Appendix F

Ecological Effects Data

Table F-1 Acute Toxicity of Oxyfluorfen to Freshwater Fish								
Species	**% A.I.**	**96-hr LC_{50}, (µg/L) (95% confidence interval)**	**Probit Slope**	**NOAEC (µg/L)**	**Study Characteristics**	**Toxicity Classification**	**MRID**	**Status**
Bluegill (*Lepomis macrochirus*)	71.4	210 (175, 346)	NA	93	Measured, Static	Highly toxic	421298-01 (Graves and Smith 1991)	Acceptable
Bluegill (*Lepomis macrochirus*)	94.0[a]	203 (182, 232)	4.38 (3.27, 5.50)	56	Nominal, flow-through	Highly toxic	38574 (Bentley 1976)	Acceptable
Rainbow trout (*Oncorhynchus mykiss*)	71.4	250 (186, 355)	2.38 (1.61,3.15)	37	Measured, static	Highly toxic	421298-02 (Graves and Smith 1991)	Acceptable
Rainbow trout (*Oncorhynchus mykiss*)	94.0[a]	402 (323, 512)[b]	6.09 (2.97, 9.21)	180	Nominal, flow-through	Highly toxic	38574 (Bentley 1976)	Acceptable
Channel catfish (*Ictalurus punctatus)*	74.0	400 (360, 450)	NA	180	Nominal, static	Highly toxic	134449 (Kuc and Cary 1977)	Acceptable

[a] Although the percentage a.i. was reported in this study at 94% active, this is unlikely for a study conducted in 1976. During this time frame, the percentage a.i. was typically 70-75%. The manufacturing process was later improved to provide technical oxyfluorfen at purities of 90-99%.
[b] Chi-square test indicated a poor fit to the probit model.

Table F-2 Chronic (Early-Life) Toxicity of Oxyfluorfen to Freshwater Fish							
Species	**% A.I.**	**NOAEC (µg/L)**	**LOAEC (µg/L)**	**Study Characteristics**	**Affected Endpoints**	**MRID**	**Status**
Fathead minnow (*Pimephales promelas*)	71	38	74	Measured, flow-through	Survival, total length, average weight	921360-57[a] (Dean 1979)	Acceptable
Fathead minnow (*Pimephales promelas*)	99.3	1.3	2.4	Mean measured, flow-through, conducted under UV lighting	Most sensitive (post-hatch survival, LC_{50} = 2.9 µg a.i./L; post-hatch physical/behavioral abnormalities) Other affected parameters (NOAEC = 2.4 µg a.i./L; hatching success, length, wet weight, dry weight)	465851-04 (Palmer *et al.* 2005)	Supplemental

[a]Also reviewed under 30249.

Table F-3 Acute Toxicity of Oxyfluorfen to Freshwater Invertebrates								
Species	**% A.I.**	**96-hr LC_{50}, (µg/L) (95% confidence interval)**	**Probit Slope**	**NOAEC (µg/L)**	**Study Characteristics**	**Toxicity Classification**	**MRID**	**Status**
Daphnia magna	82.2	48-hr LC_{50} = 1780 (1360, 2340)	2.05 (1.59, 2.51)	100	Nominal, static	Moderately toxic	134449	Acceptable
Daphnia magna	23.2 (Goal 2XL)	48-hr EC_{50} = 80 (60, 150)	NA	20	Measured, flow-through	Very highly toxic	452713-01	Supplemental
Chironomus tentans	19.5 (Goal 1.6E)	96-hr LC_{50} > 5.1 mg a.i./kg-sediment	NA	5.1 mg a.i./kg-sediment	Measured	NA	420480-01	Supplemental
Chironomus tentans	9.3	10-day LC_{50} > 97.6 mg a.i./kg-sediment	NA	55.7 mg a.i./kg-sediment	Measured, flow-through	NA	465851-02	Supplemental

Table F-4 Chronic (Life-cycle) Toxicity of Oxyfluorfen to Freshwater Invertebrates							
Species	**% A.I.**	**NOAEC (µg/L)**	**LOAEC (µg/L)**	**Study Characteristics**	**Affected Endpoints**	**MRID**	**Status**
Daphnia magna	71.8	13	28	Measured, flow-through	Growth (length), reproduction	421423-05 455502-01 (raw data)	Acceptable

Table F-5 Toxicity of Oxyfluorfen to Aquatic Plants							
Species	**% A.I.**	**96-hr EC_{50} (µg a.i./L) (95% confidence interval)**	**NOAEC (µg a.i./L)**	**Most Sensitive Endpoint**	**Study Parameters**	**MRID**	**Status/Comment**
Lemna gibba	99.3	0.35 (0.26, 0.47)	< 0.10 EC_{05} = 0.065 (0.048, 0.087)	Frond number	Static renewal, 14-day test, measured concentrations	458611-03 (Roshon 2002)	Supplemental (poor recovery of test chemical, typically < 60%)
Selenastrum capricornutum	23.2 (Goal 2XL)	0.29 (0.27, 0.30)	0.1	Cell density	Measured	452713-02 (Sutherland *et al.* 2000)	Acceptable
Pseudokirchneriella subcapitata (formerly *Selenastrum capricornutum*)	99.19	> 2.9	1.4	Cell density, area under the growth curve, growth rate	Study used an artificial sediment/humic acid system, Measured concentrations	455816-01 (Hoburg 1999)	Supplemental (non-guideline, study used an artificial sediment/humic acid system)
Selenastrum capricornutum	2.5 % oxyfluorfen and 41% glyphosate isopropylamine salt	0.213 (0.170, 0.275)	0.039	Area under the growth curve (biomass)	Measured, oxyfluorfen	459060-08 (Sutherland *et al.* 2001)	Acceptable (for end-use product containing oxyfluorfen and glyphosate, MON78095)
Anabaena flos-aquae	99.3	>101.3	20.1	Area under the growth curve (biomass)	Mean measured, 120-hr study	458611-04 (Roshon 2002)	Supplemental (poor recovery of test chemical, typically < 70%)
Navicula pelliculosa	99.3	29 (19, 43)	18.3	Cell density	Mean measured, 120-hr study	458611-05 (Roshon 2002)	Supplemental (poor recovery of test chemical, typically < 60%)

Table F-6 Avian Acute Toxicity to Oxyfluorfen						
Species	**% A.I.**	**Toxicity Endpoint**	**NOAEL or NOAEC**	**Toxicity Classification**	**MRID**	**Status**
Acute Single Oral Dose						
Bobwhite quail (*Colinus virginianus*)	70.1	LD_{50} > 2150 mg a.i./kg-bw (one mortality at highest dose)	< 1470 mg a.i./kg-bw	Practically non-toxic	921361-02[a]	Acceptable
Acute Dietary						
Bobwhite quail (*Colinus virginianus*)	70.2	LC_{50} > 5000 mg a.i./kg-diet, no mortality	625 mg a.i./kg-diet	Practically non-toxic	921361-03	Acceptable
Mallard duck (*Anas platyrhynchos*)	70.2	LC_{50} > 5000 mg a.i./kg-diet, no mortality	312 mg a.i./kg-diet	Practically non-toxic	921361-04	Acceptable
[a]Also reviewed under MRID 422559-01.						

Table F-7: Avian Chronic Toxicity to Oxyfluorfen						
Species	**% A.I.**	**NOAEC (mg a.i./kg-diet)**	**LOAEC (mg a.i./kg-diet)**	**Affected Endpoints**	**MRID**	**Status**
Northern bobwhite (*Colinus virginianus*)	72.5	< 50	50	Reduced wt of 14-day chicks	4153012-06	Supplemental
	99.3	124	256	Reduced wt of 14-day chicks, ratio of hatchling survival to number of hatchlings, viable embryos, live embryos, number of hatchlings, and ratio of hatchling survival to eggs set	460701-02	Acceptable
Mallard duck (*Anas platyrhynchos*)	72.5	100	>100	None observed	4153012-05	Supplemental
	99.3	506	751	Eggs laid, eggs set, viable embryos, the ratio of viable embryos to eggs set, live embryos, number of hatchlings, ratio of normal hatchlings to eggs set, and hatchling survival	460701-01	Acceptable

Table F-8 Mammalian Acute Toxicity to Oxyfluorfen					
Test Type	**% A.I.**	**Toxicity Endpoint**	**Toxicity Classification**	**MRID**	**Status[a]**
Acute Oral (rat)	96	LD_{50} > 5000 mg a.i./kg-bw no mortality or systemic toxicity observed	Practically non-toxic	447120-10	Acceptable
	97.1	LD_{50} > 5000 mg a.i./kg-bw no mortality or systemic toxicity observed	Practically non-toxic	448289-03	Acceptable
[a] Status (acceptability) based on HED's guidelines.					

Table F-9 Mammalian Subchronic Toxicity to Oxyfluorfen						
Test Type	**% A.I.**	**NOAEC (mg a.i./kg-diet)**	**LOAEC (mg a.i./kg-diet)**	**Affected Endpoints**	**MRID**	**Status[a]**
90-day oral-feeding (rat)	98.0	1500	6000	Decreased body weight, increased urine volume, decreased erythrocyte volume and Hb, increased relative liver wt	449331-01	Acceptable
90-day oral-feeding (rat)	72.5	< 800	$\leq$ 800	Increased liver wt, liver histology, adrenal histology	117601	Acceptable
90-day oral-feeding (rat)	72.0	200	1000	Brown livers and kidneys, increased relative liver wt, decreased thymus wt, liver and kidney histology	117603	Acceptable
90-day oral-feeding (mouse)	72.5	< 200	$\leq$ 200	Anemia, increased serum glutamate pyruvate transaminase enzyme, increased liver wt, liver histopathology	117602	Acceptable

[a] Status (acceptability) based on HED's guidelines.

Table F-10 Mammalian Developmental and Chronic Toxicity to Oxyfluorfen[a]					
Test Type	**% A.I.**	**NOAEL (mg/kg-bw/day)**	**LOAEL (mg/kg-bw/day)**	**Affected Endpoints**	**MRID**
Pre-natal developmental toxicity (rat)	98.0	Maternal $\geq$ 1000 Develop. $\geq$ 1000	Maternal > 1000 Develop. > 1000	None observed	449331-03
Pre-natal developmental toxicity (rat)	71.4	Maternal = 18 Develop. = 18	Maternal = 183 Develop. = 183	Maternal based on clinical signs Develop based on decreased fetal BW, vessel variations, bone deformities	418065-01
Pre-natal developmental toxicity (rabbit)	98.0	Maternal = 30 Develop. = 30	Maternal = 90 Develop. = 90	Maternal based on mortality, abortions, clinical signs Develop. based on increased late resorptions	449331-02
Pre-natal developmental toxicity (rabbit)	26.9 (WP formulation)	Maternal =10 Develop. = 30	Maternal = 30 Develop. = 90	Maternal based on decreased BW gain, clinical signs Develop. based on decreased litter size and increased early resorptions	94052
Test Type	**% A.I.**	**NOAEC (mg a.i./kg-diet)**	**LOAEC (mg a.i./kg-diet)**	**Affected Endpoints**	**MRID**
2-generation reproductive (rat)	71.4	Parental = 400 Repro. = 400	Parental = 1600 Repro. = 1600	Parental based on mortality, decreased BW, liver and kidney histopathology Repro. based on decreased BW, decreased live pups/litter	420149-01

[a] Status of all studies listed was acceptable, based on HED's guidelines.

Table F-11 Toxicity to Oxyfluorfen to Non-target Terrestrial Invertebrates					
Species	**% A.I.**	**Toxicity Endpoint**	**Toxicity Classification**	**MRID**	**Status**
Honey bee	71.4	LD_{50} > 100 µg/bee	Practically non-toxic	423681-01	Acceptable
Predaceous mite	42.09 (Goal 4F)	98% mortality at 1.28 lb a.i./acre	NA	452713-03	Supplemental
Predaceous mite	22.26 (Goal 2XL)	100% mortality at 1.29 lb a.i./acre	NA	459060-06	Supplemental
Parasitic wasp	22.26 (Goal 2XL)	100% mortality at 1.29 lb a.i./acre	NA	459060-03	Supplemental
Ground beetle	22.26 (Goal 2XL)	No significant reduction of survival or feeding rates at 1.29 lb a.i./acre	NA	459060-04	Supplemental
Spider	22.26 (Goal 2XL)	100% mortality at 1.08 lb a.i./acre	NA	459060-05	Supplemental
Earthworm	22.26 (Goal 2XL)	LC_{50} = 89 mg a.i./kg-dry soil NOAEC = 29 mg a.i./kg-dry soil (based on growth)	NA	459060-07	Supplemental
NA – Classification not assigned because the study is non-guideline.					

Table F-12 Non-target Terrestrial Plant Seedling Emergence and Vegetative Vigor Toxicity (Tier II) Data for Oxyfluorfen TGAI (71.5% Purity)[1]				
Crop	**Species**	**NOAEC (lb a.i./acre)**	**EC_{25} (lb a.i./acre)**	**Most Sensitive Endpoint**
Seedling Emergence				
Monocot	Corn	0.084	0.23	Shoot length
	Oat	0.0074	0.011	Shoot length
	Onion	0.0024	0.038	Shoot length
	Ryegrass	0.0024	0.0058	Shoot length
Dicot	Cabbage	0.0024	0.0026	Shoot length
	Carrot	0.0024	0.045	Shoot length
	Cucumber	0.0074	0.015	Shoot length
	Lettuce	0.0024	0.0027	Shoot length
	Soybean	0.31	1.3	Shoot length
	Tomato	0.012	0.015	Shoot length
Vegetative Vigor				
Monocot	Corn	0.14	0.095	Shoot weight
	Oat	0.10	0.0070	Root weight
	Onion	0.0071	0.0062	Shoot weight
	Ryegrass	0.0071	0.0087	Shoot weight
Dicot	Cabbage	0.0037	>0.0071	Shoot length & Shoot weight
	Carrot	0.034	0.027	Shoot weight
	Cucumber	0.0017	0.0017	Shoot weight & Root weight
	Lettuce	0.0035	0.014	Root weight
	Soybean	0.0017	0.012	Shoot weight
	Tomato	0.00066	0.00043	Shoot weight

[1]Data from MRID 416440-01 (supplemental).

Table F-13 Non-target Terrestrial Plant Seedling Emergence and Vegetative Vigor Toxicity (Tier II) Data for Oxyfluorfen TEP (Goal 2XL)

Crop	Species	NOAEC (lb a.i./acre)	EC_{25} (lb a.i./acre)	Most Sensitive Endpoint
Seedling Emergence[1]				
Monocot	Corn	0.128	0.324	Shoot dry weight
	Oat	0.032	0.091	Shoot dry weight
	Onion[b]	<0.016	0.0098[g]	Shoot dry weight
	Ryegrass	0.008	0.0062[f]	Shoot dry weight
Dicot	Cabbage	0.016	0.016	Shoot dry weight
	Radish	0.016	0.035	Shoot dry weight
	Cucumber[b]	0.128	0.155	Shoot dry weight
	Lettuce[b]	0.008[e]	0.0072[f]	Shoot dry weight
	Soybean	0.5	2.048	Shoot dry weight
	Tomato[b]	0.008	0.019	Shoot dry weight
Vegetative Vigor[2, c]				
Monocot	Corn	0.220[d]	0.577	Shoot dry weight
	Oat	0.22	0.267	Shoot dry weight
	Onion	0.00095	>1.866[b]	NA
	Ryegrass	0.0028	0.303[b]	Shoot dry weight
Dicot	Cabbage	0.00095	0.012	Shoot dry weight
	Radish	0.0028	0.0055[b]	Shoot dry weight
	Cucumber	0.023[d]	0.016	Shoot dry weight
	Lettuce	0.000035	0.0077[h]	Shoot dry weight
	Soybean	<0.00032	0.082	Shoot dry weight
	Tomato	<0.000035	0.112[b]	NA

[1]Data from MRID 458611-01 (acceptable).
[2]Data from MRID 458611-02 (acceptable).
[a]Data not suitable for model fit.
[b]Model a poor fit, based on goodness-of-fit test.
[c]NOAECs determined using Williams' test, unless otherwise noted.
[d]NOAEC determined using Wilcoxon rank-sum with Bonferroni correction.
[e]Potential hormesis based on treatment means; used Dunnett's test for NOAEC determination.
[f]Less than the lowest dose of 0.0080 lb a.i./acre (8.99 g a.i./ha).
[g]Less than the lowest dose of 0.016 lb a.i./acre (18 g a.i./ha).
[h]Although radish had a lower EC_{25} than lettuce, the fit of the radish dry weight data to the probit model was very poor based on a goodness of fit test. Therefore, lettuce was chosen as the most sensitive dicot.