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/10.39/21.31/31.52/39.91	mg/org/d	N	N	ADL	U	FD	336	d	17	w	LB	F	C	NR	3	REP	REP	EGPN	WO	39.9		Y	1.85	Y	0.0997	21.6		10	10	5	10	7	10	4	1	10	4	71
198	2112	Griminger 1977	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	5	0/0.1/0.2/0.3/0.4	% in diet	N	N	DLY	U	FD	2	w	7	mo	LB	F	C	NR	4	REP	EGG	ESTH	EG	0.1	0.2	N	1.6	Y	0.09	22.4	44.8	10	10	5	10	6	10	10	10	10	4	85
199	2294	Pearce et al 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/250/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	12	d	26	w	LB	F	C	NR	2	REP	REP	EGPN	WO	500	1000	N	1.6	Y	0.072	22.5	45.0	10	10	5	10	6	10	10	10	10	4	85
200	2160	Jackson, et. al., 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/23.5/43.84/56.47/60.43	mg/org/d	N	N	ADL	U	FD	232	d	17	w	LB	F	C	NR	4	REP	REP	EGPN	WO	43.8	56.47	Y	1.886	Y	0.10957	23.2	29.9	10	10	5	10	7	10	10	10	10	4	86
201	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/440	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	LB	F	C	NR	4	REP	REP	EGPN	WO	440		Y	1.4	Y	0.07619	23.9		10	10	10	10	7	10	4	1	10	4	76
202	2292	Stevenson and Jackson 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/250/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	6	d	24	w	LB	F	C	NR	3	REP	REP	EGPN	WO	500	1000	N	1.6	Y	0.087	27.2	54.4	10	10	5	10	6	10	10	10	10	4	85
203	2050	Chiou et al, 1997	Copper (II) sulfate	100	Chicken (*Gallus domesticus*)	1	5	0/195/405/598/758	ug/g diet	N	N	ADL	M	FD	4	w	28	w	LB	F	C	COM	3	REP	REP	EGPN	WO	405	598	Y	1.427	Y	0.097	27.5	40.6	10	10	10	10	7	10	10	10	10	4	91
204	2157	Jackson, 1977	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/0.01486/0.02857/0.04828/0.07886/0.08657	g/org/d	N	N	ADL	U	FD	35	d	NR	NR	LB	F	C	NR	4	REP	REP	PROG	WO	0.0483	0.079	Y	1.66	Y	0.01009	29.1	47.5	10	10	5	10	7	10	10	10	10	4	86
205	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/920	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	LB	F	C	NR	3	REP	REP	EGPN	WO	920		Y	1.41	Y	0.04667	30.4		10	10	10	10	7	10	4	1	10	4	76
206	2049	Chiou et al, 1998	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/400/500/600	mg/kg diet	N	N	ADL	U	FD	4	w	38	w	LB	F	C	COM	2	REP	REP	EGPN	WO	500	600	Y	1.464	Y	0.0978	33.4	40.1	10	10	5	10	7	10	10	10	10	4	86
207	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	2	0/1830	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	LB	F	C	NR	3	REP	REP	EGPN	WO	1830		Y	1.41	Y	0.02714	35.2		10	10	10	10	7	10	4	1	10	4	76
208	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	LB	F	C	NR	4	REP	REP	ORWT	OV	600	750	Y	1.77	Y	0.118	40.0	50.0	10	10	5	10	7	10	10	10	10	4	86
209	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	3	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	LB	F	C	NR	3	REP	REP	EGPN	WO	750		Y	2.13	Y	0.123	43.3		10	10	5	10	7	10	4	1	10	4	71
210	3727	Shivanandappa et al., 1983	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	6	0/200/600/800/1200/1600	mg/kg bw	N	N	DLY	U	OR	3	w	25	w	JV	M	V	NR	1	REP	REP	SPCV	TE	600	800	Y	1.7	N	0.08221	239	318	10	8	5	10	10	10	10	10	10	4	87
211	11876	Kadirvel and Kothandaraman, 1978	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/0.05	% in diet	N	N	ADL	U	FD	28	w	12	w	LB	F	C	COM	2	REP	EGG	EGWT	WO		0.05	Y	1.4976	Y	0.0591		19.7	10	10	5	10	7	10	4	10	10	4	80
212	2293	Stevenson and Jackson 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	8	w	24	w	LB	F	C	NR	3	REP	REP	EGPN	WO		500	N	1.6	Y	0.07229		22.6	10	10	5	10	6	10	4	10	10	4	79
213	3727	Shivanandappa et al., 1983	Copper oxychloride	59.51	Chicken (*Gallus domesticus*)	2	5	0/900/1200/1500/1800	mg/kg bw	N	N	DLY	U	OR	3	w	25	w	JV	M	V	NR	3	REP	REP	SPCV	TE		900	Y	1.7	N	0.08221		536	10	8	5	10	10	10	4	10	10	4	81
Growth																																														
214	2007	Hoda and Maha, 1995	Copper sulfate	25	Chicken (*Gallus domesticus*)	3	3	0/75/150	mg/kg diet	N	N	ADL	U	FD	6	w	1	d	JV	M	C	LAB	1	GRO	GRO	BDWT	WO	150		Y	1.1273	Y	0.05786	1.92		10	10	5	10	7	8	4	10	10	4	78
215	2171	Kashani et al., 1986	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	2	4	0/60/120/240	mg/kg diet	N	N	ADL	U	FD	8	w	1	d	JV	M	C	NR	1	GRO	GRO	BDWT	WO	60	120	Y	3.14	N	0.12258	2.34	4.68	10	10	5	10	6	8	10	10	10	4	83
216	2244	Pesti and Bakalli 1996	Cupric citrate	100	Chicken (*Gallus domesticus*)	8	2	0/63	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	63		N	2.393	N	0.10271	2.70		10	10	5	10	5	8	4	10	10	4	76
217	1369	Hill, 1974	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/32	mg/kg diet	N	N	ADL	U	FD	2	w	1	d	JV	B	C	COM	1	GRO	GRO	BDWT	WO	32		N	0.328	N	0.02817	2.75		10	10	5	10	5	8	4	10	10	4	76
218	2114	Guenthner et al, 1978	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	2	0/120	mg/kg diet	N	N	ADL	U	FD	24	w	1	d	JV	M	C	DOM	1	GRO	GRO	BDWT	WO	120		Y	11.61	N	0.28716	2.97		10	10	5	10	6	8	4	1	10	4	68

Ref			Exposure																					Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	Endpoint Number	General Effect Group	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 Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
219	14453	McGhee et al, 1965	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/20/40/80/160	mg/kg diet	N	N	NR	U	FD	4	w	NR	NR	JV	NR	C	NR	2	GRO	GRO	BDWT	WO	40	80	Y	0.2393	N	0.02294	3.83	7.67	10	10	5	10	6	8	10	10	10	4	83
220	2177	King, 1975	copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	1	2	0/100	mg/kg diet	N	N	ADL	U	FD	56	d	8	d	JV	B	C	COM	1	GRO	GRO	BDWT	WO	100		N	2.644	N	0.1096	4.15		10	10	5	10	5	8	4	10	10	4	76
221	2244	Pesti and Bakalli 1996	Cupric citrate	100	Chicken (*Gallus domesticus*)	6	4	0/50/75/100	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	100		N	2.19	N	0.09695	4.43		10	10	5	10	5	8	4	10	10	4	76
222	2178	King, 1972	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/100	mg/kg diet	N	N	ADL	U	FD	9	w	1	d	JV	B	C	COM	1	GRO	GRO	BDWT	WO	100		N	1.8966	N	0.08828	4.65		10	10	5	10	5	8	4	1	10	4	67
223	5149	Kayongo-Male and Palmer, 1998	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	3	0/8/75	mg/kg diet	N	N	ADL	U	FD	4	w	NR	NR	JV	NR	C	DOM	1	GRO	GRO	BDWT	WO	75		Y	0.787	N	0.0498	4.75		10	10	5	10	6	8	4	1	10	4	68
224	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	9	2	0/125	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	125		N	2.309	N	0.10035	5.43		10	10	5	10	5	8	4	10	10	4	76
225	2244	Pesti and Bakalli 1996	Cupric citrate	100	Chicken (*Gallus domesticus*)	4	3	0/63/125	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	125		N	2.155	N	0.09594	5.56		10	10	5	10	5	8	4	10	10	4	76
226	14405	Waibel et al, 1964	Cupric carbonate	100	Turkey (*Melagris gallopavo*)	1	3	0/100/800	mg/kg diet	N	N	NR	U	FD	3	w	7	d	JV	NR	C	DOM	1	GRO	GRO	BDWT	WO	100	800	N	1	N	0.0582	5.82	46.6	10	10	5	5	5	8	8	10	10	4	75
227	2007	Hoda and Maha, 1995	Copper oxide	80.0	Chicken (*Gallus domesticus*)	2	3	0/75/150	mg/kg diet	N	N	ADL	U	FD	6	w	1	d	JV	NR	C	LAB	1	GRO	GRO	BDWT	WO	150		Y	1.0887	Y	0.05698	6.28		10	10	5	10	7	8	4	10	10	4	78
228	2007	Hoda and Maha, 1995	Copper carbonate	100	Chicken (*Gallus domesticus*)	1	3	0/75/150	mg/kg diet	N	N	ADL	U	FD	6	w	1	d	JV	NR	C	LAB	1	GRO	GRO	BDWT	WO	150		Y	1.2283	Y	0.06186	7.55		10	10	5	10	7	8	4	10	10	4	78
229	92	Hill, 1974	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/100	mg/kg diet	N	N	ADL	U	FD	2	w	1	d	JV	B	C	COM	1	GRO	GRO	BDWT	WI	100		N	0.46	N	0.03511	7.63		10	10	5	10	5	8	4	10	10	4	76
230	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	7	2	0/187	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	187		N	2.26	N	0.09896	8.19		10	10	5	10	5	8	4	10	10	4	76
231	2181	Ko et al, 1985	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/54/94/134	mg/kg diet	N	N	ADL	U	FD	3	w	3	d	JV	M	C	COM	2	GRO	GRO	BDWT	WO	134		Y	0.6283	Y	0.0394	8.40		10	10	5	10	7	8	4	1	10	4	69
232	6474	Ekperigin and Vohra 1981	Copper carbonate	100	Chicken (*Gallus domesticus*)	4	4	0/100/500/1000	mg/kg diet	N	N	NR	U	FD	7	d	6	d	JV	NR	C	DOM	1	GRO	GRO	BDWT	WO	100	500	N	0.328	N	0.0282	8.59	42.9	10	10	5	10	5	8	8	10	10	4	80
233	6474	Ekperigin and Vohra 1981	Copper chloride dihydrate	100	Chicken (*Gallus domesticus*)	3	3	0/100/500/1000	mg/kg diet	N	N	NR	U	FD	7	d	7	d	JV	NR	C	DOM	1	GRO	GRO	BDWT	WO	100	500	N	0.328	N	0.0282	8.59	42.9	10	10	5	10	5	8	8	10	10	4	80
234	2107	Gill et al, 1995	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	4	0/0.05/0.1/0.5	% in diet	N	N	DLY	U	FD	3	w	4	w	JV	M	C	DOM	1	GRO	GRO	BDWT	WO	0.05	0.1	Y	0.292	Y	0.01397	9.52	19.0	10	10	5	10	7	8	10	10	10	4	84
235	25969	Skrivan et al, 2000	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/208	mg/kg diet	N	N	ADL	M	FD	38	d	1	d	JV	B	C	COM	1	GRO	GRO	BDWT	WO	208		Y	1.876	N	0.08766	9.72		10	10	10	10	6	8	4	10	10	4	82
236	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	6	5	0/2.1/9.9/50.15/250.85	mg/L	N	N	DLY	M	DR	14	d	4	d	JV	NR	C	COM	1	GRO	GRO	BDWT	WO	9.9	50.15	Y	0.2379	Y	0.245	10.2	51.6	10	5	10	10	7	8	8	10	10	4	82
237	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	5	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	250		N	2.148	N	0.09574	11.1		10	10	5	10	5	8	4	10	10	4	76
238	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/250	mg/kg diet	N	N	ADL	U	FD	42	d	21	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	250		N	1.963	N	0.09028	11.5		10	10	5	10	5	8	4	1	10	4	67
239	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	5	0/63/125/185/250	mg/kg diet	N	N	ADL	U	FD	35	d	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	250		N	1.789	N	0.08499	11.9		10	10	5	10	5	8	4	10	10	4	76
240	2226	Nam et al 1984	Copper carbonate	51.43	Chicken (*Gallus domesticus*)	1	3	0/0.05/0.10	% in diet	N	N	ADL	U	FD	4	w	3	d	JV	NR	C	COM	1	GRO	GRO	BDWT	WO	0.05	0.1	N	1.042	Y	0.04922	12.2	24.3	10	10	5	10	6	8	10	10	10	4	83
241	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	7	2	0/52.4	mg/L	N	N	DLY	M	DR	14	d	4	d	JV	NR	C	COM	1	GRO	GRO	BDWT	WO	52.4		Y	0.2594	Y	0.06226	12.6		10	5	10	10	7	8	4	10	10	4	78
242	2048	Chiou et al, 1999	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/100/250/500	mg/kg diet	N	N	NR	U	FD	3	w	3	w	JV	NR	C	DOM	1	GRO	GRO	BDWT	WO	250	500	Y	1.945	Y	0.1135	13.3	26.6	10	10	5	10	7	8	10	10	10	4	84
243	2162	Jenkins et al, 1970	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/229	mg/kg diet	N	N	ADL	M	FD	6	w	1	d	JV	B	C	COM	2	GRO	GRO	BDWT	WO	229		Y	0.986	N	0.05767	13.4		10	10	10	10	6	8	4	1	10	4	73
244	25968	Marron, et al, 2001	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	21	d	7	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	250		N	0.564	Y	0.08020	14.2		10	10	5	10	6	8	4	1	10	4	68
245	5734	Hill, 1990	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	5	0/25/50/100/200	mg/kg diet	N	N	ADL	U	FD	19	d	1	d	JV	F	C	DOM	1	GRO	GRO	BDWT	WO	200		N	0.564	N	0.04009	14.2		10	10	5	10	5	8	4	10	10	4	76
246	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	8	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	8	10	10	10	4	82
247	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/125/250/500/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	8	10	10	10	4	82
248	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	5	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	8	10	10	10	4	82
249	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/250/500/750/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	8	10	10	10	4	82
250	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	6	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	8	10	10	10	4	82
251	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	2	0/250	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250		N	1.042	N	0.05978	14.3		10	10	5	10	5	8	4	1	10	4	67
252	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	2	0/250	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250		N	1.042	N	0.05978	14.3		10	10	5	10	5	8	4	1	10	4	67
253	3717	Bakalli et al, 1995	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	41	d	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	250		N	1.042	N	0.05978	14.3		10	10	5	10	5	8	4	10	10	4	76
254	2099	Funk and Baker 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	3	0/5/8.23	mg/org/d	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	1	GRO	GRO	BDWT	WO	5	8.23	Y	0.319	Y	0.025	15.7	25.8	10	10	5	10	7	8	10	10	10	4	84
255	2221	Miles et al 1998	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	4	0/200/400/600	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	B	C	NR	2	GRO	GRO	BDWT	WO	400	600	Y	1.986	Y	0.08176	16.5	24.7	10	10	5	10	7	8	10	10	10	4	84
256	2292	Stevenson and Jackson 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/250/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	6	d	24	w	SM	F	C	NR	2	GRO	GRO	BDWT	WO	250	500	N	1.6	Y	0.107	16.7	33.4	10	10	5	10	6	8	10	10	10	4	83
257	2221	Miles et al 1998	Tribasic copper chloride	100	Chicken (*Gallus domesticus*)	4	4	0/200/400/600	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	B	C	NR	2	GRO	GRO	BDWT	WO	400	600	Y	1.966	Y	0.08452	17.2	25.8	10	10	5	10	7	8	10	10	10	4	84
258	2244	Pesti and Bakalli 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	375		N	1.884	N	0.0879	17.5		10	10	5	10	5	8	4	10	10	4	76
259	2284	Smith 1969	Cupric sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/100/200/350	mg/kg diet	N	N	ADL	U	FD	25	d	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	200	350	Y	0.2982	N	0.02647	17.8	31.1	10	10	5	10	6	8	10	10	10	4	83
260	2319	Wang et al 1987	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/125/250/500	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	250	500	N	0.564	N	0.04009	17.8	35.5	10	10	5	10	5	8	10	10	10	4	82
261	6170	Stevenson et al, 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/25.8/40.0/45.0	mg/org/d	N	N	ADL	U	FD	5	d	27	w	SM	F	C	COM	1	GRO	GRO	BDWT	WO	25.8	40	Y	1.43	Y	0.103	18.0	28.0	10	10	5	10	7	8	10	10	10	4	84
262	2164	Jensen and Maurice 1978	Copper carbonate	100	Chicken (*Gallus domesticus*)	7	2	0/250	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250		Y	0.53	N	0.0385	18.2		10	10	5	10	6	8	4	1	10	4	68
263	6788	Ward et al, 1995	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	2	0/6.34	mg/org/d	N	N	ADL	M	FD	10	d	5	d	JV	M	C	DOM	1	GRO	GRO	BDWT	WO	6.34		Y	0.3465	Y	0.116	18.3		10	10	10	10	7	8	4	1	10	4	74
264	2164	Jensen and Maurice 1978	Copper chloride	100	Chicken (*Gallus domesticus*)	5	2	0/250	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250		Y	0.516	N	0.03783	18.3		10	10	5	10	6	8	4	1	10	4	68
265	2164	Jensen and Maurice 1978	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	2	0/250	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250		Y	0.513	N	0.03769	18.4		10	10	5	10	6	8	4	1	10	4	68
266	2166	Jensen and Maurice 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/250/500/750	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250	500	Y	0.5	N	0.03706	18.5	37.1	10	10	5	10	6	8	10	10	10	4	83
267	2164	Jensen and Maurice 1978	Copper oxide	100	Chicken (*Gallus domesticus*)	6	2	0/250	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250		Y	0.496	N	0.03687	18.6		10	10	5	10	6	8	4	1	10	4	68
268	2099	Funk and Baker 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/2.49/4.71/7.33/8.42	mg/org/d	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	2	GRO	GRO	BDWT	WO	4.71	7.33	Y	0.24	Y	0.0183	19.6	30.5	10	10	5	10	7	8	10	10	10	4	84
269	11876	Kadirvel and Kothandaraman, 1978	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/0.05	% in diet	N	N	ADL	U	FD	28	w	12	w	SM	F	C	COM	1	GRO	GRO	BDWT	WO	0.05		Y	1.4976	Y	0.0591	19.7		10	10	5	10	7	8	4	1	10	4	69
270	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	1	GRO	GRO	BDWT	WO	300	450	Y	1.6	Y	0.10908	20.5	30.7	10	10	5	10	7	8	10	10	10	4	84
271	5617	Pimentel et al, 1992	Copper	100	Chicken (*Gallus domesticus*)	1	2	0/211.6	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	B	C	COM	1	GRO	GRO	BDWT	WO	211.6		Y	0.1103	Y	0.0109	20.9		10	10	5	4	7	8	4	6	10	4	68
272	2267	Robbins and Baker 1980	Copper sulfate	100	Chicken (*Gallus domesticus*)	3	3	0/250/500	mg/kg diet	N	N	DLY	U	FD	14	d	8	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250	500	Y	0.334	N	0.0285	21.3	42.7	10	10	5	10	6	8	10	10	10	4	83
273	6474	Ekperigin and Vohra 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/100/250/500/1000	mg/kg diet	N	N	NR	U	FD	7	d	9	d	JV	NR	C	DOM	1	GRO	GRO	BDWT	WO	250	500	N	0.328	N	0.0282	21.5	42.9	10	10	5	10	5	8	10	10	10	4	82
274	6474	Ekperigin and Vohra 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/250	mg/kg diet	N	N	NR	U	FD	8	d	9	d	JV	NR	C	DOM	1	GRO	GRO	BDWT	WO	250		N	0.328	N	0.0282	21.5		10	10	5	10	5	8	4	10	10	4	76

Ref			Exposure																					Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	Endpoint Number	General Effect Group	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 Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
275	2160	Jackson, et. al., 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/10.39/21.31/31.52/39.91	mg/org/d	N	N	ADL	U	FD	336	d	17	w	SM	F	C	NR	1	GRO	GRO	BDWT	WO	39.91		N	1.85	Y	0.0997	21.6		10	10	5	10	6	8	4	1	10	4	68
276	2325	Wideman et al 1996	Copper	100	Chicken (*Gallus domesticus*)	1	5	0/118/191/259/264	mg/kg diet	N	N	ADL	M	FD	2	w	1	d	JV	M	C	NR	2	GRO	GRO	BDWT	WO	264		Y	0.374	N	0.03068	21.7		10	10	10	4	6	8	4	10	10	4	76
277	2221	Miles et al 1998	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/175/341/529	mg/kg diet	N	N	ADL	M	FD	21	d	1	d	JV	B	C	NR	2	GRO	GRO	BDWT	WO	341	529	Y	0.568	Y	0.03652	21.9	34.0	10	10	10	10	7	8	10	10	10	4	89
278	2112	Griminger 1977	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	5	0/0.1/0.2/0.3/0.4	% in diet	N	N	DLY	U	FD	2	w	7	mo	SM	F	C	NR	1	GRO	GRO	BDWT	WO	0.1	0.2	N	1.6	Y	0.09	22.4	44.8	10	10	5	10	6	8	10	10	10	4	83
279	2172	Kassim and Suwanpradit, 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	250	375	N	0.564	Y	0.05127	22.7	34.1	10	10	5	10	6	8	10	10	10	4	83
280	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	SM	F	C	NR	1	GRO	GRO	BDWT	WO	450	600	Y	1.62	Y	0.0829	23.0	30.7	10	10	5	10	7	8	10	10	10	4	84
281	2160	Jackson, et. al., 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/23.5/43.84/56.47/60.43	mg/org/d	N	N	ADL	U	FD	232	d	17	w	SM	F	C	NR	1	GRO	GRO	BDWT	WO	43.84	56.47	Y	1.886	Y	0.10957	23.2	29.9	10	10	5	10	7	8	10	10	10	4	84
282	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	1	GRO	GRO	BDWT	WO	450	600	Y	1.96	Y	0.10128	23.3	31.0	10	10	5	10	7	8	10	10	10	4	84
283	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/440	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	SM	F	C	NR	1	GRO	GRO	BDWT	WO	440		Y	1.4	Y	0.07619	23.9		10	10	10	10	7	8	4	1	10	4	74
284	2250	Poupoulis and Jensen 1976	Copper chloride dihydrate	100	Chicken (*Gallus domesticus*)	11	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	500		N	1.6	N	0.07903	24.7		10	10	5	10	5	8	4	1	10	4	67
285	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	SM	F	C	NR	1	GRO	GRO	BDWT	WO	450	600	Y	1.91	Y	0.0853	26.4	35.2	10	10	5	10	7	8	10	10	10	4	84
286	6788	Ward et al, 1995	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	2	2	0/10.33	mg/org/d	N	N	ADL	M	DR	10	d	5	d	JV	M	C	DOM	1	GRO	GRO	BDWT	WO	10.33		Y	0.389	Y	0.116	26.6		10	5	10	10	7	8	4	1	10	4	69
287	5812	Ledoux et al, 1989	Copper acetate monohydrate	100	Chicken (*Gallus domesticus*)	1	4	0/100/200/300	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	M	C	DOM	2	GRO	GRO	BDWT	WO	200	300	N	0.564	Y	0.07589	26.9	40.4	10	10	5	5	6	8	10	10	10	4	78
288	2050	Chiou et al, 1997	Copper (II) sulfate	100	Chicken (*Gallus domesticus*)	1	5	0/195/405/598/758	ug/g diet	N	N	ADL	M	FD	28	d	28	w	SM	F	C	COM	4	GRO	GRO	BDWT	WO	598	758	Y	1.395	Y	0.065	27.9	35.3	10	10	10	10	7	8	10	10	10	4	89
289	7091	Hill, 1989	Copper	100	Chicken (*Gallus domesticus*)	1	4	0/100/200/400	mg/kg diet	N	N	NR	U	FD	19	d	NR	NR	JV	NR	C	DOM	1	GRO	GRO	BDWT	WO	400		N	0.564	N	0.04009	28.4		10	10	5	4	5	8	4	10	10	4	70
290	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	7	4	0/250/500/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	500	1000	N	1.042	N	0.05978	28.7	57.4	10	10	5	10	5	8	10	10	10	4	82
291	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	9	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	500		N	1.042	N	0.05978	28.7		10	10	5	10	5	8	4	1	10	4	67
292	2221	Miles et al 1998	Tribasic copper chloride	100	Chicken (*Gallus domesticus*)	2	4	0/161/305/468	mg/kg diet	N	N	ADL	M	FD	21	d	1	d	JV	B	C	NR	2	GRO	GRO	BDWT	WO	468		Y	0.619	Y	0.03905	29.5		10	10	10	10	7	8	4	10	10	4	83
293	14404	Vohra and Kratzer, 1968	Copper sulfate pentahydrate	100	Turkey (*Melagris gallopavo*)	1	3	0/400/800	mg/kg diet	N	N	ADL	U	FD	21	d	NR	NR	JV	B	C	COM	1	GRO	GRO	BDWT	WO	400	800	N	0.5	N	0.0371	29.7	59.3	10	10	5	10	5	8	10	10	10	4	82
294	5734	Hill, 1990	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/100/200/400	mg/kg diet	N	N	ADL	U	FD	19	d	1	d	JV	F	C	DOM	1	GRO	GRO	BDWT	WO	400		N	0.564	N	0.04291	30.4		10	10	5	10	5	8	4	10	10	4	76
295	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/920	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	JV	F	C	NR	1	GRO	GRO	BDWT	WO	920		Y	1.4	Y	0.04667	30.7		10	10	10	10	7	8	4	1	10	4	74
296	22	Mehring et al, 1960	Copper oxide	100	Chicken (*Gallus domesticus*)	1	5	0/403/570/749/1180	mg/kg diet	N	N	NR	M	FD	10	w	1	d	JV	B	C	NR	2	GRO	GRO	BDWT	WO	570	749	Y	1.0166	N	0.05883	33.0	43.3	10	10	10	10	6	8	10	10	10	4	88
297	2163	Jensen et al, 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/120/240/480	mg/kg diet	N	N	NR	U	FD	3	w	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	480		Y	0.567	N	0.04023	34.1		10	10	5	10	6	8	4	1	10	4	68
298	2118	Harms and Buresh 1987	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	3	0/500/750	mg/kg diet	N	N	DLY	U	FD	21	d	1	d	JV	B	C	NR	1	GRO	GRO	BDWT	WO	500	750	Y	0.3217	Y	0.02225	34.6	51.9	10	10	5	10	7	8	10	10	10	4	84
299	2099	Funk and Baker 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/2.67/5.22/10.36/18.79	mg/org/d	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	2	GRO	GRO	BDWT	WO	10.36	18.79	Y	0.294	Y	0.0235	35.2	63.9	10	10	5	10	6	8	10	10	10	4	83
300	2517	Bafundo et al, 1984	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	1	GRO	GRO	BDWT	WO	500		N	0.564	N	0.04009	35.5		10	10	5	10	5	8	4	1	10	4	67
301	5734	Hill, 1990	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	19	d	1	d	JV	F	M	DOM	1	GRO	GRO	BDWT	WO	500		N	0.564	N	0.04009	35.5		10	10	5	10	5	8	4	10	10	4	76
302	2099	Funk and Baker 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	3	0/5.78/11.51	mg/org/d	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	1	GRO	GRO	BDWT	WO	11.51		Y	0.317	Y	0.02886	36.3		10	10	5	10	7	8	4	10	10	4	78
303	2166	Jensen and Maurice 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	500		Y	0.519	N	0.03797	36.6		10	10	5	10	6	8	4	10	10	4	77
304	1278	Davis et al, 1996	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	21	d	14	d	JV	M	C	LAB	1	GRO	GRO	BDWT	WO	500		Y	0.484	Y	0.0359	37.1		10	10	5	10	7	8	4	1	10	4	69
305	2049	Chiou et al, 1998	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/400/500/600	mg/kg diet	N	N	ADL	U	FD	4	w	38	w	SM	F	C	COM	5	GRO	GRO	BDWT	WO	600		Y	1.464	Y	0.0978	40.1		10	10	5	10	7	8	4	1	10	4	69
306	6368	Southern and Baker, 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	14	d	8	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	500		Y	0.374	N	0.0307	41.0		10	10	5	10	6	8	4	1	10	4	68
307	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	3	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	1	GRO	GRO	BDWT	WO	750		Y	2.13	Y	0.123	43.3		10	10	5	10	7	8	4	1	10	4	69
308	2172	Kassim and Suwanpradit, 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	3	w	3	w	JV	M	C	COM	1	GRO	GRO	BDWT	WO	250	375	N	0.564	Y	0.11161	49.5	74.2	10	10	5	10	6	8	10	10	10	4	83
309	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	1	GRO	GRO	BDWT	WO	750		Y	1.77	Y	0.118	50.0		10	10	5	10	7	8	4	1	10	4	69
310	14404	Vohra and Kratzer, 1968	Copper sulfate pentahydrate	100	Turkey (*Melagris gallopavo*)	2	3	0/338/676	mg/kg diet	N	N	ADL	U	FD	21	d	NR	NR	JV	B	C	COM	1	GRO	GRO	BDWT	WO	676		N	0.5	N	0.0371	50.1		10	10	5	10	5	8	4	10	10	4	76
311	2157	Jackson, 1977	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/0.01486/0.02857/0.04828/0.07886/0.08657	g/org/d	N	N	ADL	U	FD	35	d	1	yr	SM	F	C	NR	1	GRO	GRO	BDWT	WO	0.0789	0.087	Y	1.55	Y	0.082	50.9	55.9	10	10	5	10	7	8	10	10	10	4	84
312	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	1	4	0/218.5/420/1024	mg/kg diet	N	N	DLY	M	FD	35	d	3	d	JV	NR	C	COM	1	GRO	GRO	BDWT	WO	218.5	420	Y	0.8	Y	0.208	56.8	109	10	10	10	10	7	8	10	10	10	4	89
313	14404	Vohra and Kratzer, 1968	Copper sulfate pentahydrate	100	Turkey (*Melagris gallopavo*)	3	5	0/810/1620/2430/3240	mg/kg diet	N	N	ADL	U	FD	21	d	NR	NR	JV	B	C	COM	1	GRO	GRO	BDWT	WO	810	1620	N	0.5	N	0.0371	60.0	120	10	10	5	10	5	8	10	10	10	4	82
314	6170	Stevenson et al, 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/25.5/52.0/100.0	mg/org/d	N	N	DLY	U	GV	5	d	27	w	SM	F	C	COM	1	GRO	GRO	BDWT	WO	100		Y	1.53	Y	0.1	65.4		10	8	10	10	7	8	4	1	10	4	72
315	2333	Yannakopoulos et al., 1990	Copper sulfate pentahydrate	100	Japanese quail (*Coturnix japonica*)	1	4	0/200/400/600	mg/kg diet	N	N	ADL	U	FD	34	d	7	d	JV	B	C	NR	1	GRO	GRO	BDWT	WO	600		Y	0.1764	Y	0.0241	82.0		10	10	5	10	7	8	4	10	10	4	78
316	2196	Leeson and Summers, 1982	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/20/40/80	mg/kg diet	N	N	ADL	U	FD	21	d	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO	80		N	0.564	Y	0.7271	103		10	10	5	10	6	8	4	1	10	4	68
317	18769	Foster, 1999	Cupric acetate monohydrate	100	Duck (*Anas platyrhynchos*)	3	2	0/1024.8	mg/kg diet	N	N	DLY	M	FD	35	d	3	d	JV	NR	C	COM	1	GRO	GRO	BDWT	WO	1024.8		Y	0.9584	Y	0.13418	143		10	10	10	5	7	8	4	10	10	4	78
318	2181	Ko et al, 1985	Copper carbonate	100	Chicken (*Gallus domesticus*)	2	4	0/42/76/98	mg/kg diet	N	N	ADL	U	FD	3	w	3	d	JV	M	C	COM	2	GRO	GRO	BDWT	WO		42	Y	0.2039	Y	0.01304		2.69	10	10	5	10	7	8	4	10	10	4	78
319	2171	Kashani et al., 1986	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	2	0/120	mg/kg diet	N	N	ADL	U	FD	8	w	1	d	JV	M	C	NR	1	GRO	GRO	BDWT	WO		120	Y	2.8	N	0.11377		4.88	10	10	5	10	6	8	4	10	10	4	77
320	9234	Harms and Eberst 1974	Copper (II) sulfate pentahydrate	25.45	Turkey (*Meleagris gallopavo*)	1	2	0/0.05	% in diet	N	N	ADL	U	FD	3	w	1	d	JV	NR	C	DOM	1	GRO	GRO	GGRO	WO		0.05	Y	0.389	N	0.03148		10.3	10	10	5	10	6	8	4	10	10	4	77
321	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	10	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO		250	N	1.042	N	0.05978		14.3	10	10	5	10	5	8	4	10	10	4	76
322	2165	Jensen and Maurice 1978	copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO		250	Y	0.591	N	0.04133		17.5	10	10	5	10	6	8	4	10	10	4	77
323	2191	Latymer and Coates, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	24	d	1	d	JV	B	V	COM	2	GRO	GRO	BDWT	WO		250	Y	0.335	N	0.02856		21.3	10	10	5	10	6	8	4	10	10	4	77
324	2293	Stevenson and Jackson 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/500/1000/2000	mg/kg diet	N	N	ADL	U	FD	8	w	24	w	SM	F	C	NR	1	GRO	GRO	BDWT	WO		500	N	1.6	Y	0.07229		22.6	10	10	5	10	6	8	4	10	10	4	77
325	2194	Ledoux, et.al. 1987	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/400/800	mg/kg diet	N	N	ADL	UX	FD	21	d	1	d	JV	F	C	NR	1	GRO	GRO	BDWT	WO		400	N	0.564	Y	0.032		22.7	10	10	10	10	6	8	4	10	10	4	82
326	2266	Robbins and Baker, 1980	Copper carbonate	100	Chicken (*Gallus domesticus*)	3	3	0/250/500	mg/kg diet	N	N	NR	U	FD	8	d	8	d	JV	M	C	NR	1	GRO	GRO	BDWT	WO		250	Y	0.181	N	0.01913		26.4	10	10	5	10	6	8	4	10	10	4	77
327	2266	Robbins and Baker, 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/250/500	mg/kg diet	N	N	NR	U	FD	8	d	8	d	JV	M	C	NR	1	GRO	GRO	BDWT	WO		250	Y	0.181	N	0.01913		26.4	10	10	5	10	6	8	4	10	10	4	77
328	1369	Hill, 1974	Copper sulfate	100	Chicken (*Gallus domesticus*)	2	2	0/500	mg/kg diet	N	N	ADL	U	FD	5	w	1	d	JV	B	C	COM	1	GRO	GRO	BDWT	WO		500	N	1.042	N	0.05978		28.7	10	10	5	10	5	8	4	10	10	4	76
329	2052	Christmas and Harms, 1979	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	3	0/500/750	mg/kg diet	N	N	ADL	U	FD	21	d	1	d	JV	B	C	DOM	1	GRO	GRO	BDWT	WO		500	Y	0.365	Y	0.0229		31.4	10	10	5	10	7	8	4	10	10	4	78
330	2165	Jensen and Maurice 1978	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	3	0/500/750	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO		500	Y	0.592	N	0.04137		34.9	10	10	5	10	6	8	4	10	10	4	77

Ref			Exposure																					Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	Endpoint Number	General Effect Group	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 Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
331	2291	Stevenson and Jackson 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	2	0/1830	mg/kg diet	N	N	ADL	M	FD	6	w	24	w	JV	F	C	NR	1	GRO	GRO	BDWT	WO		1830	Y	1.41	Y	0.02714		35.2	10	10	10	10	7	8	4	10	10	4	83
332	2084	Ekperigin and Vohra 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	3	0/500/1000	mg/kg diet	N	N	DLY	U	FD	1	w	12	d	JV	B	C	NR	1	GRO	GRO	BDWT	WO		500	N	0.564	N	0.04009		35.5	10	10	5	10	5	8	4	10	10	4	76
333	2319	Wang et al 1987	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	M	C	COM	1	GRO	GRO	BDWT	WO		500	N	0.564	N	0.04009		35.5	10	10	5	10	5	8	4	10	10	4	76
334	92	Hill, 1974	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/500/1000/1500/2000/2500	mg/kg diet	N	N	ADL	U	FD	2	w	1	d	JV	B	C	COM	1	GRO	GRO	BDWT	WO		500	N	0.328	N	0.02817		42.9	10	10	5	10	5	8	4	10	10	4	76
335	2267	Robbins and Baker 1980	Copper sulfate	100	Chicken (*Gallus domesticus*)	2	2	0/500	mg/kg diet	N	N	DLY	U	FD	12	d	8	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO		500	Y	0.211	N	0.02114		50.1	10	10	5	10	6	8	4	10	10	4	77
336	2266	Robbins and Baker, 1980	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/500	mg/kg diet	N	N	NR	U	FD	8	d	8	d	JV	M	C	NR	1	GRO	GRO	BDWT	WO		500	Y	0.16	N	0.01765		55.2	10	10	5	10	6	8	4	10	10	4	77
337	2267	Robbins and Baker 1980	Copper sulfate	100	Chicken (*Gallus domesticus*)	4	2	0/500	mg/kg diet	N	N	DLY	U	FD	8	d	8	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO		500	Y	0.144	N	0.01648		57.2	10	10	5	10	6	8	4	10	10	4	77
338	2267	Robbins and Baker 1980	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	DLY	U	FD	12	d	8	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO		500	Y	0.132	N	0.01557		59.0	10	10	5	10	6	8	4	10	10	4	77
339	14404	Vohra and Kratzer, 1968	Copper sulfate pentahydrate	100	Turkey (*Melagris gallopavo*)	4	4	0/810/910/1000	mg/kg diet	N	N	ADL	U	FD	21	d	NR	NR	JV	B	C	COM	1	GRO	GRO	BDWT	WO		810	N	0.5	N	0.0371		60.0	10	10	5	10	5	8	4	10	10	4	76
340	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	2	2	0/503.4	mg/kg diet	N	N	DLY	M	FD	35	d	3	d	JV	NR	C	COM	1	GRO	GRO	BDWT	WO		503.4	Y	0.8668	Y	0.13002		75.5	10	10	10	10	7	8	4	10	10	4	83
341	1370	Hill, 1979	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/1000	mg/kg diet	N	N	ADL	U	FD	2	w	1	d	JV	NR	C	COM	1	GRO	GRO	BDWT	WO		1000	N	0.328	N	0.02817		85.9	10	10	5	10	5	8	4	10	10	4	76
342	1403	Jensen, 1975	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/1000	mg/kg diet	N	N	ADL	U	FD	14	d	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO		1000	Y	0.141	Y	0.0131		92.9	10	10	5	10	7	8	4	10	10	4	78
343	395	Hill, 1980	Copper	100	Chicken (*Gallus domesticus*)	1	2	0/1000	mg/kg diet	N	N	NR	U	FD	1	w	1	d	JV	F	C	DOM	1	GRO	GRO	BDWT	WO		1000	N	0.084	N	0.0116		138	10	10	5	4	5	8	4	10	10	4	70
Survival																																														
344	1369	Hill, 1974	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/32	mg/kg diet	N	N	ADL	U	FD	2	w	NR	NR	JV	B	C	COM	2	MOR	MOR	MORT	WO	32		N	0.328	N	0.02817	2.75		10	10	5	10	5	9	4	3	10	4	70
345	36216	Wood and Worden, 1973	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/50	mg/kg diet	N	N	ADL	U	FD	49	d	2	d	JV	B	C	COM	2	MOR	MOR	MORT	WO	50		N	0.564	N	0.04009	3.55		10	10	5	10	5	9	4	10	10	4	77
346	36216	Wood and Worden, 1973	Copper sulfate	100	Duck (*Anas platyrhynchos*)	2	2	0/50	mg/kg diet	N	N	ADL	U	FD	49	d	2	d	JV	B	C	COM	2	MOR	MOR	MORT	WO	50		N	0.092	N	0.01231	6.69		10	10	5	10	5	9	4	10	10	4	77
347	92	Hill, 1974	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	2	0/100	mg/kg diet	N	N	ADL	U	FD	5	w	1	d	JV	B	C	COM	2	MOR	MOR	MORT	WO	100		N	0.46	N	0.03511	7.63		10	10	5	10	5	9	4	1	10	4	68
348	14453	McGhee et al, 1965	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/20/40/80/160	mg/kg diet	N	N	NR	U	FD	4	w	NR	NR	JV	NR	C	NR	1	MOR	MOR	MORT	WO	80	160	Y	0.2019	N	0.02054	8.14	16.3	10	10	5	10	6	9	10	10	10	4	84
349	2181	Ko et al, 1985	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/54/94/134	mg/kg diet	N	N	ADL	U	FD	3	w	3	d	JV	M	C	COM	1	MOR	MOR	MORT	WO	134		Y	0.6283	Y	0.0394	8.40		10	10	5	10	7	9	4	10	10	4	79
350	25969	Skrivan et al, 2000	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/208	mg/kg diet	N	N	ADL	M	FD	38	d	1	d	JV	B	C	COM	2	MOR	MOR	MORT	WO	208		Y	1.876	N	0.08766	9.72		10	10	10	10	6	9	4	1	10	4	74
351	2250	Poupoulis and Jensen 1976	Copper chloride dihydrate	100	Chicken (*Gallus domesticus*)	11	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	5	MOR	MOR	MORT	WO	500		N	1.6	N	0.07903	11.7		10	10	5	10	5	9	4	1	10	4	68
352	2162	Jenkins et al, 1970	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/229	mg/kg diet	N	N	ADL	M	FD	6	w	1	d	JV	B	C	COM	1	MOR	MOR	MORT	WO	229		Y	0.986	N	0.05767	13.4		10	10	10	10	6	9	4	10	10	4	83
353	25968	Marron, et al, 2001	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	21	d	7	d	JV	M	C	COM	4	MOR	MOR	MORT	WO	250		N	0.564	Y	0.08020	14.2		10	10	5	10	6	9	4	10	10	4	78
354	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/250/500/750/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	MOR	MOR	MORT	WO	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	9	10	10	10	4	83
355	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	5	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	MOR	MOR	MORT	WO	250	500	N	1.042	N	0.05978	14.3	28.7	10	10	5	10	5	9	10	10	10	4	83
356	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	2	0/250	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	MOR	MOR	MORT	WO	250		N	1.042	N	0.05978	14.3		10	10	5	10	5	9	4	10	10	4	77
357	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	2	0/250	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	MOR	MOR	MORT	WO	250		N	1.042	N	0.05978	14.3		10	10	5	10	5	9	4	10	10	4	77
358	36216	Wood and Worden, 1973	Copper sulfate	100	Duck (*Anas platyrhynchos*)	3	2	0/135	mg/kg diet	N	N	ADL	U	FD	16	d	2	d	JV	B	C	COM	2	MOR	MOR	MORT	WO	135		N	0.092	N	0.01231	18.1		10	10	5	10	5	9	4	10	10	4	77
359	6788	Ward et al, 1995	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	2	0/6.34	mg/org/d	N	N	ADL	M	FD	10	d	5	d	JV	M	C	DOM	5	MOR	MOR	MORT	WO	6.34		Y	0.3465	Y	0.0351	18.3		10	10	10	10	7	9	4	10	10	4	84
360	2006	Ankari et al, 1998	Copper	100	Chicken (*Gallus domesticus*)	1	4	0/50/150/250	mg/kg diet	N	N	ADL	U	FD	84	d	25	w	SM	F	C	DOM	3	MOR	MOR	MORT	WO	250		Y	1.5315	Y	0.12176	19.9		10	10	5	4	7	9	4	10	10	4	73
361	2191	Latymer and Coates, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	24	d	1	d	JV	B	V	COM	1	MOR	MOR	MORT	WO	250		Y	0.335	N	0.02856	21.3		10	10	5	10	6	9	4	1	10	4	69
362	2160	Jackson, et. al., 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/10.39/21.31/31.52/39.91	mg/org/d	N	N	ADL	U	FD	336	d	17	w	SM	F	C	NR	2	MOR	MOR	MORT	WO	39.91		Y	1.85	Y	0.0997	21.6		10	10	5	10	7	9	4	10	10	4	79
363	6788	Ward et al, 1995	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	2	2	0/10.33	mg/org/d	N	N	ADL	M	DR	10	d	5	d	JV	M	C	DOM	5	MOR	MOR	MORT	WO	10.33		Y	0.389	Y	0.116	26.6		10	5	10	10	7	9	4	10	10	4	79
364	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	7	4	0/250/500/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	MOR	MOR	MORT	WO	500	1000	N	1.042	N	0.05978	28.7	57.4	10	10	5	10	5	9	10	10	10	4	83
365	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/125/250/500/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	MOR	MOR	MORT	WO	500	1000	N	1.042	N	0.05978	28.7	57.4	10	10	5	10	5	9	10	10	10	4	83
366	1369	Hill, 1974	Copper sulfate	100	Chicken (*Gallus domesticus*)	2	2	0/500	mg/kg diet	N	N	ADL	U	FD	5	w	1	d	JV	M	C	COM	2	MOR	MOR	MORT	WO	500		N	1.042	N	0.05978	28.7		10	10	5	10	5	9	4	3	10	4	70
367	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	8	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	MOR	MOR	MORT	WO	500		N	1.042	N	0.05978	28.7		10	10	5	10	5	9	4	10	10	4	77
368	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	6	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	MOR	MOR	MORT	WO	500		N	1.042	N	0.05978	28.7		10	10	5	10	5	9	4	10	10	4	77
369	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	9	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	5	MOR	MOR	MORT	WO	500		N	1.042	N	0.05978	28.7		10	10	5	10	5	9	4	10	10	4	77
370	2250	Poupoulis and Jensen, 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	10	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	5	MOR	MOR	MORT	WO	500		N	1.042	N	0.05978	28.7		10	10	5	10	5	9	4	10	10	4	77
371	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	2	MOR	MOR	MORT	WO	750		Y	1.82	Y	0.072	29.7		10	10	5	10	7	9	4	10	10	4	79
372	2221	Miles et al, 1998	Tribasic copper chloride	100	Chicken (*Gallus domesticus*)	4	4	0/200/400/600	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	B	C	NR	3	MOR	MOR	MORT	WO	600		Y	1.335	Y	0.06617	29.7		10	10	5	10	7	9	4	10	10	4	79
373	2221	Miles et al, 1998	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	4	0/200/400/600	mg/kg diet	N	N	ADL	U	FD	42	d	1	d	JV	B	C	NR	3	MOR	MOR	MORT	WO	600		Y	1.543	Y	0.07917	30.8		10	10	5	10	7	9	4	1	10	4	70
374	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	SM	F	C	NR	2	MOR	MOR	MORT	WO	750		Y	1.78	Y	0.0751	31.6		10	10	5	10	7	9	4	10	10	4	79
375	22	Mehring et al, 1960	Copper oxide	100	Chicken (*Gallus domesticus*)	1	5	0/403/570/749/1180	mg/kg diet	N	N	NR	M	FD	10	w	1	d	JV	B	C	NR	1	MOR	MOR	MORT	WO	570	749	Y	1.0166	N	0.05883	33.0	43.3	10	10	10	10	6	9	10	10	10	4	89
376	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	2	MOR	MOR	MORT	WO	750		Y	1.33	Y	0.0624	35.2		10	10	5	10	7	9	4	10	10	4	79
377	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	SM	F	C	NR	2	MOR	MOR	MORT	WO	750		Y	1.5	Y	0.0708	35.4		10	10	5	10	7	9	4	10	10	4	79
378	2160	Jackson et al, 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/23.5/43.84/56.47/60.43	mg/org/d	N	N	ADL	U	FD	232	d	17	w	SM	F	C	NR	2	MOR	MOR	MORT	WO	60.43		Y	1.704	Y	0.07556	35.5		10	10	5	10	7	9	4	10	10	4	79
379	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	3	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	2	MOR	MOR	MORT	WO	750		Y	2.13	Y	0.123	43.3		10	10	5	10	7	9	4	10	10	4	79
380	14405	Waibel et al, 1964	Cupric carbonate	100	Turkey (*Melagris gallopavo*)	1	3	0/100/800	mg/kg diet	N	N	NR	U	FD	3	w	7	d	JV	NR	C	DOM	2	MOR	MOR	SURV	WO	800		N	1	N	0.0582	46.6		10	10	5	5	5	9	4	10	10	4	72
381	2052	Christmas and Harms, 1979	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	3	0/500/750	mg/kg diet	N	N	ADL	U	FD	21	d	1	d	JV	B	C	DOM	3	MOR	MOR	MORT	WO	750		Y	0.32	Y	0.0206	48.3		10	10	5	10	7	9	4	10	10	4	79
382	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	2	MOR	MOR	MORT	WO	750		Y	1.77	Y	0.118	50.0		10	10	5	10	7	9	4	10	10	4	79
383	14404	Vohra and Kratzer, 1968	Copper sulfate pentahydrate	100	Turkey (*Melagris gallopavo*)	3	5	0/810/1620/2430/3240	mg/kg diet	N	N	ADL	U	FD	21	d	NR	NR	JV	B	C	COM	2	MOR	MOR	MORT	WO	810	1620	N	0.5	N	0.0371	60.0	120	10	10	5	10	5	9	10	10	10	4	83
384	2157	Jackson, 1977	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/0.01486/0.02857/0.04828/0.07886/0.08657	g/org/d	N	N	ADL	U	FD	35	d	NR	NR	SM	F	C	NR	2	MOR	MOR	MORT	WO	0.0866		N	1.38	Y	0.045	62.7		10	10	5	10	6	9	4	10	10	4	78
385	92	Hill, 1974	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/500/1000/1500/2000/2500	mg/kg diet	N	N	ADL	U	FD	5	w	1	d	JV	F	C	COM	2	MOR	MOR	MORT	WO	1000	1500	N	0.38	N	0.031	81.6	122	10	10	5	10	5	9	10	10	10	4	83

Ref			Exposure																				Effects							Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	Endpoint Number	General Effect Group	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 Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
386	1370	Hill, 1979	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/1000	mg/kg diet	N	N	ADL	U	FD	2	w	1	d	JV	B	C	COM	2	MOR	MOR	MORT	WO	1000		N	0.328	N	0.02817	85.9		10	10	5	10	5	9	4	10	10	4	77
387	1403	Jensen, 1975	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/1000	mg/kg diet	N	N	ADL	U	FD	14	d	1	d	JV	NR	C	NR	2	MOR	MOR	MORT	WO	1000		Y	0.141	Y	0.0131	92.9		10	10	5	10	7	9	4	10	10	4	79
388	80	Van Vleet et al, 1981	Copper sulfate	100	Duck (*Anas platyrhynchos*)	2	2	0/1500	mg/kg diet	N	N	ADL	U	FD	15	d	1	d	JV	M	C	COM	1	MOR	MOR	MORT	WO	1500		N	0.092	N	0.01231	201		10	10	5	10	5	9	4	10	10	4	77
389	2181	Ko et al, 1985	Copper carbonate	100	Chicken (*Gallus domesticus*)	2	4	0/42/76/98	mg/kg diet	N	N	ADL	U	FD	3	w	3	d	JV	M	C	COM	1	MOR	MOR	MORT	WO		42	Y	0.2039	Y	0.01304		2.69	10	10	5	10	7	9	4	10	10	4	79
390	18769	Foster, 1999	Copper sulfate pentahydrate	100	Duck (*Anas platyrhynchos*)	4	2	0/605.4	mg/L	N	N	DLY	M	DR	4	d	4	d	JV	NR	C	COM	1	MOR	MOR	MORT	WO		605.4	N	0.092	N	0.01193		78.5	10	5	10	10	5	9	4	10	10	4	77
391	3727	Shivanandappa et al., 1983	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	6	0/200/600/800/1200/1600	mg/kg bw	N	N	DLY	U	OR	3	w	25	w	JV	M	V	NR	3	MOR	MOR	MORT	WO		200	Y	1.7	N	0.08221		79.6	10	8	5	10	10	9	4	10	10	4	80
392	80	Van Vleet et al, 1981	Copper sulfate	100	Duck (*Anas platyrhynchos*)	1	2	0/1500	mg/kg diet	N	N	ADL	U	FD	15	d	1	d	JV	M	C	COM	3	MOR	MOR	MORT	WO		1500	N	0.092	N	0.01231		201	10	10	5	10	5	9	4	10	10	4	77
393	3727	Shivanandappa et al, 1983	Copper oxychloride	59.51	Chicken (*Gallus domesticus*)	2	5	0/900/1200/1500/1800	mg/kg bw	N	N	DLY	U	OR	4	d	25	w	JV	M	V	NR	1	MOR	MOR	MORT	WO		900	Y	1.7	N	0.08221		536	10	8	5	10	10	9	4	10	10	4	80
Data Not Used to Derive TRV																																														
394	2007	Hoda and Maha, 1995	Copper sulfate	25	Chicken (*Gallus domesticus*)	3	3	0/75/150	mg/kg diet	N	N	ADL	U	FD	6	w	1	d	JV	NR	C	LAB	3	PHY	PHY	FDCV	WO	150		Y	1.1273	Y	0.05786	1.92		10	10	5	10	7	4	4	1	10	4	65
395	2160	Jackson et al, 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/10.39/21.31/31.52/39.91	mg/org/d	N	N	ADL	U	FD	336	d	17	w	SM	F	C	NR	4	BEH	FDB	FCNS	WO	39.91		Y	18.5	Y	0.0997	2.16		10	10	5	10	7	4	4	1	10	4	65
396	2329	Wilson et al, 1975	Copper sulfate	39.81	Chicken (*Gallus domesticus*)	1	3	0/48/96	mg/L	N	N	ADL	U	DR	6	w	1	d	JV	M	C	NR	3	PTH	HIS	GHIS	MT	96		N	1.042	Y	0.0712	2.61		10	5	5	10	6	4	4	1	10	4	59
397	2329	Wilson et al, 1975	Copper sulfate	39.81	Chicken (*Gallus domesticus*)	1	3	0/48/96	mg/L	N	N	ADL	U	DR	6	w	1	d	JV	M	C	NR	4	PHY	PHY	FDCV	WO	96		N	1.042	Y	0.0712	2.61		10	5	5	10	6	4	4	1	10	4	59
398	2329	Wilson et al, 1975	Copper sulfate	39.81	Chicken (*Gallus domesticus*)	1	3	0/48/96	mg/L	N	N	ADL	U	DR	6	w	1	d	JV	M	C	NR	2	GRO	GRO	BDWT	WO	96		N	1.042	Y	0.0712	2.61		10	5	5	10	6	8	4	1	10	4	63
399	2329	Wilson et al, 1975	Copper sulfate	39.81	Chicken (*Gallus domesticus*)	1	3	0/48/96	mg/L	N	N	ADL	U	DR	6	w	1	d	JV	M	C	NR	1	BEH	FDB	WCON	WO	96		N	1.042	Y	0.0712	2.61		10	5	5	10	6	4	4	1	10	4	59
400	2114	Guenthner et al, 1978	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	2	0/120	mg/kg diet	N	N	ADL	U	FD	24	w	1	d	JV	F	C	DOM	2	PHY	PHY	FDCV	WO	120		Y	11.61	N	0.28716	2.97		10	10	5	10	6	4	4	1	10	4	64
401	5149	Kayongo-Male and Palmer, 1998	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	3	0/8/75	mg/kg diet	N	N	ADL	U	FD	4	w	NR	NR	JV	NR	C	DOM	3	PTH	ORW	SMIX	LI	75		Y	0.787	N	0.0498	4.75		10	10	5	10	6	4	4	1	10	4	64
402	5149	Kayongo-Male and Palmer, 1998	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	3	0/8/75	mg/kg diet	N	N	ADL	U	FD	4	w	NR	NR	JV	NR	C	DOM	2	BIO	CHM	HMCT	BL	75		Y	0.787	N	0.0498	4.75		10	10	5	10	6	1	4	1	10	4	61
403	2171	Kashani et al, 1986	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	2	4	0/60/120/240	mg/kg diet	N	N	ADL	U	FD	24	w	1	d	JV	M	C	NR	2	PHY	PHY	FDCV	WO	240		Y	13.64	N	0.31892	5.61		10	10	5	10	6	4	4	1	10	4	64
404	2007	Hoda and Maha, 1995	Copper oxide	80.0	Chicken (*Gallus domesticus*)	2	3	0/75/150	mg/kg diet	N	N	ADL	U	FD	6	w	1	d	JV	M	C	LAB	3	PHY	PHY	FDCV	WO	150		Y	1.0887	Y	0.05698	6.28		10	10	5	10	7	4	4	1	10	4	65
405	2007	Hoda and Maha, 1995	Copper oxide	80.0	Chicken (*Gallus domesticus*)	2	3	0/75/150	mg/kg diet	N	N	ADL	U	FD	6	w	1	d	JV	M	C	LAB	2	BEH	FDB	FCNS	WO	150		Y	1.0887	Y	0.05698	6.28		10	10	5	10	7	4	4	1	10	4	65
406	36216	Wood and Worden, 1973	Copper sulfate	100	Duck (*Anas platyrhynchos*)	2	2	0/50	mg/kg diet	N	N	ADL	U	FD	49	d	2	d	JV	B	C	COM	1	PTH	ORW	ORWT	LI	50		Y	0.092	N	0.01231	6.69		10	10	5	10	6	4	4	1	10	4	64
407	2007	Hoda and Maha, 1995	Copper carbonate	100	Chicken (*Gallus domesticus*)	1	3	0/75/150	mg/kg diet	N	N	ADL	U	FD	6	w	1	d	JV	NR	C	LAB	3	PHY	PHY	FDCV	WO	150		Y	1.2283	Y	0.06186	7.55		10	10	5	10	7	4	4	1	10	4	65
408	2007	Hoda and Maha, 1995	Copper carbonate	100	Chicken (*Gallus domesticus*)	1	3	0/75/150	mg/kg diet	N	N	ADL	U	FD	6	w	1	d	JV	NR	C	LAB	2	BEH	FDB	FCNS	WO	150		Y	1.2283	Y	0.06186	7.55		10	10	5	10	7	4	4	1	10	4	65
409	2181	Ko et al, 1985	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/54/94/134	mg/kg diet	N	N	ADL	U	FD	3	w	3	d	JV	M	C	COM	4	PHY	PHY	FDCV	WO	134		Y	0.6283	Y	0.0394	8.40		10	10	5	10	7	4	4	1	10	4	65
410	2181	Ko et al, 1985	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/54/94/134	mg/kg diet	N	N	ADL	U	FD	3	w	3	d	JV	M	C	COM	3	BEH	FDB	FCNS	WO	134		Y	0.6283	Y	0.0394	8.40		10	10	5	10	7	4	4	1	10	4	65
411	2282	Shajahan and Coligado, 1982	Copper	100	Chicken (*Gallus domesticus*)	1	2	0/200	mg/kg diet	N	N	DLY	U	FD	6	w	1	d	JV	NR	C	NR	1	PTH	ORW	ORWT	IN	200		N	1.04	N	0.05971	11.5		10	10	5	4	5	4	4	1	10	4	57
412	2250	Poupoulis and Jensen, 1976	Copper chloride dihydrate	100	Chicken (*Gallus domesticus*)	11	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	BIO	CHM	PHPH	GZ	500		N	1.6	N	0.07903	11.7		10	10	5	10	5	1	4	1	10	4	60
413	2250	Poupoulis and Jensen, 1976	Copper chloride dihydrate	100	Chicken (*Gallus domesticus*)	11	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	BEH	FDB	FEFF	WO	500		N	1.6	N	0.07903	11.7		10	10	5	10	5	4	4	1	10	4	63
414	25968	Marron et al, 2001	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	21	d	7	d	JV	M	C	COM	3	PHY	PHY	FDCV	WO	250		N	0.564	Y	0.08020	14.2		10	10	5	10	6	4	4	1	10	4	64
415	25968	Marron et al, 2001	Copper (II) sulfate	39.81	Chicken (*Gallus domesticus*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	21	d	7	d	JV	M	C	COM	2	BEH	FDB	FCNS	WO	250		N	0.564	Y	0.08020	14.2		10	10	5	10	6	4	4	1	10	4	64
416	5734	Hill, 1990	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	5	0/25/50/100/200	mg/kg diet	N	N	ADL	U	FD	19	d	1	d	JV	F	C	DOM	2	BIO	CHM	GBCM	LI	200		N	0.564	N	0.04009	14.2		10	10	5	10	5	1	4	6	10	4	65
417	2250	Poupoulis and Jensen, 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	2	0/250	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	3	PTH	HIS	GHIS	GZ	250		N	1.042	N	0.05978	14.3		10	10	5	10	5	4	4	1	10	4	63
418	2250	Poupoulis and Jensen, 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	2	0/250	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO	250		N	1.042	N	0.05978	14.3		10	10	5	10	5	4	4	1	10	4	63
419	2250	Poupoulis and Jensen, 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	2	0/250	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO	250		N	1.042	N	0.05978	14.3		10	10	5	10	5	4	4	1	10	4	63
420	2164	Jensen and Maurice, 1978	Copper	100	Chicken (*Gallus domesticus*)	2	3	0/120/240	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	PHY	PHY	FDCV	WO	240		Y	0.709	N	0.04653	15.7		10	10	5	4	6	4	4	1	10	4	58
421	2164	Jensen and Maurice, 1978	Copper	100	Chicken (*Gallus domesticus*)	2	3	0/120/240	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	240		Y	0.709	N	0.04653	15.7		10	10	5	4	6	8	4	1	10	4	62
422	2164	Jensen and Maurice, 1978	Copper	100	Chicken (*Gallus domesticus*)	1	2	0/240	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	240		Y	0.606	N	0.04201	16.6		10	10	5	4	6	8	4	1	10	4	62
423	2164	Jensen and Maurice, 1978	Copper	100	Chicken (*Gallus domesticus*)	3	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	NR	C	NR	1	GRO	GRO	BDWT	WO	250		Y	0.476	N	0.0359	18.9		10	10	5	4	6	8	4	1	10	4	62
424	11876	Kadirvel and Kothandaraman, 1978	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/0.05	% in diet	N	N	ADL	U	FD	8	w	12	w	SM	F	C	COM	3	BEH	FDB	FCNS	WO	0.05		Y	1.4976	Y	0.0591	19.7		10	10	5	10	7	4	4	1	10	4	65
425	2006	Ankari et al, 1998	Copper	100	Chicken (*Gallus domesticus*)	1	4	0/50/150/250	mg/kg diet	N	N	ADL	U	FD	84	d	25	w	SM	F	C	DOM	4	GRO	GRO	BDWT	WO	250		Y	1.5315	Y	0.12176	19.9		10	10	5	4	7	8	4	1	10	4	63
426	2006	Ankari et al, 1998	Copper	100	Chicken (*Gallus domesticus*)	1	4	0/50/150/250	mg/kg diet	N	N	ADL	U	FD	84	d	25	w	SM	F	C	DOM	2	BEH	FDB	FCNS	WO	250		Y	1.5315	Y	0.12176	19.9		10	10	5	4	7	4	4	1	10	4	59
427	11876	Kadirvel and Kothandaraman, 1978	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/0.05	% in diet	N	N	ADL	U	FD	8	w	12	w	SM	F	C	COM	4	PHY	PHY	FDCV	WO	0.05		Y	1.4976	Y	0.0591	19.7		10	10	5	10	7	4	4	1	10	4	65
428	5812	Ledoux et al, 1989	Copper acetate monohydrate	100	Chicken (*Gallus domesticus*)	1	4	0/100/200/300	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	M	C	DOM	3	PHY	PHY	FDCV	WO	300		N	0.564	Y	0.0383	20.4		10	10	5	5	6	4	4	1	10	4	59
429	5617	Pimentel et al, 1992	Copper	100	Chicken (*Gallus domesticus*)	1	2	0/211.6	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	B	C	COM	3	BIO	CHM	HMGL	BL	211.6		Y	0.1103	Y	0.0109	20.9		10	10	5	4	7	1	4	6	10	4	61
430	2191	Latymer and Coates, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	24	d	1	d	JV	M	V	COM	3	BIO	CHM	GBCM	LI	250		Y	0.335	N	0.02856	21.3		10	10	5	10	6	1	4	3	10	4	63
431	5824	Ledoux et al, 1989	Cupric acetate	100	Chicken (*Gallus domesticus*)	1	4	0/100/200/300	mg/kg diet	N	N	ADL	U	FD	22	d	1	d	JV	M	C	NR	2	GRO	GRO	BDWT	WO	300		N	0.564	N	0.04009	21.3		10	10	5	5	5	8	4	1	10	4	62
432	5824	Ledoux et al, 1989	Cupric acetate	100	Chicken (*Gallus domesticus*)	1	4	0/100/200/300	mg/kg diet	N	N	ADL	U	FD	22	d	1	d	JV	M	C	NR	3	BIO	CHM	CALC	LI	300		N	0.564	N	0.04009	21.3		10	10	5	5	5	1	4	10	10	4	64
433	5824	Ledoux et al, 1989	Cupric acetate	100	Chicken (*Gallus domesticus*)	1	4	0/100/200/300	mg/kg diet	N	N	ADL	U	FD	22	d	1	d	JV	M	C	NR	1	BEH	FDB	FCNS	WO	300		N	0.564	N	0.04009	21.3		10	10	5	5	5	4	4	1	10	4	58
434	2160	Jackson et al, 1979	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/10.39/21.31/31.52/39.91	mg/org/d	N	N	ADL	U	FD	336	d	17	w	SM	F	C	NR	7	PHY	PHY	FDCV	WO	39.91		N	1.85	Y	0.0997	21.6		10	10	5	10	6	4	4	1	10	4	64
435	2099	Funk and Baker, 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	3	3	0/5/8.23	mg/org/d	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	3	PHY	PHY	FDCV	WO	8.23		Y	0.319	Y	0.025	25.8		10	10	5	10	7	4	4	1	10	4	65
436	6788	Ward et al, 1995	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	2	2	0/10.33	mg/org/d	N	N	ADL	M	DR	10	d	5	d	JV	M	C	DOM	3	PHY	PHY	FDCV	WO	10.33		Y	0.389	Y	0.116	26.6		10	5	10	10	7	4	4	1	10	4	65
437	6788	Ward et al, 1995	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	2	2	0/10.33	mg/org/d	N	N	ADL	M	DR	10	d	5	d	JV	M	C	DOM	2	BEH	FDB	FCNS	WO	10.33		Y	0.389	Y	0.116	26.6		10	5	10	10	7	4	4	1	10	4	65
438	6788	Ward et al, 1995	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	2	2	0/10.33	mg/org/d	N	N	ADL	M	DR	10	d	5	d	JV	M	C	DOM	4	BIO	CHM	HMGL	BL	10.33		Y	0.389	Y	0.116	26.6		10	5	10	10	7	1	4	1	10	4	62
439	2226	Nam et al 1984	Copper carbonate	51.43	Chicken (*Gallus domesticus*)	1	3	0/0.05/0.10	% in diet	N	N	ADL	U	FD	4	w	3	d	JV	NR	C	COM	2	BEH	FDB	FCNS	WO	0.1		N	1.042	Y	0.0543	26.8		10	10	5	10	6	4	4	1	10	4	64
440	14398	Goldberg et al, 1956	Copper acetate	100	Chicken (*Gallus domesticus*)	1	2	0/50	mg/d	N	N	DLY	U	OR	7	d	NR	NR	AD	F	C	DOM	1	BIO	CHM	HMGL	BL	50		Y	1.8	N	0.0853	27.8		10	8	5	5	6	1	4	1	3	4	47

Ref			Exposure																					Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	Endpoint Number	General Effect Group	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 Concentrations	Chemical form	Dose Quantification	Endpoint	Dose Range	Statistical Power	Exposure Duration	Test Conditions	Total
441	2250	Poupoulis and Jensen, 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	8	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO	500		N	1.042	N	0.05978	28.7		10	10	5	10	5	4	4	1	10	4	63
442	2250	Poupoulis and Jensen, 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	9	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO	500		N	1.042	N	0.05978	28.7		10	10	5	10	5	4	4	1	10	4	63
443	2250	Poupoulis and Jensen, 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	5	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO	500		N	1.042	N	0.05978	28.7		10	10	5	10	5	4	4	1	10	4	63
444	2250	Poupoulis and Jensen, 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	10	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO	500		N	1.042	N	0.05978	28.7		10	10	5	10	5	4	4	1	10	4	63
445	2250	Poupoulis and Jensen, 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	10	3	0/250/500	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	4	BIO	CHM	PHPH	GZ	500		N	1.042	N	0.05978	28.7		10	10	5	10	5	1	4	1	10	4	60
446	2159	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	5	BIO	CHM	LIPD	LI	750		Y	1.82	Y	0.072	29.7		10	10	5	10	7	1	4	1	10	4	62
447	2284	Smith, 1969	Cupric sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/100/200/350	mg/kg diet	N	N	ADL	U	FD	25	d	1	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO	350		Y	0.2982	N	0.02647	31.1		10	10	5	10	6	4	4	1	10	4	64
448	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	SM	F	C	NR	4	PTH	ORW	ORWT	LI	750		Y	1.78	Y	0.0751	31.6		10	10	5	10	7	4	4	1	10	4	65
449	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	SM	F	C	NR	7	BIO	CHM	LIPD	LI	750		Y	1.78	Y	0.0751	31.6		10	10	5	10	7	1	4	1	10	4	62
450	2172	Kassim and Suwanpradit, 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	3	w	1	d	JV	M	C	COM	3	PHY	PHY	FDCV	WO	375		N	0.564	Y	0.04827	32.1		10	10	5	10	6	4	4	1	10	4	64
451	2052	Christmas and Harms, 1979	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	3	0/500/750	mg/kg diet	N	N	ADL	U	FD	21	d	1	d	JV	NR	C	DOM	5	PHY	PHY	FDCV	WO	750		Y	0.459	Y	0.0206	33.7		10	10	5	10	7	4	4	1	10	4	65
452	2163	Jensen et al, 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/120/240/480	mg/kg diet	N	N	NR	U	FD	3	w	1	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO	480		Y	0.567	N	0.04023	34.1		10	10	5	10	6	4	4	1	10	4	64
453	2158	Jackson and Stevenson, 1981	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	280	d	18	w	SM	F	C	NR	5	PTH	ORW	ORWT	LI	750		Y	1.5	Y	0.0708	35.4		10	10	5	10	7	4	4	1	10	4	65
454	2517	Bafundo et al, 1984	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	2	PHY	PHY	FDCV	WO	500		N	0.564	N	0.04009	35.5		10	10	5	10	5	4	4	1	10	4	63
455	2517	Bafundo et al, 1984	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	3	BIO	ENZ	ALPH	BL	500		N	0.564	N	0.04009	35.5		10	10	5	10	5	1	4	1	10	4	60
456	2099	Funk and Baker, 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	4	3	0/5.78/11.51	mg/org/d	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	3	PHY	PHY	FDCV	WO	11.51		Y	0.317	Y	0.02886	36.3		10	10	5	10	7	4	4	1	10	4	65
457	1278	Davis et al, 1996	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	21	d	14	d	JV	M	C	LAB	3	PTH	ORW	ORWT	LI	500		Y	0.484	Y	0.0359	37.1		10	10	5	10	7	4	4	1	10	4	65
458	1278	Davis et al, 1996	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	21	d	14	d	JV	M	C	LAB	4	PHY	PHY	FDCV	WO	500		Y	0.484	Y	0.0359	37.1		10	10	5	10	7	4	4	1	10	4	65
459	1278	Davis et al, 1996	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	21	d	14	d	JV	M	C	LAB	2	BEH	FDB	FCNS	WO	500		Y	0.484	Y	0.0359	37.1		10	10	5	10	7	4	4	1	10	4	65
460	2049	Chiou et al, 1998	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	4	0/400/500/600	mg/kg diet	N	N	ADL	U	FD	4	w	38	w	SM	F	C	COM	3	PTH	ORW	ORWT	LI	600		Y	1.464	Y	0.0978	40.1		10	10	5	10	7	4	4	1	10	4	65
461	6368	Southern and Baker, 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	14	d	8	d	JV	M	C	COM	2	PHY	PHY	FDCV	WO	500		Y	0.374	N	0.0307	41.0		10	10	5	10	6	4	4	1	10	4	64
462	6368	Southern and Baker, 1983	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	14	d	8	d	JV	M	C	COM	3	BIO	CHM	HMGL	BL	500		Y	0.374	N	0.0307	41.0		10	10	5	10	6	1	4	1	10	4	61
463	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	3	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	5	PHY	PHY	FDCV	WO	750		Y	2.13	Y	0.123	43.3		10	10	5	10	7	4	4	1	10	4	65
464	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	3	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	4	BIO	CHM	LIPD	LI	750		Y	2.13	Y	0.123	43.3		10	10	5	10	7	1	4	1	10	4	62
465	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	3	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	8	BEH	FDB	FCNS	WO	750		Y	2.13	Y	0.123	43.3		10	10	5	10	7	4	4	1	10	4	65
466	14405	Waibel et al, 1964	Cupric carbonate	100	Turkey (*Melagris gallopavo*)	1	3	0/100/800	mg/kg diet	N	N	NR	U	FD	3	w	7	d	JV	NR	C	DOM	3	BIO	CHM	HMGL	BL	800		N	1	N	0.0582	46.6		10	10	5	5	5	1	4	1	10	4	55
467	2118	Harms and Buresh, 1987	Copper sulfate pentahydrate	100	Turkey (*Meleagris gallopavo*)	1	3	0/500/750	mg/kg diet	N	N	DLY	U	FD	21	d	1	d	JV	B	C	NR	3	PHY	PHY	FDCV	WO	750		Y	0.2877	Y	0.0186	48.5		10	10	5	10	7	4	4	1	10	4	65
468	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	5	PHY	PHY	FDCV	WO	750		Y	1.77	Y	0.118	50.0		10	10	5	10	7	4	4	1	10	4	65
469	2159	Jackson and Stevenson, 1981	Copper oxide	100	Chicken (*Gallus domesticus*)	1	6	0/150/300/450/600/750	mg/kg diet	N	N	ADL	U	FD	336	d	26	w	SM	F	C	NR	3	BEH	FDB	FCNS	WO	750		Y	1.77	Y	0.118	50.0		10	10	5	10	7	4	4	1	10	4	65
470	5824	Ledoux et al, 1989	Cupric acetate	100	Chicken (*Gallus domesticus*)	1	4	0/100/200/300	mg/kg diet	N	N	ADL	U	FD	22	d	1	d	JV	M	C	NR	1	BEH	FDB	FCNS	WO	300		N	0.564	N	0.04009	53.8		10	10	5	5	5	4	4	1	10	4	58
471	2250	Poupoulis and Jensen 1976	Copper (II) sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	5	0/250/500/750/1000	mg/kg diet	N	N	ADL	U	FD	4	w	1	d	JV	NR	C	NR	2	PHY	PHY	FDCV	WO	1000		N	1.042	N	0.05978	57.4		10	10	5	10	5	4	4	1	10	4	63
472	2099	Funk and Baker 1991	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	1	5	0/2.67/5.22/10.36/18.79	mg/org/d	N	N	ADL	U	FD	14	d	8	d	JV	M	C	NR	3	PHY	PHY	FDCV	WO	18.79		N	0.294	Y	0.0235	63.9		10	10	5	10	6	4	4	1	10	4	64
473	2172	Kassim and Suwanpradit, 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	3	w	3	w	JV	M	C	COM	3	PHY	PHY	FDCV	WO	375		N	0.564	Y	0.10858	72.2		10	10	5	10	6	4	4	1	10	4	64
474	2172	Kassim and Suwanpradit, 1996	Copper sulfate pentahydrate	100	Chicken (*Gallus domesticus*)	2	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	3	w	3	w	JV	M	C	COM	2	BEH	FDB	FCNS	WO	375		N	0.564	Y	0.10858	72.2		10	10	5	10	6	4	4	1	10	4	64
475	2333	Yannakopoulos et al, 1990	Copper sulfate pentahydrate	100	Japanese quail (*Coturnix japonica*)	1	4	0/200/400/600	mg/kg diet	N	N	ADL	U	FD	34	d	7	d	JV	B	C	NR	3	PTH	ORW	ORWT	BT	600		Y	0.1764	Y	0.0241	82.0		10	10	5	10	7	4	4	1	10	4	65
476	5619	Pimentel et al, 1992	Copper	100	Chicken (*Gallus domesticus*)	1	3	0/222.39/529.92	mg/kg diet	N	N	ADL	U	FD	21	d	1	d	JV	B	C	COM	1	BIO	CHM	HMGL	BL	529.92		N	0.0397	N	0.00712	95.1		10	10	5	4	5	1	4	10	10	4	63
477	2196	Leeson and Summers, 1982	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/20/40/80	mg/kg diet	N	N	ADL	U	FD	21	d	1	d	JV	M	C	COM	3	PHY	PHY	FDCV	WO	80		N	0.564	Y	0.7271	103		10	10	5	10	6	4	4	1	10	4	64
478	2196	Leeson and Summers, 1982	Copper sulfate	100	Chicken (*Gallus domesticus*)	1	4	0/20/40/80	mg/kg diet	N	N	ADL	U	FD	21	d	1	d	JV	M	C	COM	2	BEH	FDB	FDNG	WO	80		N	0.564	Y	0.7271	103		10	10	5	10	6	4	4	1	10	4	64
479	18769	Foster, 1999	Cupric acetate monohydrate	100	Duck (*Anas platyrhynchos*)	3	2	0/1024.8	mg/kg diet	N	N	DLY	M	FD	35	d	3	d	JV	NR	C	COM	3	BIO	CHM	HEMT	BL	1024.8		Y	0.9584	Y	0.13418	143		10	10	10	5	7	1	4	3	10	4	64
480	80	Van Vleet et al, 1981	Copper sulfate	100	Duck (*Anas platyrhynchos*)	1	2	0/1500	mg/kg diet	N	N	ADL	U	FD	15	d	1	d	JV	M	C	COM	2	BIO	ENZ	GLPX	BL	1500		N	0.092	N	0.01231	201		10	10	5	10	5	1	4	3	10	4	62
481	2006	Ankari et al, 1998	Copper	100	Chicken (*Gallus domesticus*)	1	4	0/50/150/250	mg/kg diet	N	N	ADL	U	FD	84	d	25	w	SM	F	C	DOM	5	BIO	CHM	CHOL	PL		50	Y	1.5161	Y	0.12278		4.05	10	10	5	4	7	1	4	10	10	4	65

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

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

Appendix 6-1

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

February 2007

Ref			Exposure																				Effects					Conversion to mg/kg bw/day					Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	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	2625	Cerklewski and Forbes, 1977	Copper chloride	100	Rat (*Rattus norvegicus*)	1	2	0/20	mg/kg diet	N	N	DLY	U	FD	1	w	NR	NR	JV	M	C	LAB	BIO	CHM	HMGL	UR	20		Y	0.196	Y	0.0150	1.53		10	10	5	10	7	1	4	10	10	4	71
2	36349	Uthus, 2001	Cupric carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/25	ug/g diet	N	N	ADL	U	FD	62	d	NR	NR	JV	M	C	LAB	BIO	CHM	HMGL	BL	25		Y	0.351	Y	0.0291	2.07		10	10	5	10	6	1	4	10	10	4	70
3	10086	Amer, et al, 1973	Copper sulfate pentahydrate	100	Cattle (*Bos taurus*)	1	3	0/107/201	mg/kg diet	N	N	ADL	M	FD	4	w	3	d	JV	M	C	COM	BIO	ENZ	GENZ	BL	107	201	N	220	N	5.79	2.71	5.09	10	10	10	10	5	1	10	10	10	4	80
4	36240	Miranda et al, 1981	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/55.1	ug/g diet	N	N	ADL	M	FD	5	w	NR	NR	JV	M	C	LAB	BIO	ENZ	ASAT	PL	55.1		Y	0.225	Y	0.0147	3.60		10	10	10	10	7	1	4	8	10	4	74
5	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	4	6	0/500/1000/2000/4000/8000	mg/kg diet	N	N	ADL	U	FD	13	w	6	w	JV	B	C	LAB	BIO	ENZ	AATT	BL	500	1000	Y	0.36	Y	0.0170	6.02	12.0	10	10	5	10	7	1	10	10	10	4	77
6	21243	Irie,M., 1990	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/20/200	mg/kg diet	N	N	ADL	U	FD	8	w	4	mo	JV	NR	C	DOM	BIO	CHM	FFTA	WO	200		Y	98.6	N	2.99	6.07		10	10	5	10	6	1	4	10	10	4	70
7	2304	Thacker, 1991	Copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	7	d	NR	NR	GE	F	C	NR	BIO	CHM	PRTL	MK	250		Y	232	N	6.04	6.51		10	10	5	10	6	1	4	10	10	4	70
8	20975	Kline et al, 1971	Copper sulfate	100	Pig (*Sus scrofa*)	1	4	0/151/197/246	mg/kg diet	N	N	ADL	M	FD	88	d	69	d	JV	NR	C	DOM	BIO	CHM	HMGL	BL	246		Y	87.232	N	2.71	7.63		10	10	10	10	6	1	4	1	10	4	66
9	2182	Kornegay, et al, 1986	Copper	100	Pig (*Sus scrofa*)	1	3	0/200/400	mg/kg diet	N	N	ADL	U	FD	25	d	NR	NR	JV	B	C	COM	BIO	CHM	HMGL	BL	200	400	Y	18.4	Y	0.790	8.59	17.2	10	10	5	4	7	1	10	10	10	4	71
10	2033	Brandt, 1983	Copper (II) sulfate	100	Mink (*Mustela vision*)	1	3	0/166/320	mg/kg diet	N	Y	ADL	M	FD	4	mo	90	d	JV	M	C	NR	BIO	CHM	HMGL	PL	166	320	Y	1.92	N	0.11744	10.2	19.6	10	10	10	10	6	1	10	10	10	4	81
11	3757	Suttle and Mills, 1966	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/250/425	mg/kg diet	N	N	NR	U	FD	34	d	NR	NR	JV	F	C	DOM	BIO	ENZ	ASAT	SR	250	425	Y	30	Y	1.43	11.9	20.3	10	10	5	10	7	1	10	10	10	4	77
12	3756	Smith et al, 1975	Cupric carbonate	100	Horse - Shetland pony (*Equus caballus*)	1	4	0/691.7/1209.1/2088.2	mg/org/d	N	N	ADL	M	FD	84	d	NR	NR	JV	NR	C	DOM	BIO	CHM	PCLV	BL	2088.2		Y	151.8	Y	2.64	13.8		10	10	10	10	7	1	4	1	10	4	67
13	12718	Moffitt and Murphy, 1973	Copper sulfate pentahydrate	100	Rat (*Rattus norvegicus*)	1	4	0/50/150/450	mg/L	N	N	ADL	U	DR	15	d	NR	NR	JV	B	C	LAB	BIO	ENZ	AHDX	LI	150	450	Y	0.25	N	0.0284	17.1	51.2	10	5	5	10	6	1	10	10	10	4	71
14	2020	Bassuny, 1991	Copper sulfate pentahydrate	25.45	Rabbit (*Oryctolagus cuniculus*)	1	5	0/75/150/300/450	mg/kg diet	N	N	NR	U	FD	7	w	35	d	JV	M	C	NR	BIO	CHM	PRTL	BL		75	Y	2.224	Y	0.0883		0.758	10	10	5	10	7	1	4	10	10	4	71
15	36748	Solaiman, et al, 2001	Copper sulfate pentahydrate	100	Goat (*Capra hircus*)	1	3	0/50/100	mg/org/d	N	N	DLY	U	GV	9	w	7-8	mo	JV	F	C	DOM	BIO	ENZ	GGTR	PL		50	Y	34.06	N	1.2487		1.47	10	8	10	10	6	1	4	10	10	4	73
16	36231	Kakela et al, 1999	Copper sulfate	100	Mink (*Mustela vision*)	1	2	0/62	mg/kg diet	N	N	NR	U	FD	28	d	6	mo	JV	F	C	NR	BIO	CHM	VTMA	PL		62	Y	1.4	N	0.0906		4.01	10	10	5	10	6	1	4	10	10	4	70
17	36248	Kakela and Hyvarinen, 1999	Copper sulfate	100	Mink (*Mustela vision*)	1	2	0/62	mg/kg diet	N	N	NR	U	FD	28	d	6	mo	JV	F	C	NR	BIO	CHM	FFTA	LD		62	Y	1.4	N	0.0906		4.01	10	10	5	10	6	1	4	10	10	4	70
18	3752	Adam et al, 1977	Copper (II) sulfate pentahydrate	25.45	Goat (*Capra hircus*)	1	4	0/20/40/80	mg/kg bw/d	Y	N	DLY	U	GV	144	d	12	mo	AD	B	C	NR	BIO	CHM	GLYC	LI		20	N	82.5	N	2.58		5.36	10	8	10	10	10	1	4	10	6	4	73
19	2064	DeGoey et al 1971	Copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	98	d	NR	mo	JV	NR	C	NR	BIO	CHM	HMGL	BL		250	Y	90.5	Y	2.70		7.46	10	10	5	10	7	1	4	10	10	4	71
20	14396	Gipp et al, 1973	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	12	w	NR	NR	JV	F	C	COM	BIO	CHM	HMGL	BL		250	Y	93.2	N	2.86		7.66	10	10	5	10	6	1	4	10	10	4	70
21	12809	Myres and Bowland, 1973	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	10	w	70	d	JV	B	C	COM	BIO	CHM	FFTA	LD		250	Y	64.7	Y	2.03		7.84	10	10	5	10	7	1	4	10	10	4	71
22	14402	Ritchie et al, 1963	Copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	15	w	7	w	JV	NR	C	COM	BIO	CHM	HMGL	WO		250	Y	69.31	N	2.24		8.08	10	10	5	10	6	1	4	10	10	4	70
23	2237	Onifade and Abu 1998	Copper sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	70	d	7	w	JV	NR	C	LAB	BIO	CHM	TWBC	BL		125	Y	0.5768	N	0.043704		9.47	10	10	5	10	6	1	4	10	10	4	70
24	14397	Gipp, et al, 1974	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	35	d	3	w	JV	B	C	COM	BIO	CHM	HMGL	BL		250	Y	21.9	Y	0.870		9.93	10	10	5	10	7	1	4	10	10	4	71
25	2255	Radecki et al 1992	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	DLY	U	FD	14	d	21	d	JV	B	C	NR	BIO	ENZ	G6PD	GT		250	Y	7.384	N	0.355		12.0	10	10	5	10	6	1	4	10	10	4	70
26	2064	DeGoey et al 1971	Copper sulfate	100	Pig (*Sus scrofa*)	2	2	0/500	mg/kg diet	N	N	ADL	U	FD	23	d	NR	mo	JV	NR	C	NR	BIO	CHM	HMGL	BL		500	Y	89	N	2.75		15.5	10	10	5	10	6	1	4	10	10	4	70
27	2256	Rana and Kumar 1980	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	2	0/100	mg/kg bw	N	N	DLY	U	GV	20	d	90	d	JV	M	C	LAB	BIO	CHM	RBCE	BL		100	Y	0.101	N	0.010435		39.8	10	8	10	10	10	1	4	10	10	4	77
28	2186	Kumar et al, 1987	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	2	0/0.1	g/kg bw/d	N	N	DLY	U	GV	45	d	90	d	JV	M	C	LAB	BIO	CHM	PRTL	KI		0.1	Y	0.103	N	0.010605		39.8	10	8	10	10	10	1	4	10	10	4	77
29	36346	Gautam et al, 2001	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	2	0/0.1	g/kg bw	N	N	ADL	U	FD	2	w	NR	NR	JV	NR	C	WLD	BIO	CHM	CALC	LI		0.1	Y	0.06	N	0.006801		39.8	10	10	5	10	10	1	4	10	10	4	74
30	10891	DeVries et al, 1986	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/12	mg/org/d	N	N	NR	U	DR	11	mo	3	w	JV	F	C	LAB	BIO	HRM	GHRM	BR		12	Y	0.262	Y	0.0250		45.8	10	5	5	10	7	1	4	10	10	4	66
31	25964	Aburto, et al, 2001	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/500	ug/g diet	N	N	ADL	U	FD	6	mo	10	w	JV	M	C	LAB	BIO	CHM	GCHM	LI		500	Y	0.14	N	0.0136		48.7	10	10	5	10	6	1	4	10	10	4	70
32	23825	Pribyl et al, 1980	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/12.7	mg/org/d	N	N	ADL	U	FD	4	d	NR	NR	JV	M	C	LAB	BIO	ENZ	GENZ	SR		12.7	Y	0.2	N	0.018298		63.5	10	10	5	10	6	1	4	10	10	4	70
33	36247	Rana and Verma, 1997	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/75	mg/kg bw/d	N	N	EOD	U	FD	30	d	NR	NR	JV	M	C	LAB	BIO	CHM	GLTH	LI		75	Y	0.14	N	0.0136		75.0	10	10	10	10	10	1	4	10	10	4	79
34	36389	Tatum et al, 2000	Copper chloride	100	Rat (*Rattus norvegicus*)	1	2	0/800	mg/kg diet	N	N	ADL	U	FD	6	w	NR	NR	JV	F	C	LAB	BIO	ENZ	GENZ	PL		800	Y	0.165	N	0.0156		75.7	10	10	5	10	6	1	4	10	10	4	70
35	13236	Rana et. al, 1985	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/0.1	g/kg bw/d	N	N	DLY	U	GV	30	d	90	d	JV	M	C	LAB	BIO	CHM	GLYC	LI		0.1	Y	0.1	N	0.0104		100	10	8	10	10	10	1	4	10	10	4	77
36	36364	Fuentealba et al, 2000	Copper sulfate	100	Rat (*Rattus norvegicus*)	2	2	0/1500	mg/kg diet	N	N	ADL	U	FD	12	w	21	d	JV	B	C	LAB	BIO	ENZ	AATT	LI		1500	N	0.38	N	0.0310		122	10	10	5	10	5	1	4	10	10	4	69
37	36364	Fuentealba et al, 2000	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/1500	mg/kg diet	N	N	ADL	U	FD	18	w	NR	NR	GE	F	C	LAB	BIO	ENZ	AATT	LI		1500	N	0.25	N	0.0220		132	10	10	5	10	5	1	4	10	10	4	69
38	2097	Fuentealba et al 1993	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/1500	mg/kg diet	N	N	ADL	U	FD	1	w	NR	mo	JV	M	C	NR	BIO	CHM	GBCM	LI		1500	N	0.217	N	0.01957		135	10	10	5	10	5	1	4	10	10	4	69
39	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	8	4	0/129/259/551	mg/org/d	N	N	ADL	U	FD	92	d	6	w	JV	M	C	COM	BIO	ENZ	AATT	BL		129	N	0.352	N	0.0291		146	10	10	5	10	5	1	4	10	10	4	69
40	2123	Haywood and Comerford 1980	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/2000	mg/kg diet	N	N	DLY	U	FD	1	w	NR	mo	JV	M	C	NR	BIO	ENZ	AATT	BL		2000	N	0.235	N	0.0209		178	10	10	5	10	5	1	4	10	10	4	69
41	36355	Zhang et al, 2000	Copper sulfate pentahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/357	mg/kg bw/d	N	N	5 per w	U	GV	8	w	8	w	JV	B	C	LAB	BIO	ENZ	GENZ	SR		357	N	0.217	N	0.0196		357	10	10	10	10	10	1	4	10	10	4	79
42	36374	Pettersen, et al, 2002	Copper chloride	100	Mouse (*Mus musculus*)	1	3	0/3.5/7	g/kg diet	N	N	ADL	U	FD	3	w	4	w	JV	B	C	LAB	BIO	CHM	NACO	HE		3.5	Y	0.0175	N	0.00247		494	10	10	5	10	6	1	4	10	10	4	70
43	36200	Gooneratne and Howell, 1980	Copper sulfate pentahydrate	25.45	Sheep (*Ovis aries*)	1	2	0/7.14	g/kg bw/d	N	N	5 per w	U	DR	66	d	9-12	mo	JV	M	C	COM	BIO	ENZ	GLPX	LI		7.14	N	65.1	N	4.24		1817	10	5	5	10	10	1	4	10	10	4	69
44	36234	Sansinanea et al, 1996	Copper sulfate	100	Sheep (*Ovis aries*)	1	2	0/7.14	g/kg bw/d	N	N	5 per w	U	OR	14	w	12	mo	JV	F	C	DOM	BIO	CHM	GLUC	SR		7.14	N	80	N	2.52		7140	10	8	10	10	10	1	4	10	10	4	77
Behavior																																													
45	36240	Miranda et al, 1981	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/55.1	ug/g diet	N	N	ADL	M	FD	5	w	NR	NR	JV	M	C	LAB	BEH	FDB	FCNS	WO	55.1		Y	0.225	Y	0.0147	3.60		10	10	10	10	7	4	4	6	10	4	75
46	2010	Anugwa et al, 1984	Copper (II) sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	3	0/122.2/223.67	mg/kg diet	N	N	ADL	M	FD	8	w	8	w	JV	B	C	NR	BEH	FDB	FCNS	WO	122.2	223.67	Y	1.787	Y	0.05326	3.64	6.67	10	10	10	10	7	4	10	10	10	4	85
47	2020	Bassuny, 1991	Copper sulfate pentahydrate	25.45	Rabbit (*Oryctolagus cuniculus*)	1	5	0/75/150/300/450	mg/kg diet	N	N	NR	U	FD	7	w	35	d	JV	M	C	NR	BEH	FDB	FCNS	WO	450		Y	2.218	Y	0.0823	4.25		10	10	5	10	7	4	4	10	10	4	74
48	1888	Ward, et al, 1991	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/199	mg/kg diet	N	N	ADL	M	FD	144	d	31	d	JV	B	C	NR	BEH	FDB	FDNG	WO	199		Y	108	Y	2.37	4.37		10	10	10	10	7	4	4	1	10	4	70
49	14387	Allcroft et al, 1961	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	4	0/380/560/934	mg/org/d	N	N	ADL	M	FD	4	w	8-10	w	JV	B	C	DOM	BEH	FDB	FCNS	WO	560	934	N	100	Y	2.36	5.60	9.34	10	10	10	10	6	4	10	10	10	4	84
50	136	Gershbein et al 1983	Copper (II) sulfate pentahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/75	mg/kg diet	N	N	ADL	U	FD	80	d	44	d	JV	M	C	NR	BEH	BEH	NMVM	WO	75		Y	0.47	N	0.03693	5.89		10	10	5	10	6	4	4	3	10	4	66
51	2304	Thacker, 1991	Copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	35	d	NR	NR	LC	F	C	NR	BEH	FDB	FCNS	WO	250		Y	213	Y	5.7	6.69		10	10	5	10	7	4	4	10	10	4	74
52	25922	Apgar et al, 1995	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	4	0/115/156/242	mg/kg diet	N	N	ADL	M	FD	5	w	31	d	JV	B	C	COM	BEH	FDB	FCNS	WO	242		Y	20.4	Y	0.582	6.90		10	10	10	10	7	4	4	1	10	4	70
53	25930	Cromwell et al, 1998	Copper chloride - tribasic	100	Pig (*Sus scrofa*)	1	2	0/116/218	mg/kg diet	N	N	ADL	M	FD	28	d	29	d	JV	B	C	COM	BEH	FDB	FCNS	WO	218		Y	17.7	Y	0.598	7.37		10	10	10	10	7	4	4	1	10	4	70
54	25930	Cromwell et al, 1998	Copper chloride - tribasic	100	Pig (*Sus scrofa*)	1	2	0/116/218	mg/kg diet	N	N	ADL	M	FD	28	d	29	d	JV	B	C	COM	BEH	FDB	FCNS	WO	218		Y	17.7	Y	0.598	7.37		10	10	10	10	7	4	4	1	10	4	70
55	25930	Cromwell et al, 1998	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	4	2	0/231	mg/kg diet	N	N	ADL	M	FD	28	d	30	d	JV	B	C	COM	BEH	FDB	FCNS	WO	231		Y	20.8	Y	0.739	8.21		10	10	10	10	7	4	4	1	10	4	70
56	14387	Allcroft et al, 1961	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	2	4	0/345/579/843	mg/org/d	N	N	ADL	M	FD	19	w	8-10	w	JV	B	C	DOM	BEH	FDB	FCNS	WO	843		N	100	Y	2.15	8.43		10	10	10	10	6	4	4	1	10	4	69

Ref			Exposure																				Effects					Conversion to mg/kg bw/day					Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	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
57	25930	Cromwell et al, 1998	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	2	3	0/117/226	mg/kg diet	N	N	ADL	M	FD	28	d	29	d	JV	B	C	COM	BEH	FDB	FCNS	WO	226		Y	17.7	Y	0.666	8.50		10	10	10	10	7	4	4	1	10	4	70
58	2061	Cromwell et al 1989	Copper sulfate	100	Pig (*Sus scrofa*)	5	5	0/125/250/375/500	mg/kg diet	N	N	ADL	U	FD	33	d	28	d	JV	B	C	NR	BEH	FDB	FCNS	WO	250	375	Y	18	Y	0.73	8.67	13.0	10	10	5	10	7	4	10	10	10	4	80
59	25930	Cromwell et al, 1998	Copper chloride	100	Pig (*Sus scrofa*)	3	4	0/124/167/241	mg/kg diet	N	N	ADL	M	FD	28	d	30	d	JV	B	C	COM	BEH	FDB	FCNS	WO	241		Y	20.8	Y	0.749	8.68		10	10	10	10	7	4	4	1	10	4	70
60	2061	Cromwell et al 1989	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	3	4	0/125/250/500	mg/kg diet	N	N	ADL	U	FD	28	d	28	d	JV	B	C	NR	BEH	FDB	FCNS	WO	250	500	Y	12.2	Y	0.486	10.0	19.9	10	10	5	10	7	4	10	10	10	4	80
61	2075	Edmonds and Baker 1986	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/250/650	mg/kg diet	N	N	ADL	U	FD	28	d	4	w	JV	NR	C	NR	BEH	FDB	FCNS	WO	250	650	Y	17.53	Y	0.725	10.3	26.9	10	10	5	10	7	4	10	10	10	4	80
62	25928	Apgar and Kornegay, 1996	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/16.5	mg/kg bw/d	N	N	2 per d	M	FD	14	d	NR	NR	JV	M	C	COM	BEH	FDB	FCNS	WO	16.5		Y	81.4	Y	0.066	16.5		10	10	10	10	10	4	4	1	10	4	73
63	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	1	6	0/300/1000/3000/10000/30000	mg/L	N	N	ADL	U	DR	15	d	6	w	JV	B	C	LAB	BEH	FDB	WCON	WO	1000	3000	Y	0.174	Y	0.01176	17.2	51.6	10	5	5	10	7	4	10	10	10	4	75
64	2113	Grobner et al, 1986	Anhydrous Copper sulfate	100	Rabbit (*Oryctolagus cuniculus*)	6	6	0/55.9/121.5/199.2/498.1/821.6	mg/kg diet	N	N	ADL	M	FD	28	d	28	d	JV	NR	C	NR	BEH	FDB	FCNS	WO	498.1	821.6	Y	1.6024	Y	0.0892	27.7	45.7	10	10	10	10	7	4	10	10	10	4	85
65	2043	Bush et al., 1995	Copper sulfate pentahydrate	100	Mink (*Mustela vision*)	1	3	0/308/568	mg/kg diet	N	N	ADL	M	FD	132	d	10	w	JV	B	C	COM	BEH	FDB	FCNS	WO	568		Y	2.403	N	0.141233	33.4		10	10	10	10	6	4	4	1	10	4	69
66	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	2	6	0/300/1000/3000/10000/30000	mg/L	N	N	ADL	U	DR	15	d	6	w	JV	B	C	LAB	BEH	FDB	WCON	WO	1000	3000	Y	0.0211	Y	0.0028	33.8	101	10	5	5	10	7	4	10	10	10	4	75
67	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	4	6	0/500/1000/2000/4000/8000	mg/kg diet	N	N	ADL	U	FD	13	w	6	w	JV	B	C	LAB	BEH	FDB	FCNS	WO	4000	8000	Y	0.338	Y	0.0165	49.7	99.4	10	10	5	10	7	4	10	10	10	4	80
68	2113	Grobner et al, 1986	Anhydrous Copper sulfate	100	Rabbit (*Oryctolagus cuniculus*)	5	6	0/50.9/99.1/176.9/504.5/901.5	mg/kg diet	N	N	ADL	M	FD	28	d	28	d	JV	NR	C	NR	BEH	FDB	FCNS	WO	901.5		Y	1.6276	Y	0.1066	59.0		10	10	10	10	7	4	4	1	10	4	70
69	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	3	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	7	d	6	w	JV	B	C	LAB	BEH	FDB	FCNS	WO	8000	16000	Y	0.151	Y	0.0133	179	359	10	10	5	10	7	4	10	10	10	4	80
70	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	5	0/41/113/175/140	mg/org/d	N	N	ADL	U	DR	2	w	6	w	JV	M	C	COM	BEH	FDB	WCON	WO	113	175	Y	0.174	N	0.020518	259	400	10	5	5	10	6	4	10	10	10	4	74
71	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	2	5	0/41/95/226/524	mg/org/d	N	N	ADL	U	DR	2	w	6	w	JV	M	C	COM	BEH	FDB	WCON	WO	41	95	Y	0.0277	N	0.003925	589	1365	10	5	5	10	6	4	10	10	10	4	74
72	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	3	6	0/92/180/363/777/1275	mg/org/d	N	N	ADL	U	FD	15	d	6	w	JV	M	C	COM	BEH	FDB	FCNS	WO	777	1275	Y	0.151	N	0.014524	2049	3361	10	10	5	10	6	4	10	10	10	4	79
73	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	4	6	0/168/362/773/1154/2817	mg/org/d	N	N	ADL	U	FD	15	d	6	w	JV	B	C	COM	BEH	FDB	FCNS	WO	773	1154	Y	0.0246	N	0.003268	12509	18675	10	10	5	10	6	4	10	10	10	4	79
74	36759	Ortolani et al, 2003	Copper sulfate pentahydrate	100	Sheep (*Ovis aries*)	1	2	0/3	mg/kg bw/d	N	N	ADL	U	DR	14	d	6	mo	JV	M	C	COM	BEH	FDB	FCNS	WO		3	Y	31.6	Y	0.5000		3.00	10	5	5	10	10	4	4	10	10	4	72
75	2640	Freundt and Ibrahim, 1990	Cuprous chloride	64.18	Rat (*Rattus norvegicus*)	1	2	0/100	mg/L	N	N	ADL	U	DR	91	d	NR	NR	JV	F	C	NR	BEH	FDB	WCON	WO		100	Y	0.278	N	0.031281		5.78	10	5	5	10	6	4	4	10	10	4	68
76	2064	DeGoey et al 1971	Copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	98	d	NR	NR	JV	NR	C	NR	BEH	FDB	FCNS	WO		250	Y	90.5	Y	2.70		7.46	10	10	5	10	7	4	4	10	10	4	74
77	2237	Onifade and Abu 1998	Copper sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	70	d	7	w	JV	NR	C	LAB	BEH	FDB	FCNS	WO		125	Y	0.5768	N	0.043704		9.47	10	10	5	10	6	4	4	10	10	4	73
78	14653	Boyden, 1938	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	5	0/5.1/5.05/8.2/9.8/11.8/7.6	mg/org/d	N	N	ADL	U	FD	4	w	28	d	JV	B	C	DOM	BEH	FDB	FCNS	WO		5.1	N	0.217	Y	0.0101		23.5	10	10	5	10	6	4	4	10	10	4	73
79	12079	Komulainen, 1983	Copper chloride	100	Rat (*Rattus norvegicus*)	1	4	0/28/50/64	mg/kg bw/d	N	N	ADL	U	DR	3	w	4	w	JV	M	C	COM	BEH	FDB	WCON	WO		28	Y	0.194	Y	0.00021		28.0	10	5	5	10	10	4	4	10	10	4	72
Physiology																																													
80	25941	Bailey et al, 2001	Copper sulfate	100	Cattle (*Bos taurus*)	1	3	0/28/55.31	mg/kg diet	N	N	ADL	M	FD	112	d	NR	NR	JV	NR	C	DOM	PHY	PHY	FDCV	WO	55.31		Y	363.4	N	8.742	1.33		10	10	10	10	6	4	4	1	10	4	69
81	2012	Arthur, 1965	Copper sulfate pentahydrate	100	Guinea pig (*Cavia porcellus*)	1	3	0/10/20	mg/kg diet	N	N	ADL	U	FD	8	w	NR	NR	JV	B	C	NR	PHY	PHY	GPHY	HA	20		Y	0.662	N	0.048944	1.48		10	10	5	10	6	4	4	10	10	4	73
82	43456	Omole, et al, 1976	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/125/200	mg/kg diet	N	N	ADL	U	FD	127	d	NR	NR	NR	B	C	COM	PHY	PHY	FDCV	WO	125	200	Y	90.2	Y	2.0	2.77	4.43	10	10	5	10	7	4	10	10	6	4	76
83	36748	Solaiman, et al, 2001	Copper sulfate pentahydrate	100	Goat (*Capra hircus*)	1	3	0/50/100	mg/org/d	Y	N	DLY	U	GV	9	w	7-8	mo	JV	F	C	DOM	PHY	PHY	FDCV	WO	100		Y	33.57	N	1.2339	3.14		10	8	10	10	6	4	4	3	10	4	69
84	2010	Anugwa et al, 1984	Copper (II) sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	3	0/122.2/223.67	mg/kg diet	N	N	ADL	M	FD	8	w	8	w	JV	B	C	NR	PHY	PHY	DIFD	WO	122.2	223.67	Y	1.787	Y	0.05326	3.64	6.67	10	10	10	10	7	4	10	10	10	4	85
85	1888	Ward, et al, 1991	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/199	mg/kg diet	N	N	ADL	M	FD	144	d	31	d	JV	B	C	NR	PHY	PHY	FDCV	WO	199		Y	108	Y	2.37	4.37		10	10	10	10	7	4	4	1	10	4	70
86	25922	Apgar et al, 1995	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	4	0/115/156/242	mg/kg diet	N	N	ADL	M	FD	5	w	31	d	JV	B	C	COM	PHY	PHY	FDCV	WO	242		Y	20.4	Y	0.582	6.90		10	10	10	10	7	4	4	1	10	4	70
87	25930	Cromwell et al, 1998	Copper chloride - tribasic	100	Pig (*Sus scrofa*)	1	2	0/116/218	mg/kg diet	N	N	ADL	M	FD	28	d	29	d	JV	B	C	COM	PHY	PHY	FDCV	WO	218		Y	17.7	Y	0.598	7.37		10	10	10	10	7	4	4	1	10	4	70
88	20975	Kline et al, 1971	Copper sulfate	100	Pig (*Sus scrofa*)	1	4	0/151/197/246	mg/kg diet	N	N	ADL	M	FD	88	d	69	d	JV	NR	C	DOM	PHY	PHY	FDCV	WO	246		Y	87.232	N	2.71	7.63		10	10	10	10	6	4	4	1	10	4	69
89	25930	Cromwell et al, 1998	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	4	2	0/231	mg/kg diet	N	N	ADL	M	FD	28	d	30	d	JV	B	C	COM	PHY	PHY	FDCV	WO	231		Y	20.8	Y	0.739	8.21		10	10	10	10	7	4	4	1	10	4	70
90	2034	Braude and Ryder, 1973	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	4	0/147/194/240	mg/kg diet	Y	N	DLY	M	FD	112	d	9	w	JV	NR	C	DOM	PHY	PHY	FDCV	WO	240		Y	87.5	N	2.71	8.29		10	10	10	10	6	4	4	1	10	4	69
91	25930	Cromwell et al, 1998	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	2	3	0/117/226	mg/kg diet	N	N	ADL	M	FD	28	d	29	d	JV	B	C	COM	PHY	PHY	FDCV	WO	226		Y	17.7	Y	0.666	8.50		10	10	10	10	7	4	4	1	10	4	70
92	25930	Cromwell et al, 1998	Copper chloride	100	Pig (*Sus scrofa*)	3	4	0/124/167/241	mg/kg diet	N	N	ADL	M	FD	28	d	30	d	JV	B	C	COM	PHY	PHY	FDCV	WO	241		Y	20.8	Y	0.749	8.68		10	10	10	10	7	4	4	1	10	4	70
93	2061	Cromwell et al 1989	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	3	4	0/125/250/500	mg/kg diet	N	N	ADL	U	FD	28	d	28	d	JV	B	C	NR	PHY	PHY	FDCV	WO	250	500	Y	12.2	Y	0.434	8.89	17.8	10	10	5	10	7	4	10	10	10	4	80
94	2113	Grobner et al, 1986	Anhydrous Copper sulfate	100	Rabbit (*Oryctolagus cuniculus*)	6	6	0/55.9/121.5/199.2/498.1/821.6	mg/kg diet	N	N	ADL	M	FD	28	d	28	d	JV	NR	C	NR	PHY	PHY	FDCV	WO	199.2	498.1	Y	1.86	Y	0.1237	9.45	23.6	10	10	10	10	7	4	10	10	10	4	85
95	2075	Edmonds and Baker 1986	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/250/650	mg/kg diet	N	N	ADL	U	FD	28	d	4	w	JV	NR	C	NR	PHY	PHY	FDCV	WO	250	650	Y	17.53	Y	0.725	10.3	26.9	10	10	5	10	7	4	10	10	10	4	80
96	2113	Grobner et al, 1986	Anhydrous Copper sulfate	100	Rabbit (*Oryctolagus cuniculus*)	5	6	0/50.9/99.1/176.9/504.5/901.5	mg/kg diet	N	N	ADL	M	FD	28	d	28	d	JV	NR	C	NR	PHY	PHY	FDCV	WO	504.5	901.5	Y	1.86	Y	0.1237	33.6	59.0	10	10	10	10	7	4	10	10	10	4	85
97	11928	Keen et al, 1982	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	4	0/100/1000/2000	ug/g diet	N	N	ADL	U	FD	7	w	NR	NR	JV	F	C	COM	PHY	PHY	GPHY	PL	2000		Y	0.167	N	0.015777	189		10	10	5	10	6	4	4	3	10	4	66
98	2020	Bassuny, 1991	Copper sulfate pentahydrate	25.45	Rabbit (*Oryctolagus cuniculus*)	1	5	0/75/150/300/450	mg/kg diet	N	N	NR	U	FD	7	w	35	d	JV	M	C	NR	PHY	PHY	FDCV	WO		75	Y	2.224	Y	0.0883		0.758	10	10	5	10	7	4	4	10	10	4	74
99	2061	Cromwell et al 1989	Copper sulfate	100	Pig (*Sus scrofa*)	5	5	0/125/250/375/500	mg/kg diet	N	N	ADL	U	FD	33	d	28	d	JV	B	C	NR	PHY	PHY	FDCV	WO		125	Y	18	Y	0.59		4.10	10	10	5	10	7	4	4	10	10	4	74
100	2061	Cromwell et al 1989	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	28	d	28	d	JV	B	C	NR	PHY	PHY	FDCV	WO		125	Y	15.6	Y	0.61		4.89	10	10	5	10	7	4	4	10	10	4	74
101	2064	DeGoey et al 1971	Copper sulfate	100	Pig (*Sus scrofa*)	2	2	0/500	mg/kg diet	N	N	ADL	U	FD	23	d	NR	mo	JV	NR	C	NR	PHY	PHY	IRRI	SK		500	Y	89	N	2.750143		15.5	10	10	5	10	6	4	4	10	10	4	73
102	2256	Rana and Kumar 1980	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	2	0/100	mg/kg bw	N	N	DLY	U	GV	20	d	90	d	JV	M	C	LAB	PHY	PHY	IRRI	FO		100	Y	0.101	N	0.010435		39.8	10	8	10	10	10	4	4	10	10	4	80
Pathology																																													
103	36349	Uthus, 2001	Cupric carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/25	ug/g diet	N	N	ADL	U	FD	62	d	NR	NR	JV	M	C	LAB	PTH	ORW	ORWT	KI	25		Y	0.351	N	0.029054	2.07		10	10	5	10	6	4	4	10	10	4	73
104	36240	Miranda et al, 1981	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/55.1	ug/g diet	N	N	ADL	M	FD	5	w	NR	NR	JV	M	C	LAB	PTH	ORW	SMIX	LI	55.1		Y	0.225	Y	0.0147	3.60		10	10	10	10	7	4	4	10	10	4	79
105	36762	Humann-Ziehank et al, 2001	Copper sulfate	100	Sheep (*Ovis aries*)	1	2	0/3.7	mg/kg bw/d	N	N	2 per d	U	FD	84	d	1	yr	AD	M	C	COM	PTH	ITX	GITX	WO	3.7		Y	2.5	N	0.145903	3.70		10	10	5	10	10	4	4	10	3	4	70
106	1888	Ward, et al, 1991	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/199	mg/kg diet	N	N	ADL	M	FD	144	d	31	d	JV	B	C	NR	PTH	HIS	GHIS	GT	199		Y	108	Y	2.37	4.37		10	10	10	10	7	4	4	1	10	4	70
107	3752	Adam et al, 1977	Copper (II) sulfate pentahydrate	25.45	Goat (*Capra hircus*)	1	4	0/20/40/80	mg/kg bw/d	Y	N	DLY	U	GV	144	d	12	mo	AD	B	C	NR	PTH	HIS	GHIS	LI	20	40	N	82.5	N	2.583937	5.35	10.7	10	8	10	10	10	4	10	10	6	4	82
108	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	2	6	0/300/1000/3000/10000/30000	mg/L	N	N	ADL	U	DR	15	d	6	w	JV	F	C	LAB	PTH	ORW	ORWT	TS	300	1000	Y	0.0265	Y	0.00192	5.53	18.4	10	5	5	10	7	4	8	10	10	4	73
109	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	4	6	0/500/1000/2000/4000/8000	mg/kg diet	N	N	ADL	U	FD	13	w	6	w	JV	F	C	LAB	PTH	HIS	GLSN	KI	500	1000	Y	0.36	Y	0.017	6.01	12.0	10	10	5	10	7	4	10	10	10	4	80
110	2304	Thacker, 1991	copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	7	d	NR	NR	GE	F	C	NR	PTH	GRS	BDWT	WO	250		N	232	N	6.044882	6.51		10	10	5	10	5	4	4	10	10	4	72
111	2010	Anugwa et al, 1984	Copper (II) sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	3	0/122.2/223.67	mg/kg diet	N	N	ADL	M	FD	8	w	8	w	JV	B	C	NR	PTH	ORW	SMIX	LI	223.67		Y	1.787	Y	0.05326	6.67		10	10	10	10	7	4	4	1	10	4	70
112	14402	Ritchie et al, 1963	Copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	15	w	7	w	JV	NR	C	COM	PTH	ORW	ORWT	LI	250		Y	69.31	N	2.24	8.08		10	10	5	10	6	4	4	6	10	4	69

Ref			Exposure																				Effects					Conversion to mg/kg bw/day					Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	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
113	2237	Onifade and Abu 1998	Copper sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	70	d	7	w	JV	NR	C	LAB	PTH	ORW	SMIX	BR	125	250	Y	0.5776	N	0.043754	9.47	18.9	10	10	5	10	6	4	10	10	10	4	79
114	36230	Howell et al, 1991	Copper sulfate pentahydrate	100	Sheep (*Ovis aries*)	1	2	0/14.3	mg/kg bw/d	N	N	5 per wk	U	GV	19	w	6-9	mo	JV	M	C	COM	PTH	HIS	CTYP	LI	14.3		N	65.1	N	2.126769	14.3		10	8	10	10	10	4	4	3	10	4	73
115	2253	Prince et al 1979	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	2	2	0/500	mg/kg diet	N	N	ADL	U	FD	63	d	53	d	JV	NR	C	NR	PTH	ITX	GITX	WO	500		Y	61	N	2.016034	16.5		10	10	5	10	6	4	4	10	10	4	73
116	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	1	6	0/300/1000/3000/10000/30000	mg/L	N	N	ADL	U	DR	15	d	6	w	JV	B	C	LAB	PTH	ITX	GITX	WO	1000	3000	Y	0.174	Y	0.01176	17.2	51.6	10	5	5	10	7	4	10	10	10	4	75
117	2043	Bush et al., 1995	Copper sulfate pentahydrate	100	Mink (*Mustela vision*)	1	3	0/308/568	mg/kg diet	N	N	ADL	M	FD	132	d	10	w	JV	B	C	COM	PTH	HIS	NCRO	LI	568		Y	2.403	N	0.141233	33.4		10	10	10	10	6	4	4	10	10	4	78
118	2186	Kumar et al, 1987	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	2	0/0.1	g/kg bw/d	N	N	DLY	U	GV	45	d	90	d	JV	M	C	LAB	PTH	ORW	ORWT	KI	0.1		Y	0.103	N	0.010605	39.8		10	8	10	10	10	4	4	6	10	4	76
119	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	3	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	15	d	6	w	JV	B	C	LAB	PTH	ORW	ORWT	LI	2000	4000	Y	0.183	Y	0.0147	40.9	81.8	10	10	5	10	7	4	10	10	10	4	80
120	10891	DeVries et al, 1986	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/12	mg/org/d	N	N	NR	U	DR	11	mo	3	w	JV	F	C	LAB	PTH	ORW	ORWT	LI	12		Y	0.262	Y	0.025	45.8		10	5	5	10	7	4	4	10	10	4	69
121	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	7	5	0/64/129/259/551	mg/org/d	N	N	ADL	U	FD	92	d	6	w	JV	M	C	COM	PTH	HIS	HYPL	SH	64	129	Y	0.362	N	0.0298	70.4	142	10	10	5	10	6	4	10	10	10	4	79
122	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	6	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	13	w	6	w	JV	B	C	LAB	PTH	ORW	ORWT	LI	2000	4000	Y	0.0295	Y	0.0048	82.8	166	10	10	5	10	7	4	10	10	10	4	80
123	11928	Keen et al, 1982	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	4	0/100/1000/2000	ug/g diet	N	N	ADL	U	FD	7	w	NR	NR	JV	F	C	COM	PTH	HIS	GHIS	MT	1000	2000	Y	0.198	N	0.018147	91.7	183	10	10	5	10	6	4	10	10	10	4	79
124	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	5	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	15	d	6	w	JV	M	C	LAB	PTH	ORW	ORWT	LI	2000	4000	Y	0.0246	Y	0.0047	97.2	194	10	10	5	10	7	4	10	10	10	4	80
125	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	3	6	0/92/180/363/777/1275	mg/org/d	N	N	ADL	U	FD	15	d	6	w	JV	B	C	COM	PTH	HIS	HYPL	SH	92	180	Y	0.186	N	0.017238	197	385	10	10	5	10	6	4	10	10	10	4	79
126	2069	Dodds-Smith et al., 1992	Copper chloride	100	Common shrew (*Sorex araneus*)	1	2	0/2.13	mg/org/d	N	N	DLY	U	FD	12	w	NR	NR	JV	B	C	NR	PTH	ORW	ORWT	KI	2.13		Y	0.0085	N	0.001364	251		10	10	5	10	6	4	4	6	10	4	69
127	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	5	0/41/113/175/140	mg/org/d	N	N	ADL	U	DR	2	w	6	w	JV	B	C	COM	PTH	ITX	GITX	WO	113	175	Y	0.174	N	0.020518	259	400	10	5	5	10	6	4	10	10	10	4	74
128	2121	Haywood 1985	Copper	100	Rat (*Rattus norvegicus*)	1	5	0/3000/4000/5000/6000	mg/kg diet	N	N	ADL	U	FD	1	w	NR	NR	JV	M	C	NR	PTH	HIS	NCRO	LI	3000	4000	Y	0.202	N	0.018448	274	365	10	10	5	4	6	4	10	10	10	4	73
129	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	2	5	0/41/95/226/524	mg/org/d	N	N	ADL	U	DR	2	w	6	w	JV	B	C	COM	PTH	ITX	GITX	WO	95	226	Y	0.0265	N	0.003772	1427	3395	10	5	5	10	6	4	10	10	10	4	74
130	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	10	5	0/382/736/1563/3201	mg/org/d	N	N	ADL	U	FD	92	d	6	w	JV	B	C	COM	PTH	ITX	GITX	WO	3201		Y	0.0264	N	0.003464	48270		10	10	5	10	6	4	4	10	10	4	73
131	2113	Grobner et al, 1986	Anhydrous Copper sulfate	100	Rabbit (*Oryctolagus cuniculus*)	5	6	0/50.9/99.1/176.9/504.5/901.5	mg/kg diet	N	N	ADL	M	FD	28	d	28	d	JV	NR	C	NR	PTH	ORW	ORWT	DT		50.9	Y	1.8572	Y	0.1241		3.40	10	10	10	10	7	4	4	10	10	4	79
132	2148	Howell et al, 1974	Copper sulfate pentahydrate	25.45	Sheep (*Ovis aries*)	1	3	0/20/30	mg/kg bw/d	N	N	DLY	U	GV	37	w	6-12	mo	JV	B	C	DOM	PTH	HIS	GHIS	BR		20	N	65.1	N	2.1267		5.09	10	8	10	10	10	4	4	10	10	4	80
133	36202	Gopinath et al, 1974	Copper sulfate pentahydrate	25.45	Sheep (*Ovis aries*)	1	2	0/20	mg/kg bw/d	N	N	DLY	U	DR	10	w	6	mo	JV	F	C	COM	PTH	HIS	GHIS	KI		20	N	59.1	N	3.891024		5.09	10	5	5	10	10	4	4	10	10	4	72
134	2179	King, 1975	copper sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	2	0/100	mg/kg diet	N	N	ADL	U	FD	6	w	5	w	JV	B	C	COM	PTH	ORW	SMIX	IN		100	N	3.76	N	0.204062		5.43	10	10	5	10	5	4	4	10	10	4	72
135	2155	Ishmael et al 1971	Copper sulfate pentahydrate	25.45	Sheep (*Ovis aries*)	1	2	0/0.714	g/org/d	N	N	5 per w	U	OR	88	d	6	mo	JV	F	C	NR	PTH	ORW	SMIX	LI		0.714	N	24	N	0.936463		7.57	10	8	5	10	5	4	4	10	10	4	70
136	2179	King, 1975	copper sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	2	2	0/200	mg/kg diet	N	N	ADL	U	FD	6	w	5	w	JV	B	C	COM	PTH	ORW	SMIX	IN		200	N	3.76	N	0.204062		10.9	10	10	5	10	5	4	4	10	10	4	72
137	2255	Radecki et al 1992	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	DLY	U	FD	14	d	21	d	JV	B	C	NR	PTH	HIS	GHIS	GT		250	Y	7.384	N	0.35538		12.0	10	10	5	10	6	4	4	10	10	4	73
138	2064	DeGoey et al 1971	Copper sulfate	100	Pig (*Sus scrofa*)	2	2	0/500	mg/kg diet	N	N	ADL	U	FD	23	d	NR	mo	JV	NR	C	NR	PTH	HIS	NCRO	LI		500	Y	89	N	2.750143		15.5	10	10	5	10	6	4	4	10	10	4	73
139	14653	Boyden, 1938	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	5	0/5.1/5.05/8.2/9.8/11.8/7.6	mg/org/d	N	N	ADL	U	FD	4	w	28	d	JV	B	C	DOM	PTH	ORW	ORWT	SP		5.1	N	0.217	Y	0.0101		23.5	10	10	5	10	6	4	4	10	10	4	73
140	2256	Rana and Kumar 1980	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	2	0/100	mg/kg bw	N	N	DLY	U	GV	20	d	90	d	JV	M	C	LAB	PTH	HIS	NCRO	LI		100	Y	0.101	N	0.010435		39.8	10	8	10	10	10	4	4	10	10	4	80
141	2257	Rana and Kumar 1985	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	2	0/0.1	g/kg bw/d	N	N	DLY	U	GV	20	d	90	d	AD	M	C	LAB	PTH	HIS	GHIS	LI		0.1	Y	0.1	N	0.01035		39.8	10	8	10	10	10	4	4	10	10	4	80
142	25964	Aburto, et al, 2001	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/500	ug/g diet	N	N	ADL	U	FD	12	mo	10	w	JV	M	C	LAB	PTH	HIS	GHIS	LI		500	Y	0.14	N	0.0136		48.7	10	10	5	10	6	4	4	10	10	4	73
143	2047	Chesta et al., 1989	Copper (II) sulfate	39.81	Guinea pig (*Cavia porcellus*)	1	2	0/0.185	% in diet	N	N	NR	U	DR	45	d	NR	NR	GE	F	C	LAB	PTH	HIS	GHIS	LI		0.185	N	0.9	N	0.090044		73.7	10	5	5	10	5	4	4	10	10	4	67
144	13236	Rana et. al, 1985	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/0.1	g/kg bw/d	N	N	DLY	U	GV	30	d	90	d	JV	M	C	LAB	PTH	ORW	SMIX	LI		0.1	Y	0.1	N	0.01035		100	10	8	10	10	10	4	4	10	10	4	80
145	36364	Fuentealba et al, 2000	Copper sulfate	100	Rat (*Rattus norvegicus*)	2	2	0/1500	mg/kg diet	N	N	ADL	U	FD	12	w	21	d	JV	B	C	LAB	PTH	HIS	NCRO	LI		1500	N	0.38	N	0.031013		122	10	10	5	10	5	4	4	10	10	4	72
146	36364	Fuentealba et al, 2000	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/1500	mg/kg diet	N	N	ADL	U	FD	18	w	NR	NR	GE	F	C	LAB	PTH	HIS	NCRO	LI		1500	N	0.25	N	0.021982		132	10	10	5	10	5	4	4	10	10	4	72
147	2095	Fuentealba et al 1989	Copper	100	Rat (*Rattus norvegicus*)	1	2	0/1500	mg/kg diet	N	N	ADL	U	FD	4	w	6	w	JV	M	C	NR	PTH	HIS	USTR	LI		1500	N	0.217	N	0.019567		135	10	10	5	4	5	4	4	10	10	4	66
148	2096	Fuentealba et al 1989	Copper	100	Rat (*Rattus norvegicus*)	1	2	0/1500	mg/kg diet	N	N	ADL	U	FD	16	w	NR	mo	JV	M	C	NR	PTH	HIS	HYPL	BI		1500	N	0.217	N	0.019567		135	10	10	5	4	5	4	4	10	10	4	66
149	2097	Fuentealba et al 1993	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/1500	mg/kg diet	N	N	ADL	U	FD	10	w	NR	mo	JV	M	C	NR	PTH	HIS	HYPL	BI		1500	N	0.217	N	0.01957		135	10	10	5	10	5	4	4	10	10	4	72
150	2098	Fuentealba et al 1989	Copper	100	Rat (*Rattus norvegicus*)	1	2	0/1500	mg/kg diet	N	N	ADL	U	FD	3	w	6	w	JV	M	C	NR	PTH	HIS	GHIS	KI		1500	N	0.217	N	0.023489		135	10	10	5	4	5	4	4	10	10	4	66
151	2094	Fuentealba and Haywood 1988	Copper	100	Rat (*Rattus norvegicus*)	1	2	0/1500	mg/kg diet	N	N	ADL	U	FD	1	w	6	w	JV	M	C	NR	PTH	HIS	GHIS	LI		1500	N	0.217	N	0.023489		135	10	10	5	4	5	4	4	10	10	4	66
152	2122	Haywood 1980	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/2000	mg/kg diet	N	N	ADL	U	FD	15	w	NR	mo	JV	M	C	NR	PTH	HIS	HYPL	BI		2000	N	0.4702	N	0.036946		157	10	10	5	10	5	4	4	10	10	4	72
153	2125	Haywood et al 1985	copper	100	Rat (*Rattus norvegicus*)	1	2	0/3	g/kg diet	N	N	ADL	U	FD	5	w	NR	mo	AD	M	C	NR	PTH	HIS	NCRO	KI		3	N	0.5	N	0.038861		233	10	10	5	4	5	4	4	10	10	4	66
154	2124	Haywood and Loughran 1985	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	5	0/3000/4000/5000/6000	mg/kg diet	N	N	DLY	U	FD	6	w	NR	mo	JV	M	C	NR	PTH	HIS	NCRO	LI		3000	Y	0.162	N	0.015388		285	10	10	5	10	6	4	4	10	10	4	73
155	36200	Gooneratne and Howell, 1980	Copper sulfate pentahydrate	25.45	Sheep (*Ovis aries*)	1	2	0/7.14	g/kg bw/d	N	N	5 per w	U	DR	63	d	6-9	mo	JV	M	C	COM	PTH	HIS	GHIS	MU		7.14	N	65.1	N	4.244808		1817	10	5	5	10	10	4	4	10	10	4	72
Reproduction																																													
156	2013	Aulerich et al 1982	Copper sulfate pentahydrate	100	Mink (*Mustela vision*)	1	5	0/25/50/100/200	mg/kg diet	N	N	ADL	U	FD	357	d	NR	mo	JV	F	C	NR	REP	REP	PROG	WO	50	100	Y	1.068	N	0.072517	3.40	6.79	10	10	5	10	6	10	10	10	10	4	85
157	2304	Thacker, 1991	Copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	7	d	NR	NR	GE	F	C	NR	REP	REP	PROG	WO	250		Y	232	N	6.044882	6.51		10	10	5	10	6	10	4	10	10	4	79
158	823	Webster, 1979	Copper chloride	100	Mouse (*Mus musculus*)	1	4	0/30/100/400	mg/kg diet	N	N	ADL	U	FD	19	d	4	mo	GE	F	C	LAB	REP	REP	PRWT	WO	400		Y	0.032	N	0.004057	50.7		10	10	5	10	6	10	4	10	10	4	79
159	2193	Lecyk, 1980	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	2	7	0/0/5/1.0/1.5/2.0/3.0/4.0	g/kg diet	N	N	ADL	U	FD	49	d	NR	NR	GE	B	C	LAB	REP	REP	PROG	WO	2	3	Y	0.0575	N	0.006568	90.9	136	10	10	5	10	5	10	10	10	10	4	84
160	2193	Lecyk, 1980	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	1	7	0/0.5/1.0/1.5/2.0/3.0/4.0	g/kg diet	N	N	ADL	U	FD	49	d	NR	NR	GE	B	C	LAB	REP	REP	PROG	WO	2	3	N	0.0575	N	0.006568	90.9	136	10	10	5	10	5	10	10	10	10	4	84
161	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	4	6	0/500/1000/2000/4000/8000	mg/kg diet	N	N	ADL	U	FD	13	w	6	w	JV	M	C	LAB	REP	REP	SPCL	SM	8000		Y	0.275	Y	0.0144	107		10	10	5	10	7	10	4	10	10	4	80
162	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	9	4	0/32/129/259	mg/org/d	N	N	ADL	U	FD	92	d	6	w	JV	M	C	COM	REP	REP	SPCL	SM	259		Y	0.339	N	0.028235	304		10	10	5	10	6	10	4	1	10	4	70
163	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	6	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	13	w	6	w	JV	M	C	LAB	REP	REP	SPCL	SM	8000		Y	0.029	Y	0.0051	358		10	10	5	10	7	10	4	6	10	4	76
164	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	11	4	0/173/736/3201	mg/org/d	N	N	ADL	U	FD	92	d	6	w	JV	M	C	COM	REP	REP	SPCL	SM	3201		Y	0.0264	N	0.003464	48270		10	10	5	10	6	10	4	1	10	4	70
165	2062	Cromwell et al 1993	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	783	d	10	mo	GE	F	C	NR	REP	REP	RSUC	WO		250	Y	152	Y	3.35		5.51	10	10	5	10	7	10	4	10	10	4	80
166	1717	Bataineh et al., 1998	Copper chloride dihydrate	37.28	Rat (*Rattus norvegicus*)	1	2	0/1000	mg/L	N	N	ADL	U	DR	12	w	NR	NR	AD	M	V	LAB	REP	REP	TEWT	TE		1000	Y	0.33067	N	0.036567		41.2	10	5	5	10	6	10	4	10	3	4	67

Ref			Exposure																				Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	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
Growth																																													
167	25940	Engle and Spears, 2001	Copper sulfate	100	Cattle (*Bos taurus*)	1	2	0/40	mg/kg diet	N	N	ADL	U	FD	239	d	NR	NR	JV	M	C	COM	GRO	GRO	BDWT	WO	40		Y	430	Y	8.730	0.812		10	10	5	10	7	8	4	1	10	4	69
168	25935	Engle et al, 2000	Copper chloride - tribasic	100	Cattle (*Bos taurus*)	1	2	0/40	mg/kg diet	N	N	ADL	U	FD	154	d	NR	NR	JV	M	C	COM	GRO	GRO	BDWT	WO	40		Y	400.1	Y	8.520	0.852		10	10	5	10	7	8	4	1	10	4	69
169	25941	Bailey et al, 2001	Copper sulfate	100	Cattle (*Bos taurus*)	1	3	0/28/55.31	mg/kg diet	N	N	ADL	M	FD	112	d	NR	NR	JV	NR	C	DOM	GRO	GRO	BDWT	WO	55.31		Y	361.2	N	8.698	1.33		10	10	10	10	6	8	4	1	10	4	73
170	2012	Arthur, 1965	Copper sulfate pentahydrate	100	Guinea pig (*Cavia porcellus*)	1	3	0/10/20	mg/kg diet	N	N	ADL	U	FD	8	w	NR	NR	JV	B	C	NR	GRO	GRO	BDWT	WO	20		Y	0.662	N	0.048944	1.48		10	10	5	10	6	8	4	3	10	4	70
171	36349	Uthus, 2001	Cupric carbonate	100	Rat (*Rattus norvegicus*)	1	2	0/25	ug/g diet	N	N	ADL	U	FD	62	d	NR	NR	JV	M	C	LAB	GRO	GRO	BDWT	WO	25		Y	0.351	N	0.029054	2.07		10	10	5	10	6	8	4	10	10	4	77
172	36240	Miranda et al, 1981	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/55.1	ug/g diet	N	N	ADL	M	FD	5	w	NR	NR	JV	M	C	LAB	GRO	GRO	BDWT	WO	55.1		Y	0.225	Y	0.0147	3.60		10	10	10	10	7	8	4	8	10	4	81
173	2020	Bassuny, 1991	Copper sulfate pentahydrate	25.45	Rabbit (*Oryctolagus cuniculus*)	1	5	0/75/150/300/450	mg/kg diet	N	N	NR	U	FD	7	w	35	d	JV	M	C	NR	GRO	GRO	BDWT	WO	450		Y	2.218	Y	0.0823	4.25		10	10	5	10	7	8	4	10	10	4	78
174	1888	Ward, et al, 1991	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/199	mg/kg diet	N	N	ADL	M	FD	144	d	31	d	JV	B	C	NR	GRO	GRO	BDWT	WO	199		Y	108	Y	2.37	4.37		10	10	10	10	7	8	4	1	10	4	74
175	2179	King, 1975	copper sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	2	0/100	mg/kg diet	N	N	ADL	U	FD	8	w	5	w	JV	B	C	COM	GRO	GRO	BDWT	WO	100		N	3.76	N	0.204062	5.43		10	10	5	10	5	8	4	10	10	4	76
176	2062	Cromwell et al 1993	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	783	d	10.3	mo	GE	F	C	NR	GRO	GRO	BDWT	WO	250		Y	152	Y	3.35	5.51		10	10	5	10	7	8	4	1	10	4	69
177	14387	Allcroft et al, 1961	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	4	0/380/560/934	mg/org/d	N	N	ADL	M	FD	4	w	8-10	w	JV	B	C	DOM	GRO	GRO	BDWT	WO	560	934	N	100	Y	2.36	5.6	9.34	10	10	10	10	6	8	10	10	10	4	88
178	136	Gershbein et al 1983	Copper (II) sulfate pentahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/75	mg/kg diet	N	N	ADL	U	FD	80	d	44	d	JV	M	C	NR	GRO	GRO	BDWT	WO	75		Y	0.47	N	0.036934	5.89		10	10	5	10	6	8	4	1	10	4	68
179	2010	Anugwa et al, 1984	Copper (II) sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	3	0/122.2/223.67	mg/kg diet	N	N	ADL	M	FD	8	w	8	w	JV	B	C	NR	GRO	GRO	BDWT	WO	223.67		Y	1.787	Y	0.05326	6.67		10	10	10	10	7	8	4	1	10	4	74
180	25922	Apgar et al, 1995	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	4	0/115/156/242	mg/kg diet	N	N	ADL	M	FD	5	w	31	d	JV	B	C	COM	GRO	GRO	BDWT	WO	242		Y	20.4	Y	0.582	6.90		10	10	10	10	7	8	4	1	10	4	74
181	25930	Cromwell et al, 1998	Copper chloride	100	Pig (*Sus scrofa*)	5	4	0/100/150/200	mg/kg diet	N	N	ADL	U	FD	28	d	26-32	d	JV	B	C	COM	GRO	GRO	BDWT	WO	200		Y	25.5	Y	0.917	7.19		10	10	5	10	7	8	4	1	10	4	69
182	12977	Omole, 1977	Copper sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	4	0/100/150/200	mg/kg diet	N	N	ADL	U	FD	8	w	6	w	JV	B	C	LAB	GRO	GRO	BDWT	WO	200		Y	1.724	Y	0.0633	7.34		10	10	5	10	7	8	4	1	10	4	69
183	25930	Cromwell et al, 1998	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	6	2	0/200	mg/kg diet	N	N	ADL	U	FD	28	d	26-32	d	JV	B	C	COM	GRO	GRO	BDWT	WO	200		Y	25.5	Y	0.939	7.36		10	10	5	10	7	8	4	1	10	4	69
184	25930	Cromwell et al, 1998	Copper chloride - tribasic	100	Pig (*Sus scrofa*)	1	2	0/116/218	mg/kg diet	N	N	ADL	M	FD	28	d	29	d	JV	B	C	COM	GRO	GRO	BDWT	WO	218		Y	17.7	Y	0.598	7.37		10	10	10	10	7	8	4	1	10	4	74
185	20975	Kline et al, 1971	Copper sulfate	100	Pig (*Sus scrofa*)	1	4	0/151/197/246	mg/kg diet	N	N	ADL	M	FD	88	d	69	d	JV	NR	C	DOM	GRO	GRO	BDWT	WO	246		Y	87.232	N	2.705156	7.63		10	10	10	10	6	8	4	1	10	4	73
186	14396	Gipp et al, 1973	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	12	w	NR	NR	JV	F	C	COM	GRO	GRO	BDWT	WO	250		Y	93.2	N	2.856384	7.66		10	10	5	10	6	8	4	1	10	4	68
187	2061	Cromwell et al 1989	Copper oxide	100	Pig (*Sus scrofa*)	2	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	28	d	28	d	JV	B	C	NR	GRO	GRO	BDWT	WO	250		Y	17.8	Y	0.547	7.68		10	10	5	10	7	8	4	1	10	4	69
188	25929	Luo and Dove, 1996	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	15	d	26	d	JV	M	C	COM	GRO	GRO	BDWT	WO	250		Y	10.1	Y	0.312	7.72		10	10	5	10	7	8	4	1	10	4	69
189	12809	Myres and Bowland, 1973	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	10	w	70	d	JV	B	C	COM	GRO	GRO	BDWT	WO	250		Y	64.7	Y	2.03	7.84		10	10	5	10	7	8	4	1	10	4	69
190	14402	Ritchie et al, 1963	Copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	15	w	7	w	JV	NR	C	COM	GRO	GRO	BDWT	WO	250		Y	69.31	N	2.24	8.08		10	10	5	10	6	8	4	1	10	4	68
191	25930	Cromwell et al, 1998	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	4	2	0/231	mg/kg diet	N	N	ADL	M	FD	28	d	30	d	JV	B	C	COM	GRO	GRO	BDWT	WO	231		Y	20.8	Y	0.739	8.21		10	10	10	10	7	8	4	1	10	4	74
192	2034	Braude and Ryder, 1973	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	4	0/147/194/240	mg/kg diet	Y	Y	DLY	M	FD	112	d	9	w	JV	NR	C	DOM	GRO	GRO	BDWT	WO	240		Y	87.5	N	2.711985	8.29		10	10	10	10	6	8	4	1	10	4	73
193	14387	Allcroft et al, 1961	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	2	4	0/345/579/843	mg/org/d	N	N	ADL	M	FD	19	w	8-10	w	JV	B	C	DOM	GRO	GRO	BDWT	WO	843		N	100	Y	2.15	8.43		10	10	10	10	6	8	4	1	10	4	73
194	2253	Prince et al 1979	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	59	d	64	d	JV	NR	C	NR	GRO	GRO	BDWT	WO	250		Y	54	N	1.82383	8.44		10	10	5	10	6	8	4	1	10	4	68
195	25930	Cromwell et al, 1998	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	2	3	0/117/226	mg/kg diet	N	N	ADL	M	FD	28	d	29	d	JV	B	C	COM	GRO	GRO	BDWT	WO	226		Y	17.7	Y	0.666	8.50		10	10	10	10	7	8	4	1	10	4	74
196	25930	Cromwell et al, 1998	Copper chloride	100	Pig (*Sus scrofa*)	3	4	0/124/167/241	mg/kg diet	N	N	ADL	M	FD	28	d	30	d	JV	B	C	COM	GRO	GRO	BDWT	WO	241		Y	20.8	Y	0.749	8.68		10	10	10	10	7	8	4	1	10	4	74
197	2061	Cromwell et al 1989	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	28	d	28	d	JV	B	C	NR	GRO	GRO	BDWT	WO	250		Y	15.6	Y	0.599	9.60		10	10	5	10	7	8	4	1	10	4	69
198	14397	Gipp, et al, 1974	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	35	d	3	w	JV	B	C	COM	GRO	GRO	BDWT	WO	250		Y	21.9	Y	0.87	9.93		10	10	5	10	7	8	4	1	10	4	69
199	2033	Brandt, 1983	Copper (II) sulfate	100	Mink (*Mustela vision*)	1	3	0/166/320	mg/kg diet	N	N	ADL	M	FD	4	mo	90	d	JV	M	C	NR	GRO	GRO	BDWT	WO	166	320	Y	1.92	N	0.117444	10.2	19.6	10	10	10	10	6	8	10	10	10	4	88
200	2075	Edmonds and Baker 1986	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/250/650	mg/kg diet	N	N	ADL	U	FD	28	d	4	w	JV	NR	C	NR	GRO	GRO	BDWT	WO	250	650	Y	17.53	Y	0.725	10.3	26.9	10	10	5	10	7	8	10	10	10	4	84
201	2255	Radecki et al 1992	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	DLY	U	FD	14	d	21	d	JV	B	C	NR	GRO	GRO	BDWT	WO	250		Y	7.384	N	0.35538	12.0		10	10	5	10	6	8	4	1	10	4	68
202	2013	Aulerich et al 1982	Copper sulfate pentahydrate	100	Mink (*Mustela vision*)	1	5	0/25/50/100/200	mg/kg diet	N	N	ADL	U	FD	20	w	NR	mo	JV	B	C	NR	GRO	GRO	BDWT	WO	200		Y	1.753	N	0.10898	12.4		10	10	5	10	6	8	4	1	10	4	68
203	3760	Felsman et al., 1973	Copper sulfate	100	Cattle (*Bos taurus*)	1	4	0/125/250/500	mg/kg diet	N	N	ADL	U	FD	98	d	6	w	JV	M	C	NR	GRO	GRO	BDWT	WO	500		Y	269	N	6.826736	12.7		10	10	5	10	6	8	4	1	10	4	68
204	3756	Smith et al, 1975	Cupric carbonate	100	Horse - Shetland pony (*Equus caballus*)	1	4	0/691.7/1209.1/2088.2	mg/org/d	N	N	ADL	M	FD	84	d	NR	NR	JV	NR	C	DOM	GRO	GRO	BDWT	WO	2088.2		Y	151.8	Y	2.64	13.8		10	10	10	10	7	8	4	1	10	4	74
205	3757	Suttle and Mills, 1966	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/250/425	mg/kg diet	N	N	NR	U	FD	14	d	NR	NR	JV	F	C	DOM	GRO	GRO	BDWT	WO	250	425	Y	22	Y	1.43	16.2	27.6	10	10	5	10	7	8	10	10	10	4	84
206	2061	Cromwell et al 1989	Copper sulfate	100	Pig (*Sus scrofa*)	5	5	0/125/250/375/500	mg/kg diet	N	N	ADL	U	FD	33	d	28	d	JV	B	C	NR	GRO	GRO	BDWT	WO	500		Y	18	Y	0.59	16.4		10	10	5	10	7	8	4	1	10	4	69
207	25928	Apgar and Kornegay, 1996	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/16.5	mg/kg bw/d	N	N	2 per d	M	FD	14	d	NR	NR	JV	M	C	COM	GRO	GRO	BDWT	WO	16.5		Y	81.4	Y	0.066	16.5		10	10	10	10	10	8	4	1	10	4	77
208	2061	Cromwell et al 1989	Copper oxide	100	Pig (*Sus scrofa*)	4	4	0/125/250/500	mg/kg diet	N	N	ADL	U	FD	28	d	28	d	JV	B	C	NR	GRO	GRO	BDWT	WO	500		Y	13.2	Y	0.441	16.7		10	10	5	10	7	8	4	1	10	4	69
209	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	1	6	0/300/1000/3000/10000/30000	mg/L	N	N	ADL	U	DR	15	d	6	w	JV	B	C	LAB	GRO	GRO	BDWT	WO	1000	3000	Y	0.174	Y	0.01176	17.2	51.6	10	5	5	10	7	8	10	10	10	4	79
210	2189	Lalich,, et. al., 1965	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	2	0/0.5	g/kg diet	N	N	ADL	U	FD	42	d	NR	NR	JV	M	C	NR	GRO	GRO	BDWT	WO	0.5		Y	0.2509	N	0.022047	17.5		10	10	5	10	6	8	4	1	10	4	68
211	2061	Cromwell et al 1989	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	3	4	0/125/250/500	mg/kg diet	N	N	ADL	U	FD	28	d	28	d	JV	B	C	NR	GRO	GRO	BDWT	WO	500		Y	12.2	Y	0.434	17.8		10	10	5	10	7	8	4	1	10	4	69
212	3760	Felsman et al., 1973	Copper sulfate	100	Cattle (*Bos taurus*)	2	4	0/300/600/900	mg/kg diet	N	N	ADL	U	FD	98	d	6	w	JV	M	C	NR	GRO	GRO	BDWT	WO	900		Y	263	N	6.70132	22.9		10	10	5	10	6	8	4	1	10	4	68
213	2113	Grobner et al, 1986	Anhydrous Copper sulfate	100	Rabbit (*Oryctolagus cuniculus*)	6	6	0/55.9/121.5/199.2/498.1/821.6	mg/kg diet	N	N	ADL	M	FD	28	d	28	d	JV	NR	C	NR	GRO	GRO	BDWT	WO	498.1	821.6	Y	1.6024	Y	0.0892	27.7	45.7	10	10	10	10	7	8	10	10	10	4	89
214	2237	Onifade and Abu 1998	Copper sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	4	0/125/250/375	mg/kg diet	N	N	ADL	U	FD	70	d	7	w	JV	NR	C	LAB	GRO	GRO	BDWT	WO	375		Y	0.5761	N	0.04366	28.4		10	10	5	10	6	8	4	10	10	4	77
215	2043	Bush et al., 1995	Copper sulfate pentahydrate	100	Mink (*Mustela vision*)	1	3	0/308/568	mg/kg diet	N	N	ADL	M	FD	132	d	10	w	JV	B	C	COM	GRO	GRO	BDWT	WO	568		Y	2.403	N	0.141233	33.4		10	10	10	10	6	8	4	10	10	4	82
216	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	2	6	0/300/1000/3000/10000/30000	mg/L	N	N	ADL	U	DR	8	d	6	w	JV	B	C	LAB	GRO	GRO	BDWT	WO	1000	3000	N	0.0211	Y	0.0028	33.8	101	10	5	5	10	6	8	10	10	10	4	78
217	2179	King, 1975	copper sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	2	2	0/200	mg/kg diet	N	N	ADL	U	FD	6	w	5	w	JV	B	C	COM	GRO	GRO	BDWT	WO	200		N	3.76	N	0.204062	37.1		10	10	5	10	5	8	4	1	10	4	67
218	2324	White et al, 1985	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	50	d	21	d	JV	M	C	NR	GRO	GRO	BDWT	WO	500		Y	0.280	N	0.024128	43.1		10	10	6	10	5	8	4	1	10	4	68
219	10891	DeVries et al, 1986	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/12	mg/org/d	N	N	NR	U	DR	11	mo	3	w	JV	F	C	LAB	GRO	GRO	BDWT	WO	12		Y	0.262	Y	0.025	45.8		10	5	5	10	7	8	4	10	10	4	73
220	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	4	6	0/500/1000/2000/4000/8000	mg/kg diet	N	N	ADL	U	FD	13	w	6	w	JV	B	C	LAB	GRO	GRO	BDWT	WO	4000	8000	Y	0.338	Y	0.0165	49.8	99.6	10	10	5	10	7	8	10	10	10	4	84
221	12079	Komulainen, 1983	Copper chloride	100	Rat (*Rattus norvegicus*)	1	4	0/28/50/64	mg/kg bw/d	N	N	ADL	U	DR	1	w	4	w	JV	M	C	COM	GRO	GRO	BDWT	WO	50	64	Y	0.112	Y	0.00019	50.0	64.0	10	5	5	10	10	8	10	10	10	4	82
222	2113	Grobner et al, 1986	Anhydrous Copper sulfate	100	Rabbit (*Oryctolagus cuniculus*)	5	6	0/50.9/99.1/176.9/504.5/901.5	mg/kg diet	N	N	ADL	M	FD	28	d	28	d	JV	NR	C	NR	GRO	GRO	BDWT	WO	901.5		Y	1.6276	Y	0.1066	59.0		10	10	10	10	7	8	4	1	10	4	74
223	2225	Myers et al, 1993	Copper (I) acetate	51.84	Rat (*Rattus norvegicus*)	1	2	0/0.125	% in diet	N	N	DLY	U	DR	6	w	NR	mo	JV	M	C	LAB	GRO	GRO	BDWT	WO	0.125		Y	0.261	N	0.029554	73.4		10	5	5	5	6	8	4	10	10	4	67

Ref			Exposure																				Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	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
224	36389	Tatum et al, 2000	Copper chloride	100	Rat (*Rattus norvegicus*)	1	2	0/800	mg/kg diet	N	N	ADL	U	FD	6	w	NR	NR	JV	F	C	LAB	GRO	GRO	BDWT	WO	800		Y	0.165	N	0.015622	75.7		10	10	5	10	6	8	4	1	10	4	68
225	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	3	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	15	d	6	w	JV	B	C	LAB	GRO	GRO	BDWT	WO	4000	8000	Y	0.178	Y	0.0144	82.5	165	10	10	5	10	7	8	10	10	10	4	84
226	11928	Keen et al, 1982	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	4	0/100/1000/2000	ug/g diet	N	N	ADL	U	FD	7	w	NR	NR	JV	F	C	COM	GRO	GRO	BDWT	WO	1000	2000	Y	0.198	N	0.018147	91.7	183	10	10	5	10	6	8	10	10	10	4	83
227	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	5	6	0/32/64/129/259/551	mg/org/d	N	N	ADL	U	FD	92	d	6	w	JV	M	C	COM	GRO	GRO	BDWT	WO	129	259	Y	0.352	N	0.029122	146	293	10	10	5	10	6	8	10	10	10	4	83
228	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	6	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	13	w	6	w	JV	B	C	LAB	GRO	GRO	BDWT	WO	4000	8000	Y	0.029	Y	0.0051	179	358	10	10	5	10	7	8	10	10	10	4	84
229	440	Dodds-Smith et al., 1992	Copper chloride	100	Common shrew (*Sorex araneus*)	1	2	0/2.11	mg/org/d	N	N	DLY	U	FD	12	w	NR	NR	JV	B	C	NR	GRO	GRO	BDWT	WO	2.11		Y	0.0092	N	0.001456	229		10	10	5	10	6	8	4	10	10	4	77
230	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	5	0/41/113/175/140	mg/org/d	N	N	ADL	U	DR	2	w	6	w	JV	M	C	COM	GRO	GRO	BDWT	WO	113	175	Y	0.174	N	0.020518	259	400	10	5	5	10	6	8	10	10	10	4	78
231	36374	Pettersen, et al, 2002	Copper chloride	100	Mouse (*Mus musculus*)	1	3	0/3.5/7	g/kg diet	N	N	ADL	U	FD	3	w	4	w	JV	B	C	LAB	GRO	GRO	BDWT	WO	3.5	7	Y	0.0175	N	0.00247	494	988	10	10	5	10	6	8	10	10	10	4	83
232	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	5	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	15	d	6	w	JV	B	C	LAB	GRO	GRO	BDWT	WO	16000		Y	0.0236	Y	0.004	690		10	10	5	10	7	8	4	1	10	4	69
233	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	3	6	0/92/180/363/777/1275	mg/org/d	N	N	ADL	U	FD	15	d	6	w	JV	M	C	COM	GRO	GRO	BDWT	WO	363	777	Y	0.178	N	0.016627	812	1738	10	10	5	10	6	8	10	10	10	4	83
234	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	2	5	0/41/95/226/524	mg/org/d	N	N	ADL	U	DR	2	w	6	w	JV	M	C	COM	GRO	GRO	BDWT	WO	95	226	Y	0.0265	N	0.003772	1427	3395	10	5	5	10	6	8	10	10	10	4	78
235	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	6	6	0/173/382/736/1563/3201	mg/org/d	N	N	ADL	U	FD	92	d	6	w	JV	M	C	COM	GRO	GRO	BDWT	WO	173	382	Y	0.0326	N	0.004119	2113	4665	10	10	5	10	6	8	10	10	10	4	83
236	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	4	6	0/168/362/773/1154/2817	mg/org/d	N	N	ADL	U	FD	15	d	6	w	JV	F	C	COM	GRO	GRO	BDWT	WO	1154	2817	Y	0.0236	N	0.003159	19466	47519	10	10	5	10	6	8	10	10	10	4	83
237	36748	Solaiman, et al, 2001	Copper sulfate pentahydrate	100	Goat (*Capra hircus*)	1	3	0/50/100	mg/org/d	N	N	DLY	U	GV	9	w	7-8	mo	JV	F	C	DOM	GRO	GRO	BDWT	WO		50	Y	34.06	N	1.2487		1.47	10	8	10	10	6	8	4	10	10	4	80
238	36759	Ortolani et al, 2003	Copper sulfate pentahydrate	100	Sheep (*Ovis aries*)	1	2	0/3	mg/kg bw/d	N	N	ADL	U	DR	35	d	6	mo	JV	M	C	COM	GRO	GRO	BDWT	WO		3	Y	33.1	Y	0.5		3.00	10	5	5	10	10	8	4	10	10	4	76
239	2640	Freundt and Ibrahim, 1990	Cuprous chloride	64.18	Rat (*Rattus norvegicus*)	1	2	0/100	mg/L	N	N	ADL	U	DR	91	d	NR	NR	JV	F	C	NR	GRO	GRO	BDWT	WO		100	Y	0.278	N	0.031281		5.78	10	5	5	10	6	8	4	10	10	4	72
240	2064	DeGoey et al 1971	Copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	98	d	NR	NR	JV	B	C	NR	GRO	GRO	BDWT	WO		250	Y	90.5	Y	2.7		7.46	10	10	5	10	7	8	4	10	10	4	78
241	2064	DeGoey et al 1971	Copper sulfate	100	Pig (*Sus scrofa*)	2	2	0/500	mg/kg diet	N	N	ADL	U	FD	23	d	NR	NR	JV	NR	C	NR	GRO	MPH	MUSC	MU		500	Y	89	N	2.750143		15.5	10	10	5	10	6	8	4	10	10	4	77
242	14653	Boyden, 1938	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	5	0/5.1/5.05/8.2/9.8/11.8/7.6	mg/org/d	N	N	ADL	U	FD	4	w	28	d	JV	B	C	DOM	GRO	GRO	BDWT	WO		5.1	N	0.217	Y	0.0101		23.5	10	10	5	10	6	8	4	10	10	4	77
243	2186	Kumar et al, 1987	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	2	0/0.1	g/kg bw/d	N	N	DLY	U	GV	45	d	90	d	JV	M	C	LAB	GRO	GRO	BDWT	WO		0.1	Y	0.103	N	0.010605		39.8	10	8	10	10	10	8	4	10	10	4	84
244	2256	Rana and Kumar 1980	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	2	0/100	mg/kg bw	N	N	DLY	U	GV	20	d	90	d	JV	M	C	LAB	GRO	GRO	BDWT	WO		100	Y	0.101	N	0.010435		39.8	10	8	10	10	10	8	4	10	10	4	84
245	2203	Llewellyn et al, 1985	Copper acetate	51.84	Rat (*Rattus norvegicus*)	1	2	0/2600	mg/kg diet	N	N	ADL	U	FD	21	w	NR	NR	JV	M	C	LAB	GRO	GRO	BDWT	WO		2600	N	0.4702	N	0.036946		106	10	10	5	5	5	8	4	10	10	4	71
246	36364	Fuentealba et al, 2000	Copper sulfate	100	Rat (*Rattus norvegicus*)	2	2	0/1500	mg/kg diet	N	N	ADL	U	FD	12	w	21	d	JV	B	C	LAB	GRO	GRO	BDWT	WO		1500	N	0.38	N	0.031013		122	10	10	5	10	5	8	4	10	10	4	76
247	2121	Haywood 1985	Copper	100	Rat (*Rattus norvegicus*)	1	5	0/3000/4000/5000/6000	mg/kg diet	N	N	ADL	U	FD	15	w	NR	NR	JV	M	C	NR	GRO	GRO	BDWT	WO		3000	Y	0.202	N	0.018448		274	10	10	5	4	6	8	4	10	10	4	71
248	2124	Haywood and Loughran 1985	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	5	0/3000/4000/5000/6000	mg/kg diet	N	N	DLY	U	FD	6	w	NR	mo	JV	M	C	NR	GRO	GRO	BDWT	WO		3000	Y	0.162	N	0.015388		285	10	10	5	10	6	8	4	10	10	4	77
Survival																																													
249	2020	Bassuny, 1991	Copper sulfate pentahydrate	25.45	Rabbit (*Oryctolagus cuniculus*)	1	5	0/75/150/300/450	mg/kg diet	N	N	NR	U	FD	7	w	35	d	JV	M	C	NR	MOR	MOR	MORT	WO	450		Y	2.218	Y	0.0823	4.25		10	10	5	10	7	9	4	10	10	4	79
250	2062	Cromwell et al 1993	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	783	d	10.3	mo	GE	F	C	NR	MOR	MOR	MORT	WO	250		Y	152	Y	3.35	5.51		10	10	5	10	7	9	4	1	10	4	70
251	14387	Allcroft et al, 1961	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	4	0/380/560/934	mg/org/d	N	N	ADL	M	FD	4	w	8-10	w	JV	B	C	DOM	MOR	MOR	MORT	WO	560	934	N	100	Y	2.36	5.6	9.34	10	10	10	10	6	9	10	10	10	4	89
252	2033	Brandt, 1983	Copper (II) sulfate	100	Mink (*Mustela vision*)	1	3	0/166/320	mg/kg diet	N	N	ADL	M	FD	4	mo	90	d	JV	M	C	NR	MOR	MOR	MORT	WO	166	320	Y	1.92	N	0.117444	10.2	19.6	10	10	10	10	6	9	10	10	10	4	89
253	48117	Jenkins, 1989	Copper	100	Cattle (*Bos taurus*)	1	5	0/50/200/500/1000	mg/kg diet	N	N	ADL	U	FD	6	w	3	d	JV	M	C	DOM	MOR	MOR	MORT	WO	500	1000	N	67	N	2.177661	16.3	32.5	10	10	5	4	5	9	10	10	10	4	77
254	14653	Boyden, 1938	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	5	0/5.1/5.05/8.2/9.8/11.8/7.6	mg/org/d	N	N	ADL	U	FD	1	w	28	d	JV	B	C	DOM	MOR	MOR	MORT	WO	5.05	7.6	N	0.217	Y	0.0059	23.3	35.0	10	10	5	10	6	9	10	10	10	4	84
255	2075	Edmonds and Baker 1986	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/250/650	mg/kg diet	N	N	ADL	U	FD	28	d	4	w	JV	NR	C	NR	MOR	MOR	MORT	WO	650		Y	15.71	Y	0.626	25.9		10	10	5	10	7	9	4	10	10	4	79
256	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	1	6	0/300/1000/3000/10000/30000	mg/L	N	N	ADL	U	DR	15	d	6	w	JV	B	C	LAB	MOR	MOR	MORT	WO	3000	10000	Y	0.088	Y	0.00384	33.3	111	10	5	5	10	7	9	8	10	10	4	78
257	2043	Bush et al., 1995	Copper sulfate pentahydrate	100	Mink (*Mustela vision*)	1	3	0/308/568	mg/kg diet	N	N	ADL	M	FD	132	d	10	w	JV	B	C	COM	MOR	MOR	MORT	WO	568		Y	2.403	N	0.141233	33.4		10	10	10	10	6	9	4	10	10	4	83
258	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	2	6	0/300/1000/3000/10000/30000	mg/L	N	N	ADL	U	DR	15	d	6	w	JV	F	C	LAB	MOR	MOR	MORT	WO	1000	3000	Y	0.0211	Y	0.0028	33.8	101	10	5	5	10	7	9	10	10	10	4	80
259	2113	Grobner et al, 1986	Anhydrous Copper sulfate	100	Rabbit (*Oryctolagus cuniculus*)	6	6	0/55.9/121.5/199.2/498.1/821.6	mg/kg diet	N	N	ADL	M	FD	28	d	28	d	JV	NR	C	NR	MOR	MOR	MORT	WO	821.6		Y	1.2328	Y	0.0683	45.5		10	10	10	10	7	9	4	1	10	4	75
260	2113	Grobner et al, 1986	Anhydrous Copper sulfate	100	Rabbit (*Oryctolagus cuniculus*)	5	6	0/50.9/99.1/176.9/504.5/901.5	mg/kg diet	N	N	ADL	M	FD	28	d	28	d	JV	NR	C	NR	MOR	MOR	MORT	WO	901.5		Y	1.6276	Y	0.1066	59.0		10	10	10	10	7	9	4	1	10	4	75
261	11928	Keen et al, 1982	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	4	0/100/1000/2000	ug/g diet	N	N	ADL	U	FD	7	w	NR	NR	JV	F	C	COM	MOR	MOR	MORT	WO	1000	2000	Y	0.198	N	0.018147	91.7	183	10	10	5	10	6	9	10	10	10	4	84
262	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	4	6	0/500/1000/2000/4000/8000	mg/kg diet	N	N	ADL	U	FD	13	w	6	w	JV	B	C	LAB	MOR	MOR	MORT	WO	8000		Y	0.275	Y	0.0144	107		10	10	5	10	7	9	4	10	10	4	79
263	440	Dodds-Smith et al., 1992	Copper chloride	100	Common shrew (*Sorex araneus*)	1	2	0/2.11	mg/org/d	N	N	DLY	U	FD	12	w	NR	NR	JV	B	C	NR	MOR	MOR	MORT	WO	2.11		Y	0.0092	N	0.001456	229		10	10	5	10	6	9	4	10	10	4	78
264	2127	Hebert et al 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	5	0/41/113/175/140	mg/org/d	N	N	ADL	U	DR	2	w	6	w	JV	M	C	COM	MOR	MOR	MORT	WO	113	175	Y	0.174	N	0.020518	259	400	10	5	5	10	6	9	10	10	10	4	79
265	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Rat (*Rattus norvegicus*)	3	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	15	d	6	w	JV	B	C	LAB	MOR	MOR	MORT	WO	16000		Y	0.122	Y	0.0092	307		10	10	5	10	7	9	4	10	10	4	79
266	2121	Haywood 1985	Copper	100	Rat (*Rattus norvegicus*)	1	5	0/3000/4000/5000/6000	mg/kg diet	N	N	ADL	U	FD	2	w	NR	NR	JV	M	C	NR	MOR	MOR	MORT	WO	5000	6000	Y	0.202	N	0.018448	457	548	10	10	5	4	6	9	10	10	10	4	78
267	2126	Hebert 1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	5	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	15	d	6	w	JV	B	C	LAB	MOR	MOR	MORT	WO	16000		Y	0.0236	Y	0.004	690		10	10	5	10	7	9	4	1	10	4	70
268	2126	Hebert,1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	6	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	13	w	6	w	JV	B	C	LAB	MOR	MOR	MORT	WO	16000		Y	0.0268	Y	0.005	760		10	10	5	10	7	9	4	10	10	4	79
269	2127	Hebert et al, 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	5	6	0/32/64/129/259/551	mg/org/d	N	N	ADL	U	FD	92	d	6	w	JV	B	C	COM	MOR	MOR	MORT	WO	551		Y	0.275	N	0.023773	798		10	10	5	10	6	9	4	10	10	4	78
270	2127	Hebert et al, 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	2	5	0/41/95/226/524	mg/org/d	N	N	ADL	U	DR	2	w	6	w	JV	B	C	COM	MOR	MOR	MORT	WO	95	226	Y	0.0265	N	0.003772	1427	3395	10	5	5	10	6	9	10	10	10	4	79
271	2127	Hebert et al, 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	3	6	0/92/180/363/777/1275	mg/org/d	N	N	ADL	U	FD	15	d	6	w	JV	M	C	COM	MOR	MOR	MORT	WO	1275		Y	0.122	N	0.012188	4160		10	10	5	10	6	9	4	10	10	4	78
272	2127	Hebert et al, 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	4	6	0/168/362/773/1154/2817	mg/org/d	N	N	ADL	U	FD	15	d	6	w	JV	B	C	COM	MOR	MOR	MORT	WO	2817		Y	0.0236	N	0.003159	47519		10	10	5	10	6	9	4	10	10	4	78
273	2127	Hebert et al, 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	6	6	0/173/382/736/1563/3201	mg/org/d	N	N	ADL	U	FD	92	d	6	w	JV	B	C	COM	MOR	MOR	MORT	WO	3201		Y	0.0264	N	0.003464	48270		10	10	5	10	6	9	4	10	10	4	78
274	36202	Gopinath et al, 1974	Copper sulfate pentahydrate	25.45	Sheep (*Ovis aries*)	1	2	0/20	mg/kg bw/d	N	N	DLY	U	DR	10	w	6	mo	JV	F	C	COM	MOR	MOR	MORT	WO		20	N	59.1	N	3.891024		5.09	10	5	5	10	10	9	4	10	10	4	77
275	2155	Ishmael et al, 1971	Copper sulfate pentahydrate	25.45	Sheep (*Ovis aries*)	1	2	0/0.714	g/org/d	N	N	5 per w	U	OR	31	d	6	mo	JV	F	C	NR	MOR	MOR	MORT	WO		0.714	N	24	N	0.936463		7.57	10	8	5	10	5	9	4	10	10	4	75
276	14402	Ritchie et al, 1963	Copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	15	w	7	w	JV	NR	C	COM	MOR	MOR	MORT	WO		250	Y	69.31	N	2.24		8.08	10	10	5	10	6	9	4	10	10	4	78
277	2064	DeGoey et al, 1971	Copper sulfate	100	Pig (*Sus scrofa*)	2	2	0/500	mg/kg diet	N	N	ADL	U	FD	23	d	NR	NR	JV	NR	C	NR	MOR	MOR	MORT	WO		500	Y	89	N	2.750143		15.5	10	10	5	10	6	9	4	10	10	4	78
278	2216	McNatt et al, 1971	Copper (I) acetate	51.84	Rat (*Rattus norvegicus*)	1	2	0/0.2	% in diet	N	N	ADL	U	DR	3	w	4-11	mo	JV	M	C	COM	MOR	MOR	MORT	WO		0.200	Y	0.356	N	0.039079		114	10	5	5	5	6	9	4	10	10	4	68
Data Not Used to Derive TRV																																													
279	25940	Engle and Spears, 2001	Copper sulfate	100	Cattle (*Bos taurus*)	1	2	0/40	mg/kg diet	N	N	ADL	U	FD	239	d	NR	NR	JV	M	C	COM	PHY	PHY	FDCV	WO	40		Y	430	Y	8.730	0.812		10	10	5	10	7	4	4	1	10	4	65

Ref			Exposure																				Effects						Conversion to mg/kg bw/day				Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	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
280	25940	Engle and Spears, 2001	Copper sulfate	100	Cattle (*Bos taurus*)	1	2	0/40	mg/kg diet	N	N	ADL	U	FD	239	d	NR	NR	JV	M	C	COM	BEH	FDB	FCNS	WO	40		Y	430	Y	8.730	0.812		10	10	5	10	7	4	4	1	10	4	65
281	25940	Engle and Spears, 2001	Copper sulfate	100	Cattle (*Bos taurus*)	1	2	0/40	mg/kg diet	N	N	ADL	U	FD	239	d	NR	NR	JV	M	C	COM	BIO	CHM	CHOL	PL	40		Y	430	Y	8.730	0.812		10	10	5	10	7	1	4	1	10	4	62
282	25935	Engle et al, 2000	Copper chloride - tribasic	100	Cattle (*Bos taurus*)	1	2	0/40	mg/kg diet	N	N	ADL	U	FD	154	d	NR	NR	JV	M	C	COM	BEH	FDB	FCNS	WO	40		Y	400.1	Y	8.520	0.852		10	10	5	10	7	4	4	1	10	4	65
283	25935	Engle et al, 2000	Copper chloride - tribasic	100	Cattle (*Bos taurus*)	1	2	0/40	mg/kg diet	N	N	ADL	U	FD	112	d	NR	NR	JV	M	C	COM	BIO	CHM	CHOL	SR	40		Y	400.1	Y	8.520	0.852		10	10	5	10	7	1	4	1	10	4	62
284	36762	Humann-Ziehank et al, 2001	Copper sulfate	100	Sheep (*Ovis aries*)	1	2	0/3.7	mg/kg bw/d	N	N	2 per d	U	FD	84	d	1	yr	AD	M	C	COM	GRO	GRO	BDWT	WO	3.7		Y	2.5	N	0.145903	3.70		10	10	5	10	10	8	4	1	3	4	65
285	43456	Omole et al, 1976	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/125/200	mg/kg diet	N	N	ADL	U	FD	127	d	NR	NR	NR	B	C	COM	GRO	GRO	BDWT	WO	200		Y	90.2	Y	2	4.43		10	10	5	10	7	8	4	1	6	4	65
286	43456	Omole et al, 1976	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/125/200	mg/kg diet	N	N	ADL	U	FD	127	d	NR	NR	NR	B	C	COM	BEH	FDB	FCNS	WO	200		Y	90.2	Y	2	4.43		10	10	5	10	7	4	4	1	6	4	61
287	2062	Cromwell et al, 1993	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	783	d	10	mo	GE	F	C	NR	BEH	FDB	FCNS	WO	250		Y	152	Y	3.35	5.51		10	10	5	10	7	4	4	1	10	4	65
288	757	Mercado and Bibby, 1973	Copper chloride dihydrate	100	Rat (*Rattus norvegicus*)	1	2	0/50	mg/L	N	N	ADL	U	DR	50	d	23	d	JV	M	C	NR	PHY	PHY	GPHY	TH	50		N	0.267	N	0.03016	5.65		10	5	5	10	5	4	4	1	10	4	58
289	757	Mercado and Bibby, 1973	Copper chloride dihydrate	100	Rat (*Rattus norvegicus*)	1	2	0/50	mg/L	N	N	ADL	U	DR	50	d	23	d	JV	M	C	NR	GRO	GRO	BDWT	WO	50		N	0.267	N	0.03016	5.65		10	5	5	10	5	8	4	1	10	4	62
290	136	Gershbein et al, 1983	Copper (II) sulfate pentahydrate	100	Rat (*Rattus norvegicus*)	1	2	0/75	mg/kg diet	N	N	ADL	U	FD	80	d	44	d	JV	M	C	NR	PTH	HIS	GHIS	MT	75		Y	0.47	N	0.036934	5.89		10	10	5	10	6	4	4	1	10	4	64
291	41706	Omole and Bowland, 1974	Copper	100	Pig (*Sus scrofa*)	1	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	99	d	NR	NR	JV	B	C	COM	PHY	PHY	FDCV	WO	200		Y	77.1	Y	2.41	6.25		10	10	5	4	7	4	4	1	10	4	59
292	41706	Omole and Bowland, 1974	Copper	100	Pig (*Sus scrofa*)	1	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	99	d	NR	NR	JV	B	C	COM	GRO	GRO	BDWT	WO	200		Y	77.1	Y	2.41	6.25		10	10	5	4	7	8	4	1	10	4	63
293	41706	Omole and Bowland, 1974	Copper	100	Pig (*Sus scrofa*)	1	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	99	d	NR	NR	JV	B	C	COM	BEH	FDB	FDNG	WO	200		Y	77.1	Y	2.41	6.25		10	10	5	4	7	4	4	1	10	4	59
294	25930	Cromwell et al, 1998	Copper chloride	100	Pig (*Sus scrofa*)	5	4	0/100/150/200	mg/kg diet	N	N	ADL	U	FD	28	d	26-32	d	JV	B	C	COM	PHY	PHY	FDCV	WO	200		Y	25.5	Y	0.917	7.19		10	10	5	10	7	4	4	1	10	4	65
295	25930	Cromwell et al, 1998	Copper chloride	100	Pig (*Sus scrofa*)	5	4	0/100/150/200	mg/kg diet	N	N	ADL	U	FD	28	d	26-32	d	JV	B	C	COM	BEH	FDB	FCNS	WO	200		Y	25.5	Y	0.917	7.19		10	10	5	10	7	4	4	1	10	4	65
296	12977	Omole, 1977	Copper sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	4	0/100/150/200	mg/kg diet	N	N	ADL	U	FD	8	w	6	w	JV	B	C	LAB	PHY	PHY	FDCV	WO	200		Y	1.724	Y	0.0633	7.34		10	10	5	10	7	4	4	1	10	4	65
297	12977	Omole, 1977	Copper sulfate pentahydrate	100	Rabbit (*Oryctolagus cuniculus*)	1	4	0/100/150/200	mg/kg diet	N	N	ADL	U	FD	8	w	6	w	JV	B	C	LAB	BEH	FDB	FCNS	WO	200		N	1.724	Y	0.0633	7.34		10	10	5	10	7	4	4	1	10	4	65
298	25930	Cromwell et al, 1998	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	6	2	0/200	mg/kg diet	N	N	ADL	U	FD	28	d	26-32	d	JV	B	C	COM	PHY	PHY	FDCV	WO	200		Y	25.5	Y	0.939	7.36		10	10	5	10	7	4	4	1	10	4	65
299	25930	Cromwell et al, 1998	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	6	2	0/200	mg/kg diet	N	N	ADL	U	FD	28	d	26-32	d	JV	B	C	COM	BEH	FDB	FCNS	WO	200		Y	25.5	Y	0.939	7.36		10	10	5	10	7	4	4	1	10	4	65
300	2064	DeGoey et al, 1971	Copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	98	d	NR	NR	JV	NR	C	NR	PHY	PHY	IRRI	SK	250		Y	90.5	Y	2.7	7.46		10	10	5	10	7	4	4	1	10	4	65
301	14396	Gipp et al, 1973	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	12	w	NR	NR	JV	F	C	COM	PHY	PHY	FDCV	WO	250		Y	93.2	N	2.856384	7.66		10	10	5	10	6	4	4	1	10	4	64
302	2061	Cromwell et al, 1989	Copper oxide	100	Pig (*Sus scrofa*)	2	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	28	d	28	d	JV	B	C	NR	PHY	PHY	FDCV	WO	250		Y	17.8	Y	0.547	7.68		10	10	5	10	7	4	4	1	10	4	65
303	2061	Cromwell et al, 1989	Copper oxide	100	Pig (*Sus scrofa*)	2	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	28	d	28	d	JV	B	C	NR	BEH	FDB	FCNS	WO	250		Y	17.8	Y	0.547	7.68		10	10	5	10	7	4	4	1	10	4	65
304	25929	Luo and Dove, 1996	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	15	d	26	d	JV	M	C	COM	PHY	PHY	FDCV	WO	250		Y	10.1	Y	0.312	7.72		10	10	5	10	7	4	4	1	10	4	65
305	25929	Luo and Dove, 1996	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	15	d	26	d	JV	M	C	COM	BIO	ENZ	GENZ	IN	250		Y	10.1	Y	0.312	7.72		10	10	5	10	7	1	4	1	10	4	62
306	25929	Luo and Dove, 1996	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	15	d	26	d	JV	M	C	COM	BEH	FDB	FCNS	WO	250		Y	10.1	Y	0.312	7.72		10	10	5	10	7	4	4	1	10	4	65
307	12809	Myres and Bowland, 1973	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	10	w	70	d	JV	B	C	COM	PTH	ORW	ORWT	LI	250		Y	64.7	Y	2.03	7.84		10	10	5	10	7	4	4	1	10	4	65
308	12809	Myres and Bowland, 1973	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	10	w	70	d	JV	B	C	COM	PHY	PHY	FDCV	WO	250		Y	64.7	Y	2.03	7.84		10	10	5	10	7	4	4	1	10	4	65
309	12809	Myres and Bowland, 1973	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	10	w	70	d	JV	B	C	COM	BEH	FDB	FCNS	WO	250		Y	64.7	Y	2.03	7.84		10	10	5	10	7	4	4	1	10	4	65
310	14402	Ritchie et al, 1963	Copper sulfate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	15	w	7	w	JV	NR	C	COM	PHY	PHY	FDCV	WO	250		Y	69.31	N	2.24	8.08		10	10	5	10	6	4	4	1	10	4	64
311	3755	Olson et al, 1984	Copper	100	Sheep (*Ovis aries*)	1	2	0/257	mg/kg diet	N	N	DLY	M	FD	140	d	4-13	yr	AD	F	C	DOM	PTH	ITX	GITX	WO	257		N	65.1	N	2.126769	8.40		10	10	10	4	5	4	4	10	3	4	64
312	2253	Prince et al, 1979	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	59	d	64	d	JV	NR	C	NR	BEH	FDB	FEFF	WO	250		Y	54	N	1.82383	8.44		10	10	5	10	6	4	4	1	10	4	64
313	2061	Cromwell et al, 1989	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/125/250	mg/kg diet	N	N	ADL	U	FD	28	d	28	d	JV	B	C	NR	BEH	FDB	FCNS	WO	250		Y	15.6	Y	0.599	9.60		10	10	5	10	7	4	4	1	10	4	65
314	14397	Gipp et al, 1974	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	2	0/250	mg/kg diet	N	N	ADL	U	FD	35	d	3	w	JV	B	C	COM	BEH	FDB	FCNS	WO	250		Y	21.9	Y	0.870	9.93		10	10	5	10	7	4	4	1	10	4	65
315	2013	Aulerich et al, 1982	Copper sulfate pentahydrate	100	Mink (*Mustela vision*)	1	5	0/25/50/100/200	mg/kg diet	N	N	ADL	U	FD	153	d	NR	mo	JV	M	C	NR	PTH	ORW	SMIX	LI	200		Y	1.753	N	0.10898	12.4		10	10	5	10	6	4	4	1	10	4	64
316	2013	Aulerich et al, 1982	Copper sulfate pentahydrate	100	Mink (*Mustela vision*)	1	5	0/25/50/100/200	mg/kg diet	N	N	ADL	U	FD	357	d	NR	mo	JV	B	C	NR	BIO	CHM	HMGL	BL	200		Y	1.753	N	0.10898	12.4		10	10	5	10	6	1	4	1	10	4	61
317	3760	Felsman et al, 1973	Copper sulfate	100	Cattle (*Bos taurus*)	1	4	0/125/250/500	mg/kg diet	N	N	ADL	U	FD	98	d	6	w	JV	M	C	NR	BEH	FDB	FCNS	WO	500		Y	269	N	6.826736	12.7		10	10	5	10	6	4	4	1	10	4	64
318	3760	Felsman et al, 1973	Copper sulfate	100	Cattle (*Bos taurus*)	1	4	0/125/250/500	mg/kg diet	N	N	ADL	U	FD	98	d	6	w	JV	M	C	NR	BIO	CHM	HMGL	BL	500		Y	269	N	6.826736	12.7		10	10	5	10	6	1	4	1	10	4	61
319	36756	Zacharias et al, 2003	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/80/175	mg/kg diet	N	N	CON	U	FD	60	d	NR	NR	NR	M	C	COM	GRO	GRO	BDWT	WO	175		Y	55	Y	4.456	14.2		10	10	5	10	7	8	4	1	6	4	65
320	36756	Zacharias et al, 2003	Copper sulfate pentahydrate	100	Pig (*Sus scrofa*)	1	3	0/80/175	mg/kg diet	N	N	CON	U	FD	60	d	NR	NR	NR	M	C	COM	BIO	CHM	CALC	BO	175		Y	55	Y	4.456	14.2		10	10	5	10	7	1	4	1	6	4	58
321	2085	Elliot and Bowland, 1972	Copper	100	Rat (*Rattus norvegicus*)	1	2	0/250	mg/kg diet	N	N	DLY	U	FD	8	w	3	w	JV	B	C	LAB	PHY	PHY	FDCV	WO	250		N	0.267	Y	0.0175	16.4		10	10	5	10	6	4	4	1	10	4	64
322	2085	Elliot and Bowland, 1972	Copper	100	Rat (*Rattus norvegicus*)	1	2	0/250	mg/kg diet	N	N	DLY	U	FD	8	w	3	w	JV	B	C	LAB	BIO	CHM	FFTA	WO	250		Y	0.267	Y	0.0175	16.4		10	10	5	4	7	1	4	1	10	4	56
323	2085	Elliot and Bowland, 1972	Copper	100	Rat (*Rattus norvegicus*)	1	2	0/250	mg/kg diet	N	N	DLY	U	FD	8	w	3	w	JV	B	C	LAB	GRO	GRO	BDWT	WO	250		N	0.267	Y	0.0175	16.4		10	10	5	4	6	8	4	1	10	4	62
324	2085	Elliot and Bowland, 1972	Copper	100	Rat (*Rattus norvegicus*)	1	2	0/250	mg/kg diet	N	N	DLY	U	FD	4	w	3	w	JV	B	C	LAB	BEH	FDB	FCNS	WO	250		N	0.267	Y	0.0175	16.4		10	10	5	4	6	4	4	1	10	4	58
325	2061	Cromwell et al, 1989	Copper oxide	100	Pig (*Sus scrofa*)	4	4	0/125/250/500	mg/kg diet	N	N	ADL	U	FD	28	d	28	d	JV	B	C	NR	PHY	PHY	FDCV	WO	500		Y	13.2	Y	0.441	16.7		10	10	5	10	7	4	4	1	10	4	65
326	2061	Cromwell et al, 1989	Copper oxide	100	Pig (*Sus scrofa*)	4	4	0/125/250/500	mg/kg diet	N	N	ADL	U	FD	28	d	28	d	JV	B	C	NR	BEH	FDB	FCNS	WO	500		Y	13.2	Y	0.441	16.7		10	10	5	10	7	4	4	1	10	4	65
327	2189	Lalich et al, 1965	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	2	0/0.5	g/kg diet	N	N	ADL	U	FD	42	d	NR	NR	JV	M	C	NR	PTH	HIS	GHIS	BO	0.5		Y	0.2509	N	0.022047	17.5		10	10	5	10	6	4	4	1	10	4	64
328	2182	Kornegay et al, 1986	Copper	100	Pig (*Sus scrofa*)	1	3	0/200/400	mg/kg diet	N	N	ADL	U	FD	5	w	NR	NR	JV	B	C	COM	PHY	PHY	FDCV	WO	400		Y	17.5	Y	0.79	18.1		10	10	5	4	7	4	4	1	10	4	59
329	2182	Kornegay et al, 1986	Copper	100	Pig (*Sus scrofa*)	1	3	0/200/400	mg/kg diet	N	N	ADL	U	FD	5	w	NR	NR	JV	B	C	COM	GRO	GRO	BDWT	WO	400		Y	17.5	Y	0.79	18.1		10	10	5	4	7	8	4	1	10	4	63
330	2182	Kornegay et al, 1986	Copper	100	Pig (*Sus scrofa*)	1	3	0/200/400	mg/kg diet	N	N	ADL	U	FD	5	w	NR	NR	JV	B	C	COM	BEH	FDB	FCNS	WO	400		Y	17.5	Y	0.79	18.1		10	10	5	4	7	4	4	1	10	4	59
331	3760	Felsman et al, 1973	Copper sulfate	100	Cattle (*Bos taurus*)	2	4	0/300/600/900	mg/kg diet	N	N	ADL	U	FD	98	d	6	w	JV	M	C	NR	BIO	CHM	HMGL	BL	900		Y	266	N	6.764091	22.9		10	10	5	10	6	1	4	1	10	4	61
332	3760	Felsman et al, 1973	Copper sulfate	100	Cattle (*Bos taurus*)	2	4	0/300/600/900	mg/kg diet	N	N	ADL	U	FD	98	d	6	w	JV	M	C	NR	BEH	FDB	FCNS	WO	900		Y	266	N	6.764091	22.9		10	10	5	10	6	4	4	1	10	4	64
333	12718	Moffitt and Murphy, 1973	Copper sulfate pentahydrate	100	Rat (*Rattus norvegicus*)	1	4	0/50/150/450	mg/L	N	N	ADL	U	DR	30	d	NR	NR	JV	B	C	LAB	BEH	FDB	WCON	WO	450		Y	250	N	14.2489	25.6		10	5	5	10	6	4	4	1	10	4	59
334	13235	Rana and Kumar, 1979	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	1	2	0/0.100	g/kg bw	N	N	ADL	U	FD	20	d	NR	NR	JV	B	C	LAB	BIO	ENZ	ALPH	KI	0.1		Y	0.11	N	0.011194	39.8		10	10	5	10	10	1	4	1	10	4	65
335	2324	White et al, 1985	Copper sulfate	100	Rat (*Rattus norvegicus*)	1	2	0/500	mg/kg diet	N	N	ADL	U	FD	50	d	21	d	JV	M	C	NR	BIO	CHM	HMGL	BL	500		Y	0.280	N	0.024128	43.1		10	10	6	10	5	1	4	1	10	4	61
336	12718	Moffitt and Murphy, 1973	Copper sulfate pentahydrate	100	Rat (*Rattus norvegicus*)	1	4	0/50/150/450	mg/L	N	N	ADL	U	DR	30	d	NR	NR	JV	B	C	LAB	GRO	GRO	BDWT	WO	450		Y	0.25	N	0.02843	51.2		10	5	5	10	6	8	4	1	10	4	63
337	12079	Komulainen, 1983	Copper chloride	100	Rat (*Rattus norvegicus*)	1	4	0/28/50/64	mg/kg bw/d	N	N	ADL	U	DR	3	w	4	w	JV	M	C	COM	BIO	HRM	DOPA	BR	64		Y	0.158	Y	0.00016	64.0		10	5	5	10	10	1	4	6	10	4	65

Ref			Exposure																				Effects					Conversion to mg/kg bw/day					Result		Data Evaluation Score										
Result #	Ref N.	Reference	Chemical Form	MW%	Test Species	Phase #	# of Conc/ Doses	Conc/ Doses	Conc/Dose Units	Wet Weight Reported?	Percent Moisture	Application Frequency	Method of Analyses	Route of Exposure	Exposure Duration	Duration Units	Age	Age Units	Lifestage	Sex	Control Type	Test Location	General Effect Group	Effect Type	Effect Measure	Response Site	Study NOAEL	Study LOAEL	Body Weight Reported?	Body Weight in kg	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
338	36389	Tatum et al, 2000	Copper chloride	100	Rat (*Rattus norvegicus*)	1	2	0/800	mg/kg diet	N	N	ADL	U	FD	6	w	NR	NR	JV	F	C	LAB	PTH	ORW	SMIX	LI	800		Y	0.165	N	0.015622	75.7		10	10	5	10	6	4	4	1	10	4	64
339	2216	McNatt et al, 1971	Copper (I) acetate	51.84	Rat (*Rattus norvegicus*)	1	2	0/0.2	% in diet	N	N	ADL	U	DR	4	w	4-11	mo	JV	M	C	COM	PTH	ORW	SMIX	LI	0.2		Y	0.356	N	0.039079	114		10	5	5	5	6	4	4	8	10	4	61
340	2216	McNatt et al, 1971	Copper (I) acetate	51.84	Rat (*Rattus norvegicus*)	1	2	0/0.2	% in diet	N	N	ADL	U	DR	4	w	4-11	mo	JV	M	C	COM	GRO	GRO	BDWT	WO	0.2		Y	0.356	N	0.039079	114		10	5	5	5	6	8	4	8	10	4	65
341	2126	Hebert, 1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	5	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	15	d	6	w	JV	B	C	LAB	BEH	FDB	FCNS	WO	16000		Y	0.0236	Y	0.0040	690		10	10	5	10	7	4	4	1	10	4	65
342	2127	Hebert et al, 1993	Copper (II) sulfate	39.81	Rat (*Rattus norvegicus*)	5	6	0/32/64/129/259/551	mg/org/d	N	N	ADL	U	FD	92	d	6	w	JV	B	C	COM	BEH	FDB	FCNS	WO	551		Y	0.275	N	0.023773	798		10	10	5	10	6	4	4	1	10	4	64
343	2126	Hebert, 1993	Copper (II) sulfate pentahydrate	25.45	Mouse (*Mus musculus*)	6	6	0/1000/2000/4000/8000/16000	mg/kg diet	N	N	ADL	U	FD	13	w	6	w	JV	B	C	LAB	BEH	FDB	FCNS	WO	16000		Y	0.0268	Y	0.0050	1188		10	10	5	10	7	4	4	1	10	4	65
344	2127	Hebert et al, 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	4	6	0/168/362/773/1154/2817	mg/org/d	N	N	ADL	U	FD	15	d	6	w	JV	B	C	COM	PTH	ORW	ORWT	MT	2817		Y	0.0236	N	0.003159	47519		10	10	5	10	6	4	4	1	10	4	64
345	2127	Hebert et al, 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	6	6	0/173/382/736/1563/3201	mg/org/d	N	N	ADL	U	FD	92	d	6	w	JV	B	C	COM	BIO	CHM	FECO	SP	3201		Y	0.0264	N	0.003464	48270		10	10	5	10	6	1	4	1	10	4	61
346	2127	Hebert et al, 1993	Copper (II) sulfate	39.81	Mouse (*Mus musculus*)	6	6	0/173/382/736/1563/3201	mg/org/d	N	N	ADL	U	FD	92	d	6	w	JV	B	C	COM	BEH	FDB	FCNS	WO	3201		Y	0.0264	N	0.003464	48270		10	10	5	10	6	4	4	1	10	4	64
347	36201	Gopinath and McC. Howell, 1975	Copper sulfate pentahydrate	25.45	Sheep (*Ovis aries*)	1	2	0/30	mg/kg bw/d	N	N	DLY	U	DR	55	d	NR	NR	AD	F	C	COM	PTH	HIS	GHIS	KI		30	N	73	N	4.705717		7.64	10	5	5	10	10	4	4	10	3	4	65
348	2307	Thompson and Todd, 1976	Copper acetate	100	Sheep (*Ovis aries*)	1	2	0/250	mg/kg diet	N	N	NR	U	FD	1	mo	NR	NR	MA	NR	C	DOM	BIO	ENZ	GLRE	ER		250	N	65.1	N	2.126769		8.17	10	10	5	5	5	1	4	10	3	4	57
349	3755	Olson et al, 1984	Copper	100	Sheep (*Ovis aries*)	1	2	0/257	mg/kg diet	N	N	DLY	M	FD	140	d	4-13	yr	AD	F	C	DOM	BIO	ENZ	GENZ	BL		257	N	65.1	N	2.126769		8.40	10	10	10	4	5	1	4	10	3	4	61
350	36321	Ozcelik et al, 2003	Copper	100	Rat (*Rattus norvegicus*)	1	2	0/100	mg/L	N	N	ADL	U	DR	4	w	NR	NR	JV	M	C	LAB	BIO	CHM	GBCM	PL		100	Y	0.21	N	0.024301		11.6	10	5	5	4	6	1	4	10	10	4	59
351	1717	Bataineh et al, 1998	Copper chloride dihydrate	37.28	Rat (*Rattus norvegicus*)	1	2	0/1000	mg/L	N	N	ADL	U	DR	12	w	NR	NR	AD	M	V	LAB	PTH	GRS	BDWT	WO		1000	Y	0.33067	N	0.036567		41.2	10	5	5	10	6	4	4	10	3	4	61
352	1717	Bataineh et al, 1998	Copper chloride dihydrate	37.28	Rat (*Rattus norvegicus*)	1	2	0/1000	mg/L	N	N	ADL	U	DR	12	w	NR	NR	AD	M	V	LAB	BEH	BEH	AGGT	WO		1000	Y	0.33067	N	0.036567		41.2	10	5	5	10	6	4	4	10	3	4	61
353	2225	Myers et al, 1993	Copper (I) acetate	51.84	Rat (*Rattus norvegicus*)	1	2	0/0.125	% in diet	N	N	DLY	U	DR	6	w	NR	mo	JV	M	C	LAB	PTH	HIS	GHIS	LI		0.125	Y	0.261	N	0.029554		73.4	10	5	5	5	6	4	4	10	10	4	63
354	2225	Myers et al, 1993	Copper (I) acetate	51.84	Rat (*Rattus norvegicus*)	1	2	0/0.125	% in diet	N	N	DLY	U	DR	6	w	NR	mo	JV	M	C	LAB	BIO	CHM	PHPH	LI		0.125	Y	0.261	N	0.029554		73.4	10	5	5	5	6	1	4	10	10	4	60
355	2047	Chesta et al, 1989	Copper (II) sulfate	39.81	Guinea pig (*Cavia porcellus*)	1	2	0/0.185	% in diet	N	N	NR	U	DR	45	d	NR	NR	GE	F	C	LAB	BIO	CHM	GBCM	PL		0.185	N	0.9	N	0.090044		73.7	10	5	5	10	5	1	4	10	10	4	64
356	2216	McNatt et al, 1971	Copper (I) acetate	51.84	Rat (*Rattus norvegicus*)	1	2	0/0.2	% in diet	N	N	ADL	U	DR	4	w	4-11	mo	JV	M	C	COM	BIO	ENZ	ACPH	LI		0.2	Y	0.356	N	0.039079		114	10	5	5	5	6	1	4	10	10	4	60

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

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