Appendix B. Chlorothalonil Ecological Effects Characterization

This appendix presents additional details on available registrant-submitted and open literature studies available on chlorothalonil and its major degradate of toxicological concern, SDS-3701. Studies submitted to the Agency in support of pesticide registration or re-registration are categorized as either; acceptable, supplemental, or invalid. Acceptable means that all essential information was reported, the data are scientifically valid, and the study was performed according to recommended protocols. Studies in the "acceptable" category fulfill the corresponding data requirement in 40 CFR Part 158 and are appropriate for use in risk assessment. Supplemental studies are also scientifically valid; however, they were either performed under conditions that deviate from recommended guideline protocols or certain data necessary for complete verification are missing. Supplemental studies may be used quantitatively in the risk assessment and can, at the Agency's discretion, fulfill the corresponding data requirement in 40 CFR Part 158. Invalid studies are not scientifically valid, or deviate substantially from recommended protocols such that they are not useful for risk assessment. Invalid studies do not fulfill the corresponding data requirement in 40 CFR Part 158.

With respect to the open literature, studies may be classified as either; qualitative, quantitative, or invalid. The degree to which open literature data are quantitatively or qualitatively characterized is dependent on whether the information is directly correlated with the assessment endpoints (i.e., maintenance of the survival, reproduction, and growth of the California red-legged frog and PCEs of their designated critical habitat identified in the problem formulation). Open literature studies classified as qualitative are not appropriate for quantitative use but are of good quality, address issues of concern to the risk assessment, and, when appropriate, are discussed qualitatively in the risk characterization discussion. Those open literature studies that are classified as quantitative are appropriate for quantitative use in the risk assessment including calculation of RQs. This appendix includes registrant-submitted studies in addition to studies identified in the open literature. In general, effects data in the open literature that are more conservative than the registrant-submitted data or that add to the weight of evidence on the toxicity to under-represented species or taxa are considered for quantitative use. Open literature studies that were either rejected by ECOTOX or that were not considered in this assessment are in Appendix H. Those appendices also include rationale for rejection of studies that did not pass the ECOTOX screen and those that were not evaluated as part of this endangered species assessment. Further detail on the ECOTOX exclusion categories is provided in the Agency's *Guidance of the*

Evaluation Criteria for Ecological Toxicity Data in the Open Literature (U.S. EPA, 2004).

B.1 Toxicity to Birds, Reptiles, and Terrestrial Phase Amphibians

No studies in reptiles or terrestrial phase amphibians have been submitted to the Agency or were located in the open literature. Therefore, birds were used as surrogates for terrestrial phase amphibians. Acute oral, subacute dietary, and chronic reproduction toxicity studies for birds are discussed in Sections B.1.1 through B.1.3. All avian studies described below are registrant-submitted studies. No additional information on the acute, subacute, and/or chronic toxicity of chlorothalonil or SDS-3701 to birds was located in the open literature that suggests greater sensitivity than the registrant submitted data. In addition, no relevant information on the toxicity of chlorothalonil and/or SDS-3701 to reptiles and/or terrestrial-phase amphibians was located in the open literature.

B.1.1 Birds: Acute and Subacute Studies

Chlorothalonil

An acute oral toxicity study using the technical grade of the active ingredient (TGAI) is required to establish the toxicity of chlorothalonil to birds. The preferred test species is either mallard duck (*Anas platyrhynchos*; a waterfowl) or bobwhite quail (*Colinus virginianus*; an upland gamebird). Results of these studies are summarized below in Table B.1-1 and B.1-2. These studies suggest that chlorothalonil is practically non-toxic to birds on an acute basis.

Table B.1-1. Avian Acute Oral Toxicity Findings for Chlorothalonil

Test Species	% a.i.	LD_{50} mg/kg	Citation (MRID)	Toxicity Category	Fulfills Guideline?
Mallard	96%	> 4640	00068753	Practically non-toxic	Yes
Japanese quail	Tech.	> approx. 2000	40964105	Practically non-toxic	Supplemental

Table B.1-2. Avian Subacute Dietary Toxicity Findings for Chlorothalonil					
Test Species	**% a.i.**	**LC_{50} ppm**	**Citation (MRID)**	**Toxicity Category**	**Fulfills Guideline?**
Northern Bobwhite	96%	> 10,000	00030388	Practically non-toxic	Yes
Mallard	93.6%	> 21,500	00039146	Practically non-toxic	Yes
Mallard	96%	> 10,000	00030389	Practically non-toxic	Yes

SDS-3701

Acute avian LD_{50} data for the chlorothalonil degradate, SDS-3701, are summarized in Table B.1-3. These studies show that SDS-3701 is "moderately toxic" on an acute oral basis and "slightly toxic" on a dietary basis to the test birds on an acute basis. Sublethal effects were seen in some birds at the lowest test level with the mallard, including lethargy, depression, lost reaction to stimuli, lost coordination, and wing droop.

In an acute oral study (MRID 00030395), fourteen-day old mallard ducks were dosed with 46, 100, 215, 464, and 1000 mg/kg of technical SDS-3701. No deaths occurred in the control pens. The acute oral LD50 for SDS-3701 was 158 mg/kg, with 95% confidence limits of 125 to 201 mg/kg. The highest dose at which no deaths occurred was 46 mg/kg. All the birds died in the two highest dosing groups.

Table B.1-3. Avian Acute Oral and Subacute Dietary Toxicity Findings for SDS-3701					
Test Species	**% a.i.**	**Results**	**Citation (MRID #)**	**Toxicity Category**	**Fulfills Guideline?**
Mallard	SDS-3701 (87%)	LD_{50} = 158 mg/kg	00030395	Moderately toxic	Yes
Northern Bobwhite	SDS-3701 (87%)	LC_{50} = 1746mg/kg NOEL = 562 mg/kg	00115109	Slightly toxic	Yes
Mallard	SDS-3701 (87%)	LC_{50} = 2000 mg/kg	00115108	Slightly toxic	Yes

B.1.3 Birds: Reproduction Studies

Chlorothalonil

Avian reproduction studies using the TGAI are required because chlorothalonil is persistent (i.e., half-life exceeds 4 days in aerobic soils) and has multiple applications per growing season. The preferred test species are mallard duck and bobwhite quail. Results of these tests are summarized in Table B.1-4.

Table B.1-4. Avian Reproduction Findings of Chlorothalonil Exposure

Test Species	% a.i.	NOEL PPM	LOEL PPM	Endpoints affected	Citation (MRID #)	Fulfills Guideline ?
Bobwhite	Tech.	1000 (reprod.)	5000 (reprod.)	"Overt signs of toxicity and reduced reproduction" cited at 5000 ppm; "overt signs of toxicity, mortalities, and profound effects upon several reproductive parameters related to egg production, hatching success, and survival of hatchlings" cited at 10,000 ppm.	40964104	Yes
Bobwhite	Tech.	153	624	18% reduction in no. of eggs laid per hen.	45710218	Yes
Bobwhite	99.6	50 ppm	Not established. Highest level of 50 ppm did not cause impairment.	None	00041440	Supplemental
Mallard	Tech.	>10,000 (reprod.)	>10,000 (reprod.)	No reproductive effects cited at any test level (1000, 5000, 10,000 ppm)	40964102	Yes
Mallard	99.6	50 ppm	Not established. Highest	None	00041441	Suppleme

Table B.1-4. Avian Reproduction Findings of Chlorothalonil Exposure						
Test Species	**% a.i.**	**NOEL PPM**	**LOEL PPM**	**Endpoints affected**	**Citation (MRID #)**	**Fulfills Guideline ?**
			level of 50 ppm did not cause impairment.			ntal

In the most sensitive avian reproduction study (MRID 45710218) chlorothalonil was administered to bobwhite quail in the diet at nominal concentrations of 0 (negative control), 40, 160, or 640 ppm. Mean-measured concentrations were <1.5 (<LOD, control), 41, 153, and 624 ppm a.i., respectively. A treatment-related reduction in the number of eggs laid/hen and thus in the number of 14-day old survivors/hen were observed at the 624 ppm a.i. level. The number of eggs laid/hen was 62.0 for the control group, and 62.4, 68.9, and 51.0 for the 41, 153, and 624 ppm a.i. test groups, respectively. The number of 14-day old survivors/hen was 37.2 for the control group, and 42.8, 42.2, and 30.4 for the 41, 153, and 624 ppm a.i. test groups, respectively. Although not statistically significant, these findings were considered to be biological significance by the study authors and the study reviewers.

SDS-3701

Avian reproduction studies have also been required for SDS-3701. These studies are summarized in the following table. The most sensitive NOAEC was 50 ppm based on reduction in eggshell thickness. However, the relevance of this endpoint to terrestrial amphibians is questionable. Therefore, the NOAEC of 100 ppm was chosen for use in risk assessment.

Table B.1-5. Avian Reproduction Findings (SDS-3701)

Test Species	% SDS-3701	NOEL PPM	LOEL PPM	Endpoints affected	Citation (MRID)	Fulfills Guideline?
Mallard	99.6	50	100	Reduction in eggshell thickness seen at 100 ppm; at 250 ppm adult body weight, food consumption, and gonad development affected, as well as effects on numbers of eggs laid, embryonic development, eggshell thickness, hatchability, and hatching survival.	40729402	Yes
Bobwhite	99.6	100	250	Reduction in numbers of eggs laid	40729404	Yes

B.2 Toxicity to Mammals

Wild mammal testing is required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use patterns, and pertinent environmental fate characterisitics. For this assessment, registrant-submitted reproduction toxicity data obtained from the Agency's Health Effects Division (HED) was used. Acute and chronic toxicity data for mammals is presented in Sections B.2.1 and B.2.2, respectively.

B.2.1 Mammals, Acute

Chlorothalonil

Acute mammalian toxicity studies for chlorothalonil are summarized in Table B.2-2. The available mammalian data indicate that chlorothalonil is "practically non-toxic" to small mammals on an acute oral basis, based on the rat oral LD_{50}.

Table B.2-1 Mammalian Acute Toxicity Findings--Chlorothalonil					
Test Species	**% a.i.**	**LD50**	**Citation (MRID #)**	**Toxicity Category**	**Fulfills guidelines?**
Rat (small mammal surrogate)	96%	Oral >10,000	MRID 00094941	practically non-toxic	Yes

SDS-3701

Data on the toxicity of SDS-3701 to mammals are tabulated below. These data indicate that the degradate SDS-3701 is more toxic to mammals than the parent chlorothalonil, and is moderately toxic on an acute oral basis.

Table B.2-2 Mammalian Acute Toxicity Findings--SDS-3701				
Test Species	**LD_{50} mg/kg**	**Comments**	**Citation (MRID #)**	**Toxicity Category**
Rat (small mammal surrogate)	242 (females)	The LD50 for males was 422 mg/kg-bw and was 332 for the combined sexes	MRIDs MRID 00047938, 00047939, and 00095783	moderately toxic

B.2.2 Mammals, Reproduction Studies

Chlorothalonil

When available, 2-generation reproduction toxicity studies are used to estimate chronic risk to mammals. In a two-generation study, Sprague Dawley rats were administered chlorothalonil (98%) in the diet at levels of 0, 500, 1500 or 3000 ppm (0, 38, 115 and 234 mg/kg/day). For parental/systemic toxicity, the NOAEL was less than 500 ppm (<38 mg/kg/day). The LOEL was 500 ppm (38 mg/kg/day) based on hyperplasia of renal and forestomach tissues. For offspring toxicity, the NOEL was 1500 ppm (115 mg/kg/day) and the LOEL was 3000 ppm (234 mg/kg/day) based on lower neonatal body weights by day 21 (MRID 41706201).

Test Species	Offspring NOAEL	Offspring LOAEL	Citation (MRID)	Fulfills Guidelines?
Rat (2 generation reproduction)	1500 ppm	3000 ppm decrease in pup weight	41706201C	Yes

SDS-3701

Data on the toxicity of the SDS-3701 degradate to mammalian reproduction are tabulated below. In a 1-generation reproduction study in Sprague-Dawley rats, SDS-3701 was administered at 0, 10, 20, 30, 60, or 120 ppm (approximately 0, 0.5, 1.0, 1.5, 3.0 or 6.0 mg/kg/day). For parental systemic toxicity, the NOEL was 1.5 mg/kg/day and the LOEL was 3.0 mg/kg/day. No ecologically relevant reproductive or offspring toxicity occurred at up to the highest level tested (MRID 00127845).

In a 3-generation reproduction study in Sprague-Dawley rats, SDS-3701 was administered at 0, 10, 60 or 125 ppm (approximately 0, 0.5, 3.0 or 6.25 mg/kg/day). No ecologically relevant reproductive or offspring toxicity occurred at up to the highest level tested, 6.25 mg/kg/day (MRID 00127844).

Test Species	Reproduction NOAEL	Reproduction LOAEL	Citation (MRID #)
Rat (3-generation reproduction)	120 ppm	None	00127844
Rat (1-generation reproduction)	125 ppm	None	00127845

B.2.3 Mammals: Open Literature

Based on a review of the open literature, no additional information on the acute or chronic toxicity of chlorothalonil or SDS-3701 to mammals was located that produced more sensitive endpoints relevant to ecological risk assessment.

B.3 Toxicity to Non-Target Terrestrial Invertebrates

B.3.1 Honey Bee Acute Contact Study

Hhoney bee acute contact LD_{50} study is required if the proposed use will likely result in exposure to honey bees. The available acute contact toxicity findings for chlorothalonil are summarized in Table B.3-1. The available data suggests that chlorothalonil is practically non-toxic to honey bees.

Table B.3-1: Non-target Insect Acute Contact Toxicity Findings

Test Species	% a.i.	Results	Citation (MRID)	Toxicity Category	Fulfills Guideline?
Honey bee	Tech.	at 181 ug/bee, 14.28% mortality	00036935	Practically non-toxic	Yes
Honey bee	Tech.	non-toxic at 181 ug/bee	00077759	Practically non-toxic	Yes

In addition, a number of studies were located in the open literature that evaluated the toxicity of chlorothalonil to terrestrial invertebrates (Table B.3-2). The available data suggest that sensitive terrestrial invertebrates exist, but many of the species tested were not sensitive to chlorothalonil at the levels tested, which typically approximated maximum labeled application rates.

Table B.3-2: Nontarget Invertebrate Acute Contact Toxicity Findings from the Open Literature

Test Species	Material Tested	Results Summary	Citation ECOTOX#	Comment
Aphid endoparasitoid wasp *(Aphidius rhopalosiphi*)	Daconil 500 Flowable (50% a.i.)	NOEL =1250 g a.i./ hectare (1.1 lbs a.i./Acre;	64665 (Jansen, 1999)	Chlorothalonil was considered "slightly harmful" to *A. rhopalosiphi.* Endpoints evaluated included mortality and reproduction
Earthworms and arthropods	Daconil 2787	NOAEL = 12.6 kg (AI)/ha (11.25 lbs a.i./acre)	71484 (Potter et. al. 1990)	Endpoint studied was abundance and biomass
Carabidae	Daconil (54% a.i.)	NOAEL = 8.2 kg a.i./ha (7.3 lbs a.i./Acre)	89639 (Smitley and Rothwell, 2003)	Transient reduction in abundance occurred after the first week of treatment.
		No reduction in		--

Test Species	Material Tested	Results Summary	Citation ECOTOX#	Comment
Onion Thrips *Thrips tobaci*	Bravo 500	abundance occurred at an application rate of 4.5 pints/acre (approx. 2.3 lbs a.i./Acre).	90255 (Al-Dosari et.al 1996)	
Corn earworm; fall armyworm	Bravo 720	Dietary exposure to the fall armyworm and corn earworm at 800 ppm and higher resulted in high mortality rates.	90193 (Lynch, 1996)	--
Mustard beetle (*Phaedon cochleariae*)	Jupital	No significant effects on survival.	90531 (Cherry et. al. 1992)	--
Rove Beetle (*Aleochara bilineata*)	Daconil 500 (50%)	No effects occurred at levels reportedly equivalent to maximum application rate.	63488 (Samsoe-Petersen, 1995)	Effects evaluated included reproduction, egg production and viability.
Predatory mite (*Amblyseius victoriensis*)	Bravo	<10% mortality at up to 10-times the reported maximum field rate	67984 (James et.al. 1995)	--
Aphid Predatory Midge (*Aphidoletes aphidimyza*)	Repulse	Mortality was approximately 10% in larvae after 72 hours at 1100 mg a.i./L.	89884 (Helyer, 1991)	Test level was reportedly equivalent to the maximum labeled application rate.
Aphareta pallipes E. muscae Delia antique D. platura *Coenosio tigrina*	Bravo 6 F	LC50 = 7.83% 100% mortality at 0.0054% No effects to these species were observed at any test level	71029 (Carruthers et. al. 1985)	Cups sprayed with various concentrations of chlorothalonil from 0.0054% to 10.8%.

B.4 Toxicity to Freshwater Animals

B.4.1 Freshwater Fish, Acute Submitted Data

In order to establish the toxicity of a pesticide to freshwater fish, the minimum data required on the technical grade of the active ingredient are two (one cold water and one warm water) freshwater fish toxicity studies. The freshwater fish acute toxicity findings for the technical grade of the active ingredient are summarized in the Table B.4-1. The registrant submitted studies are consistent with each other and indicate that chlorothalonil is very highly toxic to freshwater fish.

Table B.4-1: Freshwater Fish Acute Toxicity Findings					
Test Species	**% a.i.**	**LC_{50} ppb a.i.**	**Citation (MRID #)**	**Toxicity Category**	**Fulfills Guideline?**
Rainbow trout	96	42.3	00056486	very highly toxic	Supplemental
Rainbow Trout	96	18	45710219	very highly toxic	Yes
Bluegill	96	60	00041439	very highly toxic	Yes
Bluegill	99	84	00029410	very highly toxic	Yes
Bluegill	98	51	RIOCHL01 Pitcher (1976)	very highly toxic	Yes
Channel catfish	96	48	00030390	very highly toxic	Yes
Fathead minnow	96	23	00030391	very highly toxic	Yes

The most sensitive LC50 value for registrant-submitted freshwater fish studies was from MRID 45710219. In this study Rainbow Trout (*Oncorhynchus mykiss*) were exposed under flow-through conditions to chlorothalonil at nominal concentrations of 0 (negative and solvent controls), 0.010, 0.018, 0.032, 0.056, and 0.10 ppm. Mean-measured concentrations were ≤0.0004 (≤LOD, solvent control), 0.0085, 0.0177, 0.0357, 0.0491, and 0.0739 ppm a.i., respectively. Following 96 hours of exposure, cumulative mortality was 0% in control groups and 0, 60, 90, 100, and 100% in the 0.0085, 0.0177, 0.0357, 0.0491, and 0.0739 ppm a.i. treatment groups, respectively. The 96-hour LC_{50} (with 95% C.I.) was 0.018 (0.013-0.023) ppm a.i., which classifies chlorothalonil as very highly toxic to Rainbow Trout (*Oncorhynchus mykiss*) on an acute toxicity basis. Swimming and/or hanging at the surface, lethargy, loss of equilibrium, and/or moribundity were observed in surviving fish from the ≥0.0177 ppm a.i. groups; effects were first observed within 6 hours of exposure and continued through 96 hours in groups with surviving fish. The NOEC (for mortality and sub-lethal effects) was 0.0085 ppm a.i.

B.4.2 Freshwater Fish, Open Literature Data

Acute LC50s reported in the open literature are summarized in Table B.4-2. One study (Davies and White, 1985) located in the open literature reported an LC50 that was more sensitive than the most sensitive registrant submitted studies. Davies and White (1985) reported an LC50 of 10.5 ppb in rainbow trout. The most sensitive rainbow trout LC50 from registrant submitted studies was 18 ppb (MRID 45710219), which is similar to the LC50 reported by Davies and White (1985) of 10.5 ppb. Although the LC50 of 10.5 ppb was from a study that used low oxygen levels, the oxygen levels utilized did not affect

controls and were not outside values commonly found in the environment. Therefore, an LC50 of 10.5 ppb was chosen for use in risk estimation.

Table B.4-2: Freshwater Fish Lethal Effect Studies from the Open Literature

Test Species	LC_{50} ppb a.i.	Citation (MRID or Ecotox No.)	Toxicity Category	Comment
Jollytail	16	Ecotox No. 87454	very highly toxic	--
Spotted mountain galaxias	19 – 29	Ecotox No. 87454	very highly toxic	Tested species has not been evaluated in registrant submitted studies.
Threespine stickleback	69	Ecotox No. 7055	very highly toxic	Tested species has not been evaluated in registrant submitted studies.
Rainbow trout	10.5 - 76	Ecotox No. 87454; 7055	very highly toxic	The 10.5 ug/L value is the most sensitive acute LC50 available and is consistent with the range of LC50s in rainbow trout. 10.5 ug/L was chosen for use in risk quotient calculations. Study used an oxygen level of 50%; however, controls were not affected by the low DO, and the oxygen levels are not outside of the range expected to occur in the environment.
Tilapia	100 - 120	Ecotox No. 229772	highly toxic	--

A number of studies were also located in the open literature that evaluated sublethal endpoints such as biochemical endpoints. These studies did not report more sensitive toxicity values on endpoints that are correlated with assessment endpoints (survival and reproduction).

B.4.3. Toxicity of Formulated Products:

Formulated product testing is specified for products with direct application to aquatic habitats and for typical end-use products where the EEC for the active ingredient is $\geq$ LC_{50}. The previous Phase IV Review (1/12/93) specified further testing of a 54% ai flowable concentrate due to a cranberry use. The freshwater fish acute toxicity findings for the 54%, 75%, and Bravo W-75 formulations are summarized in Table B.4-3. The data suggest that studies using chlorothalonil products were of similar toxicity than studies using technical grade chlorothalonil.

Table B.4-3: Freshwater Fish Acute Toxicity Findings—Formulated Products				
Test Species	**% a.i.**	**LC_{50} ppb formulation**	**Citation (MRID #)**	**Toxicity Category (FP)**
Rainbow trout	54 (Bravo 720)	61 (33.2 ppb ai)	43302101	very highly toxic
Bluegill	54 (Bravo 720)	49 (26.3 ppb ai)	42433804	very highly toxic
Rainbow trout	75	152 (114 ppb ai; 48-hr study)	00087304	highly toxic
Rainbow trout	75	103 (77.2 ppb ai)	00087303	highly toxic
Bluegill	Bravo W-75	167 (125 ppb ai)	00087258	highly toxic

B.4.4. Toxicity of SDS-3701

Testing using the degradate SDS-3701 has been previously specified due to its persistence in water. Freshwater fish acute toxicity findings for the degradate SDS-3701 are summarized in Table B.4-3. These studies show that SDS-3701 is "slightly toxic" to the bluegill and therefore is significantly less toxic than parent chlorothalonil.

Table B.4-4: Freshwater Fish Acute Toxicity Findings—SDS-3701

Test Species	**% SDS-3701**	**LC_{50} (ppb)**	**Citation (MRID #)**	**Toxicity Category**
Bluegill	not avail.	45,000	00029415	slightly toxic
Bluegill	99	15,000	00030393	slightly toxic

B.4.5. Freshwater Fish, Chronic Submitted Data

Data from fish early life-stage testing is required for chlorothalonil since it can be expected to be transported to water from the intended use site, acute LC_{50} values are less than 1 mg/L, and aquatic EECs are $\geq$ 0.01 of LC_{50}s. The fish early life stage data are summarized in Table B.4-5.

In an early life-stage study in fathead minnows (MRID 00030391), fish were exposed to chlorothalonil at 0, 0.6, 1.4, 3.0, 6.5, and 16 ppb under flow-through conditions. Exposure at 16 and 6.5 ppb chlorothalonil produced adverse effects on egg production and on the survival. Specifically, the hatching success in the control groups averaged

between 90% and 92.5% compared with 79.5% at 6.5 ppb and 46.5% at 16 ppb. The percent survival of the Fo generation in the control groups averaged 94% compared with 9% at 16 ppb. The results indicate that fathead minnow hatching success and survival were affected between 3 and 6.5 ppb.

Table B.4-5. Chronic Fish Toxicity Findings

Test Species	% a.i.	NOAEL (ppb)	LOAEL (ppb)	Citation (MRID #)	Endpoints Affected
Fathead minnow	96	3	6.5	00030391	Hatching success and survivability

B.4.7. Effects to Amphibians

No relevant data on terrestrial or aquatic phase amphibians were located in the open literature or were submitted by chlorothalonil registrants.

B.4.8. Freshwater Invertebrates, Acute Submitted Data

Registrant submitted freshwater invertebrate toxicity studies for technical grade chlorothalonil are summarized in Table B.4-6. Two studies in daphnids were submitted that reported consistent results. The lowest EC50 was 54 ppb (MRID 45710221).

Table B.4-6: Freshwater Invertebrate Toxicity Findings

Test Species	% a.i.	LC_{50} (ppb)	Citation (MRID #)	Toxicity Category	Fulfills Guideline?
Daphnia magna	Tech.	68	00068754	very highly toxic	Yes
Daphnia magna	Tech.	54	45710221	very highly toxic	Supplemental

B.4.9. Freshwater Invertebrates, Open Literature Data

Table B.4-7 summarizes the information available from the open literature. The data found in the open literature are not inconsistent with the registrant submitted studies; however, the only species tested in registrant submitted studies was the daphnid. Acute studies in several additional species were located in the open literature, which are summarized in Table B.4-7.

Table B.4-7: Freshwater Invertebrate Acute Effect Studies from the Open Literature

Study type / Test material	Test Organism (Common and Scientific Name) and Age and/or Size	Test Design	Endpoint Concentration in ppb	Citation (ECOTOX #)	Rationale for Use in Risk Assessment[(1)]
Acute (48 hr) Bravo 500 (40% a.i.)	Water flea (Daphnia magna) adult egg-bearing	Static Renewal; 4 treatment levels; 2 replicates, one fed and one not fed; algal food source	LC50 = 129 (95% CI 84-174) EC50 = 97 (95% CI 81-113)	Ernst et. al. 1991 (7055)	Qualitative. EC50 is not more sensitive than the lowest registrant-submitted study. Results based on nominal chlorothalonil levels.
Acute: Lethal and Sublethal 4 and 7 day values reported ≥ 98% a.i.	Giant Tasmanian Freshwater Crayfish (*Astacopsis gouldi*)	Flow through; 4 and 7 day values reported; 5 treatment levels	LC50 = 12.0 (7.9-18.1) 4 Day LC50 = 3.6 (2.1-6.0) 7-Day value	Davies et. al 1994 (64835)	Quantitative (acute lethal studies only)
Acute: Lethal and Sublethal 4 and 7 day values reported ≥ 98% a.i.	Amphipod (*Neoniphargus sp. A*)	Flow through; 4 and 7 day values reported; 5 treatment levels	LC50 = >40 (4 and 7 Day)	Davies et. al 1994 (64835)	QUAL The LC50 value was above the highest test concentration.
Acute: Lethal and Sublethal 4 and 7 day values reported ≥ 98% a.i.	Isopod (*Colubotelson chiltoni minor*)	Flow through; 4 and 7 day values reported; 5 treatment levels	LC50 = >40 (4 and 7 Day)	Davies et. al 1994 (64835)	QUAL The LC50 value was above the highest test concentration.
Acute: Lethal and Sublethal 4 and 7 day values reported ≥ 98% a.i.	Freshwater aytid shrimp Parataya australiensis	Flow through; 4 and 7 day values reported; 5 treatment levels	LC50 = 16 (14.4-17.9) 4-Day LC50 = 10.9 (9.1-13.1) 7-Day	Davies et. al 1994 (64835)	Quantitative (acute lethal data). The LC50 value is definitive and bounded by a 95% confidence interval. Study design appears adequate.

Toxicity of Formulated Product: The freshwater invertebrate toxicity findings for formulated product testing are summarized in the following table.

Table B.4-8: Freshwater Invertebrate Toxicity Findings—Formulated Product

Test Species	% a.i.	LC_{50} (ppb) formulation	Citation (MRID #)	Toxicity Category (FP)	Fulfills Guideline? (for FP tested)
Daphnia magna	54 (Bravo 720)	180 (97; ai) Probit slope = 7.9	42433806	highly toxic	Yes

Toxicity of SDS-3701: The freshwater invertebrate toxicity findings for the degradate, SDS-3701, are summarized in the following table. The data indicate that SDS-3701 is slightly toxic to aquatic invertebrates.

Table B.4-8: Freshwater Invertebrate Toxicity Findings—SDS-3701

Test Species	% SDS-3701	EC_{50} (ppb)	Citation (MRID #)	Toxicity Category	Fulfills Guideline?
Daphnia magna	99	26,000 Probit slope = 5.75	00030394	slightly toxic	Yes (for SDS-3701)

In MRID 00030394, the acute toxicity of SDS-3701 was evaluated in daphnids. Procedures used in this acute toxicity test were based on EPA protocols specified in "Methods for Acute Toxicity Tests with Fish, MAcroinvertebrates, and amphibians (U.S.EPA, 1975). Acetone was used as asolvent and in a solvent control. Nominal concentrations were 10, 15. 22. 32,46, 68 and 100 mg/L (ppm) and were tested in triplicate. The 48-hour EC50 for Daphnids exposed to SDS-3701 was calculated to be 26 ppm with 95% confidence limits of 21 to 31 ppm. The lowest concentration at which 100% mortality occurred was 68 ppm, while highest concentration in which there were no deaths was 10 ppm.

B.4.6 Freshwater Invertebrate, Chronic Submitted Data

The aquatic invertebrate life-cycle toxicity findings are summarized in the following table.

Table B.4-9: Aquatic Invertebrate Life-Cycle Toxicity Findings

Test Species	NOEL (ppb)	LOEL (ppb)	Citation (MRID #)	Endpoints Affected	Fulfills Guideline?
Daphnia magna	39	79	00115107	survival, cumulative numbers of offspring/ female	Yes
	0.6	1.8	45710222	Survival	

In the most sensitive chronic study in aquatic invertebrates (MRID 45710222), the 21-day-chronic toxicity of chlorothalonil to *Daphnia magna* was studied under static renewal conditions. Nominal concentrations were 0 (negative and solvent controls), 0.0010, 0.0032, 0.010, 0.032, and 0.10 ppm. Mean-measured concentrations were <0.0001 (<LOD, solvent control), 0.00060, 0.0018, 0.0058, 0.019, and 0.075 ppm a.i., respectively. However, chlorothalonil was unstable under the static renewal conditions employed in this test, declining to less than the level of detection to 62% of nominal concentrations in expired test media. Because chlorothalonil concentrations declined to < the level of detection at the lower concentrations, there is considerable uncertainty in the chlorothalonil levels associated with toxic effects in this study.

After 21 days of exposure, cumulative adult mortality/immobility was 7% for both control groups, and 5, 25, 40, 55, and 60% in the 0.00060, 0.0018, 0.0058, 0.019, and 0.075 ppm a.i. treatment groups, respectively. There was a significant inhibitory effect on reproduction (number of live young/adult) at the 0.075 ppm a.i. test level. The total number of live young produced per adult was at least 40 for the control through 0.019 ppm a.i. test groups, and was 31 for the 0.075 ppm a.i. group. No dead young were observed during the study in any test group, and the number of unhatched eggs per adult was <1 for all control and test groups. Terminal growth measurements were not performed. The NOAEC for survival was 0.6 ug/L (0.0006 mg/L).

B.5 Toxicity to Non-target Terrestrial Plants

B.5.1 Non-Target Terrestrial Plants: Submitted Data

The required tier 1 plant toxicity data are summarized in Table B.5-1.

Table B.5-1: Nontarget Terrestrial Plant Toxicity Findings

Study	% a.i.	Results (lb ai/A)	Citation (MRID #)	Fulfills Guideline?
Seed germination/seedling emergence--Tier 1 (122-1A); 10 species	97.9	NOEL ≥ 16	42433808	Yes
Vegetative vigor--Tier 1 (122-1B); 10 species	97.9	NOEL ≥ 16	42433809	Yes

B.5.2 Non-Target Terrestrial Plants: Open Literature Data

Based on a review of the open literature, no additional information was located that indicates greater non-target terrestrial plant sensitivity to chlorothalonil than the submitted data. Studies located in the open literature were predominantly efficacy studies (i.e., studies that evaluated effects of chlorothalonil on fungal diseases) or were studies that did not elicit adverse effects to plants.

B.5.3 Aquatic Plants: Registrant Submitted Data

Available aquatic plant toxicity data summarized in Table B.5-2. The most sensitive aquatic plant species from registrant studies was the diatom with an EC50 of 14 ppb.

Table B.5-2: Nontarget Aquatic Plant Toxicity Findings

Test Species	% a.i.	Results (ppb)	Citation (MRID #)	Meets Guideline Requirements
Freshwater Vascular Plant Duckweed (*Lemna gibba*)	TGAI	Number of fronds EC50 = 730 ppb (670-800ppb Probit slope = 8.08 Biomass (dry weight) EC50 = 630 ppb (550-730ppb) Probit Slope = 5.3 NOEC 290ppb	44908102	The only DER available is a contractor version. The contractor classifies this study as core.
Freshwater non-vascular plant. *Selenastrum capricornutum*	97.9	EC_{50} = 190 NOEC = 50 LOEC = 100 Slope = 4.027 95% CI 1.34-6.71	42432801	Yes

Test Species	% a.i.	Results (ppb)	Citation (MRID #)	Meets Guideline Requirements
Freshwater non-vascular plant. (Diatom) *Navicula pelliculosa*	TGAI	EC50 = 14 ppb (12-17 ppb) Probit slope = 4.49 NOEC = 3.9 ppb	44908105	The only DER available is a contractor version. The contractor classifies this study as core.

B.5.3 Aquatic Plants: Open Literature Data

Aquatic plant studies located in the open literature are summarized in Table B.5-3. The most sensitive aquatic plant study was from Mezcua et al. (2002), which reported a 72-hour EC50 of 6.8 ppb in *Selenastrum capricorotum*. This study reportedly followed OECD 201.

Table B.5-3: Aquatic Plant Toxicity Tests (Laboratory)

Study type/ Test material	Test Organism (Common and Scientific Name)	Test Design	Endpoint Concentration / Results	Citation (ECOTOX)	Study Classification[(1)]
30% SC	Green Algae *Scenedesmus obliqnus*	Laboratory bioassay	EC50 = 100 ppb	65723 (Ma et. al., 2001)	QUAL
30% SC	Green Algae *Chlorella pyrenoidosa*	Laboratory bioassay	EC50 = 8069 ppb		QUAL
Tech.	Green Algae *Selenastrum capricorotum*	Laboratory bioassay using Toxkit Algaltoxkit™ (Creasel Belgium) a growth inhibition assay – study reportedly followed OECD 201.	72-hr EC50 = 6.8 ppb. The EC50 @ 30 h = 42,400ppb	80747 (Fernandez-Alba et. al., 2002) 80359 (Mezcua et. al. 2002)	QUAN.

[(1)] QUAL = The paper is not appropriate for quantitative use but is of good quality, addresses issues of concern to the risk assessment and is used in the risk characterization discussion.

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