UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

April 18, 2007

PC Code: 129121
DP Barcode: D338854

MEMORANDUM

SUBJECT: Updated Section 18 Ecological Risk Assessment for Fipronil Use to Control Cabbage Maggot in Turnip and Rutabaga.

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Attached is the EFED risk assessment for the Section 18 request from the Oregon Department of Agriculture for in-furrow use of fipronil (Regent® 4SC) on rutabaga and turnips. This risk assessment represents an update to the 2005 risk assessment for the same Section 18 use. The updates reflect: (1) completion of the search and analysis of available effects data from ECOTOX as summarized in the February 2007 combined Risk assessment for fipronil, (2) Assessment of risk quotients for a single year use, and (3) additional analysis regarding run-off buffer and alternative application rate effects on the distributions of risk quotients calculable from the entire time series of the PRZM/EXAMS model output for water concentrations associate with a use pattern involving a 3-year rotation of crop and fipronil application. The proposed application of

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fipronil will be a single, in-furrow, at-plant application rate of 0.13 lbs ai./A (0.1456 kg ai/ha). The total acreage for rutabagas and turnips is not expected to exceed 600 acres. Therefore, the total amount of fipronil to be applied should not exceed 78 lbs fipronil for the Section 18. The Section 18 will be limited to Clackamas, Marion, Multnomah, and Umatilla counties in Oregon.

The risk assessment indicates that in-furrow use of fipronil, formulated as REGENT 4SC, is likely to pose acute lethal and reproduction risks to birds from ingestion of fipronil residues in seeds and invertebrates exposed at the time of pesticide application. Moreover, residues accumulated in terrestrial invertebrate food items from treated soil and residues in incidentally consumed soil in treatment areas may also pose acute risks to small birds foraging on treated fields following application of the pesticide. Similar concerns for reproduction effects in insectivorous mammals are also suggested by the results of the risk assessment. Fipronil and its degradates, while not exceeding acute or chronic toxic levels of concern for freshwater fish, are of concern for acute and chronic effects to freshwater invertebrates. Estuarine and marine species were not evaluated in this risk assessment owing to the proposed locations of use not occurring in proximity to such habitats.

The environmental fate data indicate that fipronil and its degradates have a moderate soil sorption affinity and moderate to high persistence in terrestrial and aquatic environments. Because fipronil residues exhibit a high environmental persistence, there is a high potential for accumulation in terrestrial and aquatic environments. Accumulation of fipronil residues (particularly fipronil degradates) is likely to result in long-term exposure. In-furrow application of fipronil, however, is expected to limit exposure, which is expected to reduce direct exposure to fipronil and to reduce the potential for fipronil movement in run-off waters.

While some preliminary assessment have been completed with respect to endangered species, comprehensive effects determinations for such species as the salmonids has not been completed at this time.

Fipronil
Environmental Fate and Ecological Effects Assessment and Characterization for Section 18 Registration of In-Furrow Applications to Rutabaga and Turnips

I. EXECUTIVE SUMMARY

EFED calculated terrestrial animal and freshwater aquatic animal and plant risk quotients for the proposed in-furrow, at plant use of fipronil on rutabaga and turnips. Estimated fipronil and selected degradate exposures for aquatic invertebrates exceed Agency levels of concern for acute and chronic effects to Federally listed threatened and endangered species (listed species) and non-listed species. No concerns for direct effects to aquatic plants or freshwater fish are identified by the risk assessment. While no acute effects in mammals are identified as a concern, there is concern for reproduction effects in insectivorous small mammals consuming terrestrial invertebrates directly treated at the time of pesticide application. Concerns for birds extend to acute and chronic effects to listed and non-listed species from consuming pesticide residues in seeds and invertebrates directly treated with the pesticide at the time of application as well as consumption of invertebrates accumulating the pesticide from treated soil in the case of small birds in the 20 g in size category. A shift from upper bound residue assumptions to mean values does not appreciably alter concerns for avian risk. However, exposures to mammals, under the assumption of mean pesticide residues in food items, are below levels triggering concern.

As has been the case for a number of fipronil use scenarios in the past, the environmental fate profile of the chemical and its degradates suggest a concern for the potential accumulation of residues both on the field and in sediments of surface waters receiving these compounds with runoff from treated areas.

II. PROBLEM FORMULATION

Nature of the Chemical Stressor

This Section 18 screening level risk assessment addresses the ecological impacts from at plant, in-furrow uses of fipronil (5-amino-1-(2,6-dichloro-4-(trifluoromethyl)phenyl)-4-((1,R,S)-(trifluoromethyl) sulfinyl)-1-H-pyrazole-3-carbonitrile) on turnips and rutabagas in Oregon. Fipronil is a phenylpyrazole insecticide (CAS #: 120068-37-3, PC Code: 129121). Under the proposed Section 18, Regent 4SC® will be used as the formulation (40% active ingredient) for in-furrow applications at an application rate of 0.13 lbs ai./A (0.1456 kg/ha). It is applied into seed furrows as a solid stream after dissolving in water and liquid fertilizer. The Section 18 is limited to Clackamas, Marion, Multnomah, and Umatilla counties of Oregon, which are not associated with estuarine areas in the state. The target insect is the cabbage maggot.

Fipronil affects the gamma-aminobutyric acid neurotransmission system by interfering with the passage of chloride . In addition, research data indicate that fipronil displays a higher potency in the insect GABA chloride channel than in the vertebrate GABA chloride channel which may indicate selective toxicity (Hainzl and Casida, 1996).

Fipronil is moderately persistent to persistent ($t_{1/2}$= 128 to 300 days) and relatively immobile (mean K_{oc} 727 ml/g) in terrestrial environments. Major routes of dissipation appear to be dependant on photodegradation in water, microbially-mediated degradation, and soil binding.

Fipronil degrades to form MB46136 and RPA 200766 in aerobic soil metabolism studies. MB46513 is a major degradate in photolysis studies however the soil surface photolysis half-life of 149 days suggests that this photodegradate is not rapidly produced in terrestrial systems. MB45950 appears to be predominantly formed under low oxygen conditions from microbial-mediated processes. These degradates appear to be persistent and relatively immobile in terrestrial and aquatic environments. Field dissipation studies confirm the persistence and relative immobility of fipronil and its degradates. Available toxicity data suggest that both parent fipronil and the degradates MB46136, MB46513, and MB45950 are of toxicological concern.

III. CONCEPTUAL MODEL

Chemical Stressors Considered in the Risk Assessment

This risk assessment considers parent fipronil and the degradates MB46136, MB46513, and MB45950. However, available exposure tools limit the extent to which degradates are considered in all terrestrial risk assessment scenarios. For example, this screening-level risk assessment does not address the contribution of fipronil degradates when exposure is modeled as residues in seeds and soil invertebrates present on the field at the time of application. However, degradates are considered for terrestrial exposures modeled as mass of applied material per unit area, and in the risk discussion when accumulation in soil invertebrates from soil is considered. In addition, the long soil surface photolytic half-life of fipronil suggests that the photodegradate MB46513 will not readily be produced in terrestrial systems to an extent that terrestrial food items will contain appreciable levels of this degradate.

Receptors

This screening level risk assessment approaches the analysis for adverse effects through the use of broad plant and animal taxonomic groups including:

- Birds (also used as surrogate for terrestrial-phase amphibians and reptiles),
- Mammals,
- Freshwater fish (also used as a surrogate for aquatic phase amphibians),
- Freshwater invertebrates (including sediment-dwelling species),
- Algae and vascular aquatic plants

Because the Section 18 is limited to non-estuarine counties, the following taxonomic groups are not addressed in this risk assessment:

- Estuarine/marine fish,
- Estuarine/marine invertebrates

This risk assessment will evaluate effects to Federally-listed threatened and endangered (listed species) and non-listed species associated with the above taxonomic groups.

It is important to note that this screening-level risk assessment does not address risks to terrestrial plants. Currently, terrestrial plant testing is not required for pesticides other than herbicides except on a case-by-case basis (*e.g.*, labeling shows phytotoxicity warnings incident data or literature that demonstrate phytotoxicity). This policy has been applied to the data requirements for fipronil and consequently, no terrestrial plant effects data are available to quantify potential risks of any fipronil use on non-target plants. While the in-furrow application of the pesticide is expected to reduce drift to such an extent that off-site transport by this route is inconsequential., there remains the potential for off site transport to terrestrial plants via surface runoff. Though not quantitatively assessed in this document, there is insufficient information available to preclude a potential for risks to terrestrial plants at this time

It is also important to note that this screening level risk assessment does not address risks to non-target beneficial insects. The rationale for exclusion of these insects from the assessment is based on the expectation that pesticide exposure pathways to these insects are incomplete. The pesticide is used at-planting and so will not involve application of the pesticide to crop plant when they would be attractive to beneficial insects. Moreover, the in-furrow application of the pesticide is expected to reduce drift to such an extent that off-site transport by this route is inconsequential.

Exposure Pathways Considered for Terrestrial Animals

For the purposes of this risk assessment, terrestrial non-target animals are assumed to occupy the treated field and areas immediately adjacent to treated fields. These organisms are assumed to obtain their diet exclusively from treated areas. A number of exposure pathways extending from the point of pesticide release to non-target terrestrial animals are possible and include the following (note: bulleted items with * are quantitatively considered as individual pathways in this risk assessment):

- Direct impingement of pesticide spray on wildlife dietary items and subsequent consumption of these food items by wildlife*;
- Spray contamination of surface soil and subsequent consumption of soil incidental to feeding/preening activities*;
- Spray contamination of surface soil and subsequent dermal contact with soil by wildlife;
- Spray contamination of surface soil, bioaccumulation of pesticide from soil in vegetative or animal matter and subsequent ingestion of these items by feeding wildlife*;
- Spray contamination of surface soil and vegetation, volatilization of the pesticide from these surfaces, and subsequent inhalation by wildlife;
- Inhalation of applied pesticide spray droplets at the time of application;
- Direct application of spray droplets to wildlife skin;
- Incidental contact of wildlife skin with dislodgeable residues from directly sprayed soil and vegetative surfaces as well as pesticide in contaminated water sources
- Wildlife ingestion of pesticide contaminated drinking water from directly sprayed puddles, puddles in contact with treated soil, or dew formed on treated surfaces.

From this list it is evident that a number potentially complete pathways are not addresses on a specific quantitative manner in this risk assessment. However, the risk assessment does include a more general exposure approach that assesses risk on the basis of total potential availability of the pesticide from all possible exposure pathways (i.e., an exposure based on pesticide mass applied to a square foot of treated field).

Exposure Pathways Considered for Aquatic Organisms

In this risk assessment, aquatic organisms (animal and plant) are assumed to occupy surface water bodies immediately adjacent to treated fields. A number of pathways from the application of the pesticide to surface water bodies are possible and include the following (note: bulleted items with * are quantitatively considered as individual pathways in this risk assessment:

- Deposition of drifted spray application the surface water body
- Partitioning of pesticide from treated soil to runoff water emptying into the surface water body
- Erosion of treated soil particles with runoff emptying into the surface water body.

Once a pesticide is released to the surface water body, aquatic organisms may be exposed via the following routes (note: bulleted items with * are quantitatively considered as individual pathways in this risk assessment):

- uptake of the pesticide dissolved in surface water across the gill surface, body integument, or plant membranes*;
- uptake of the pesticide dissolved in sediment pore water across the gill surface and body integument*;
- uptake of the pesticide associated with sediment solids across the gut*;
- uptake of the pesticide concentrated in food items (plant and animal) across the gut of animal consumers

Assessment Endpoints

Assessment endpoints for this screening-level pesticide ecological risk assessments are reduced survival and reproductive impairment for both aquatic and terrestrial animal species from both direct acute and direct chronic exposures. These assessment endpoints, while measured at the individual level, provide insight about risks at higher levels of biological organization (e.g., populations). It is assumed that toxicant do not affect populations or communities except through the impact on the individuals comprising the population or community and the demographics of birth, growth, and death that govern population dynamics. The number of individuals within a population change (intrinsic rate of increase) primarily because of births (fecundity) and deaths (survival) and secondarily from migration in and out of a specific area. If effects on the survival and reproduction of individuals are limited, it is assumed that risks at the population level from such effects will be of minor consequence. However, as the risk of reductions in survival and/or reproduction rates increase, the greater the potential risk to populations.

For aquatic plants, this risk assessment is concerned with the maintenance and growth of standing crop or biomass. Measurement endpoints for this assessment focus on algal growth rates and biomass measurements as well as similar measurements for vascular plants.

Measures of Effects and Exposure

Because this screening-level risk assessment is conducted on a broad taxonomic basis, measurement endpoints for both exposure and effects are generically derived and applied across those taxonomic groups.

Exposure Measures

Exposures estimated in the screening-level risk assessment for non-target organisms are likewise not specific to a given species. Aquatic organism (plant and animals) exposures are based on a set of standardized water body assumptions (water body size, watershed size, proximity to field, etc.) that result in high-end estimates of exposure. The measurement endpoints for this risk assessment are the single day peak, 21-day, and 60-day average water concentrations with a 1 in 10 year return frequency.

Estimates of exposure for terrestrial birds and mammals assume that animals are in the treatment area, and exposure estimates involve grouping taxa based on food preferences (e.g., obligate insectivores, herbivores, granivores) and generic weight classes. Because the risk assessment involves an in-furrow application of the pesticide at planting, direct deposition of the pesticide to seeds and invertebrates at the time of application, is used as an exposure measurement endpoint for the dietary route for birds and mammals feeding on recently treated fields. In addition, the mass of pesticide applied per square foot of treatment area was also used as an overall exposure measure of available pesticide for potential wildlife exposure. Finally, the risk description section describes the potential for pesticide in soil to accumulate in terrestrial invertebrates as a wildlife dietary source and as an incidental soil ingestion source. In both cases an instantaneous at time of application concentration in soil serves as the measure of exposure.

Effects Measures

This screening-level risk assessment relies on a suite of toxicity studies performed on a limited number of organisms in the following broad groupings (organisms in parentheses capture the available tested species in the data set for fipronil and its degradates considered in this risk assessment):

- Birds (mallard duck, bobwhite quail, pigeon, red-legged partridge, ringed-neck pheasant, and house sparrow) used as surrogate for terrestrial-phase amphibians and reptiles,
- Mammals (laboratory rat),
- Freshwater fish (bluegill sunfish, rainbow trout, and channel catfish) used as a surrogate

for aquatic phase amphibians,

- Freshwater invertebrates (*Daphnia magna, Chironomus tentans, C. teperi, Procambarus clarkii*),
- Estuarine/marine fish (sheepshead minnow),
- Estuarine/marine invertebrates (*Crassostrea virginica* and *Mysidopsis bahia*),
- Algae and aquatic plants (*Navicula pellicosaLemna gibba, Skeletonema costatum, Anabaena flos-aquae, and Selenastrum capricornutum*)

Within each of these very broad taxonomic groups, an acute and a chronic endpoint have been selected from the available test data. Short-term exposure measurements of growth, mobility, and lethality and longer term exposures and measures of growth, development, and reproduction are considered. The selection of appropriate endpoints is made from the most sensitive species tested within a given taxonomic group. The contributing data and the final selection of effects endpoints are summarized in the effects characterization portion of the Analysis section of this document

Risk Hypothesis

The risk hypothesis for this screening-level risk assessment is that fipronil, used in accordance with the proposed Section 18 label, results in adverse effects upon survival and reproduction of non-target terrestrial and freshwater aquatic animals; and survival and growth of aquatic, semi-aquatic, and terrestrial plants.

IV. ANALYSIS

Environmental Fate and Transport Assessment

Fipronil dissipation appears to be dependent on photodegradation in water, microbially mediated degradation, and soil binding. Data indicate that fipronil is relatively persistent and immobile in terrestrial environments. In aquatic environments, a determination of the environmental behavior of fipronil is more tentative because soil and aquatic metabolism studies provide contradictory data on fipronil persistence to microbially mediated degradative processes. Photolysis is expected to be a major factor in controlling fipronil dissipation in aquatic environments. Fipronil degrades to form persistent and immobile degradates. These degradates are considered in the HED dietary tolerance expression for fipronil. Since fipronil and its degradates have a moderate to high sorption affinity to organic carbon, it is likely sorption on soil organic matter will limit fipronil residue movement into ground and surface waters. However, fipronil residue may have the potential to move in very vulnerable soils (e.g., coarse-textured soils with low organic matter content). In-furrow fipronil applications are expected to limit runoff potential.

Abiotic Degradation

The chemical degradation of fipronil appears to be dependent predominately on photodegradation in water and, to a lesser extent, on alkaline-catalyzed hydrolysis. Fipronil is stable ($t_{1/2} > 30$

days) in pH 5 and pH 7 buffer solution and hydrolyzes slowly ($t_{1/2}$=28 days) in pH 9 buffer solution. The major hydrolysis degradate is RPA 200766 (5-amino-3-carbamoyl-1-(2,6-dichloro-4-trifluoromethylphenyl)-4-trifluoro-methanesulfinyl pyrazole. Photodegradation of fipronil is a major route of degradation (photodegradation in water half-life=3.63 hours) in aquatic environment. In contrast, fipronil photodegradation on soil surfaces (dark control corrected half-life=149 days) does not appear to a major degradation pathway. Major photolysis products of fipronil are MB 46513 (5-amino-3-cyano-1-(2,6-dichloro-4-trifluoromethyl-phenyl)-4-trifluoro-methylpyrazole 350, and RPA 104615 (5-amino-3-cyano-1-(2,6-dichloro-4-trifluoro methyl phenyl) pyrazole-4-sulfonic acid).

Biotic Degradation

Fipronil degradation in terrestrial and aquatic systems appears to be controlled by slow microbially-mediated processes. In aerobic mineral soil, fipronil is moderately persistent to persistent ($t_{1/2}$= 128 to 300 days). Major aerobic soil degradates (>10% of applied of fipronil) are RPA 200766 and MB 46136 (5-amino-1-(2,6-dichloro-4-trifluoro methylphenyl)-3-cyano-4-trifluoromethyl-sulphonyl-pyrazole). Minor degradates (<10% of applied fipronil) are MB 45950 (5-amino-1-(2,6-dichloro-4-trifluoromethylphenyl)-3-cyano-4-trifluoro-methyl-thio-pyrazole) and MB46513. These degradation products are not unique soil metabolism degradation products. Fipronil degraded ($t_{1/2}$=14.5 days to 35 days) under stratified redox aquatic/sediment systems. Fipronil also is moderately persistent (anaerobic aquatic $t_{1/2}$ = 116-130 days) in anoxic aquatic environments. Major anaerobic aquatic degradates are MB 45950 and RPA 200766. Supplemental aerobic aquatic metabolism data indicate that fipronil degradation ($t_{1/2}$=14 days) is rapid in aquatic environments with stratified redox potentials. These data contradict the longer fipronil persistence reported in anaerobic aquatic and aerobic soil studies.

Mobility

Fipronil has a moderate sorption affinity (K_f=4.19 to 20.69 ml/g; 1/n= 0.938 to 0.969; K_{oc}= 427 to 1248 ml/g) on five non-United States soils. Fipronil sorption appears to be lower (K_f< 5 ml/g) on coarse-textured soils with low organic matter contents. Desorption coefficients for fipronil ranged from 7.25 to 21.51 ml/g. These data suggest that fipronil sorption on soil is not a completely reversible process. Since the fipronil sorption affinity correlates with soil organic matter content, fipronil mobility may be adequately described using a K_{oc} partitioning model. Soil column leaching studies confirm the immobility of fipronil.

Environmental Fate of Fipronil Degradates

Conclusions regarding the environmental fate of fipronil degradates, except MB 46513, are more tentative because they are based on a preliminary review of interim data, not a formal evaluation of a fully documented study report. Since discernable decline patterns for the fipronil degradates were not observed in metabolism studies, the degradates are assumed to be persistent ($t_{1/2}$≈700 days) to microbially mediated degradation in terrestrial and aquatic environments. However, the fipronil degradate, MB46136, rapidly photodegrades ($t_{1/2}$=7 days) in water. Radiolabelled MB

46513, applied at 0.1 µg/g, had an extrapolated half-life of 630 or 693 days in loamy sand soils when incubated aerobically in the dark at 25°C. The major metabolite of MB 46513 was RPA 105048 (5-amino-3-carbamoyl-1-(2,6-dichloro-4-trifluoromethylphenyl)-4-trifluoromethylsulfonyl pyrazone).

Fipronil degradation products have relatively low potential mobility because of a moderate to high sorption affinity to soil organic matter. Organic carbon partitioning coefficients for fipronil degradates can range from 1150 to 1498 ml/g for MB 46513, 1619 to 3521 ml/g for MB 45950, and 1448 to 6745 ml/g for MB 46136. The high sorption affinity of fipronil degradates is expected to limit movement into ground and surface water.

Soil Field Dissipation

Terrestrial field studies confirm observations of the relative persistence and immobility of fipronil residues in laboratory studies. Fipronil, formulated as a 1% granular, had half-lives of 1.1 to 1.5 months on bare ground in North Carolina (NC) and Florida (FL), 0.4 to 0.5 months on turf in NC and FL, and 3.4 to 7.3 months for in-furrow applications on field corn in California (CA), Nebraska (NE), NC, and Washington (WA). Fipronil, formulated as 80WG and applied foliar spray at 0.3 lbs ai/A, had a field dissipation half-life of 159 days on a cotton site in California, 30.2 days on cotton site in Washington, and 192 days on a potato site in Washington.

The fipronil degradates MB 46136, MB45950, and RPA 200766 were detected in the field studies for in-furrow and turf uses. The degradate MB46513 was detected during field trails with the foliar spray. Fipronil residues were predominately detected in the 0 to 15 cm soil depth at all test sites. However, there was detection of fipronil, MB 45950, MB 46136 and RPA 200766 at a depth of 15 to 45 cm for in-furrow treatments on coarse sandy loam soil in Ephrata, Washington. Although the field dissipation half-life of individual residues was not reported, the half-life of combined fipronil residues (including fipronil, MB 46136, MB 46513, MB 45950, and RPA 200766) ranged from 9 to 16 months.

The bioconcentration factor for radiolabelled fipronil was 321X in whole fish, 164X in edible tissues, and 575X in non-edible tissues. Accumulated fipronil residues were eliminated (>96%) after a 14-day depuration period. Because fipronil exhibited a high depuration rate, fipronil is not expected to accumulate under flowing water conditions.

Aquatic Exposure Assessment (*see Appendix A for model output information*)

Tier II PRZM (version PRZM 3.12 beta) /EXAM (version 2.97.5) modeling using was conducted using the Oregon sweet corn scenario as surrogate runoff assessment. This scenario was selected because it is located in Marion County, OR, which is one of the counties listed in the Section 18 applications. Uncertainties in the surface water modeling are predominately associated with persistence of fipronil degradates in terrestrial and aquatic environments. Other uncertainties are associated with the formation efficiency of fipronil degradation products. Formation efficiencies were modeled according to the maximum percent formation observed in aerobic soil metabolism studies. Although higher degradate formation efficiencies were observed for MB46513 and MB45950 in other laboratory studies (photodegradation in water and anaerobic aquatic), these degradation pathways are not expected to be important in the soil furrow. It is important to note that the aquatic exposure modeling assumed a treatment once every three years for the given application site. This coincides with a rotational frequency of three years for the crops in question.

Modeling Parameters

The dissipation of fipronil in surface water should be dependent on photodegradation in water and, to a lesser extent, microbial-mediated processes. Since photolysis is a major route of degradation for fipronil, its dissipation is expected to be dependent on physical components of the water (*i.e.* sediment loading) which affect sunlight penetration. For example, fipronil is expected to degrade faster in clear, shallow water bodies than in murky and/or deeper waters. Since fipronil and its transformation products have moderate soil-water partitioning coefficients, binding to sediments may also be a route of dissipation.

The following data were used as input for the PRZM/EXAMS modeling of fipronil:

Parameter	Value	Source
Application rate	0.1456 kg/ha	REGENT 4SC
Soil K_{oc}	727 ml/g[1]	MRID 44039003
Aerobic soil half-life	128 days	MRID 42918663
Plotolysis Half-life	0.16 days	MRID 42918661
Hydrolysis pH 7	Stable	MRID 42194701
Aerobic Aquatic Half-life	33.7 days[2]	MRID 44661301, 44261909
Anaerobic Aquatic Half-life	33.7 days[2]	MRID 44661301, 44261909
Water solubility	2.4 mg/L	EFGWB one-liner

1- Mean Koc value

2-Represents the 90th percentile of the mean Aerobic aquatic and anaerobic aquatic metabolism half-lives were derived from redox-stratified, aerobic aquatic metabolism studies. Because redox potentials were stratified in the aerobic aquatic studies, the total system half-lives were used to represent the extent of fipronil degradation in both aqueous and sediment phases

EFED also conducted surface water modeling for the individual degradates including MB 46513, MB 46136 and MB45950. Environmental fate properties of the fipronil degradates are shown in the following table. The modeling was conducted assuming the maximum daily conversion efficiency for the compound was represented by the maximum percentage formed in the environmental fate laboratory studies. Degradate application was assumed to coincide with fipronil application. Because the fipronil degradates are formed through abiotic or biotic degradation pathways in soil and water, the degradates were assumed to have a 100% application efficiency on the soil surface. This approach for estimating degradate concentrations is expected to be conservative.

Fate Properties of Fipronil Degradates

Fate Parameter	MB 46136	MB 46513	MB 45950
Mean Koc	4208 ml/g	1290 ml/g	2719 ml/g
Aerobic Soil Metabolism Half-life	700 days	660 days	700 days
Aqueous Photolysis Half-life	7 days	Stable	Stable
Hydrolysis Half-life	Stable	Stable	Stable
Aquatic Metabolism Half-lives	1400 days	1320 days	1400 days
Water Solubility	0.16 mg/L	0.95 mg/L	0.1 mg/L
Single Row Spacing Application Rate (kg a.i./ha)	0.0349	0.0014	0.0072
References	**RP# 201555 ACD/EAS/Im/255 Theissen 10/97**	MRID 44262831 44262830 **Theissen 10/97**	**RP 201578 Theissen 10/97**

Concentrations, expressed as fipronil equivalents, are presented as individual concentrations and as cumulative fipronil residues. The cumulative residue approach assumes that fipronil and its degradation products have equal toxicity profiles.

Aquatic Exposure Measurement Values

Tier II PRZM-EXAMS model simulation of at plant, in-furrow application indicates the 1 in 10 year daily peak, 21 day average and 60-day average concentrations for fipronil are not likely to exceed 417 and 341, and 253 ng/L respectively (see following table).

Estimated Concentrations of Fipronil and its Degradation Products in the Standard Pond From In-furrow Turnip and Rutabaga Cropping Systems in Marion County, Oregon (ppt or ng L^{-1})

Chemical	Peak	96 Hour Average	21 Day Average	60 Day Average
Fipronil	357	330	258	218
MB46513[2]	6	6	5	3
MB46136[2]	61	54	35	21
MB45950[2]	14	12	8	5

2-Indicates year to year correlation prevented calculation of a 1 in 10 year concentration. Reported concentrations represent the concentrations in the first simulation year (1961).

Uncertainties in Modeling

A major uncertainty in the modeling was the use of an OR sweet corn scenario as a surrogate scenario for turnips and rutabagas. This scenario was selected because it represents an agricultural soil in Marion County, OR.

Another uncertainty is the half-life of fipronil and its degradates in aerobic aquatic environments. The aerobic aquatic metabolism data (MRID 44261909) indicate that fipronil has a half-life of 14.5 days in aerobic aquatic environments. These data appear to contradict the persistence of fipronil ($t_{1/2}$=128 to 308 days) in aerobic soil metabolism studies. The registrant has submitted additional aerobic aquatic data showing first-order half-life for fipronil was 16 days for Ongar and 35.62 days for Manningtree sediment/water systems (RPA Document 201604). Based on the available aerobic aquatic metabolism data, the 90th percentile aerobic aquatic half-life for fipronil is 33.7 days. It's important to note that the aerobic aquatic metabolism studies were conducted under stratified redox conditions which lead to the formation of MB45950, a toxic degradation product. This compound was predominately associated with the sediment phase. Similar formation patterns were not observed in the aerobic soil metabolism studies (MRID 42928663).

Tier II modeling indicates the individual residues contribute substantially to the summed residue concentration of fipronil. The concentration of MB 46513 is expected to be conservative because its application rate is base on a maximum degradate formation efficiency (1%) from aerobic soil metabolism study (MRID 42918663). Lower concentrations of MB 46513 have been detected in other environmental fate studies. MB 45950 had low concentrations in all environmental fate studies except for the aquatic metabolism studies. The highest conversion efficiency of MB45950 was not considered because it is associated with anoxic (anaerobic environments).

Surface Water Monitoring

Available monitoring data were taken from the several sources including a USGS presentation, registrant sponsored runoff studies, and rice monitoring studies. Although these studies provide some context on estimated environmental concentrations from fipronil use, the uses with the exception of in-furrow corn are not expected to be representative of the proposed in-furrow, at plant use on rutabagas and turnips.

The USGS found that most frequent detections (14 to 34%) of fipronil residues are associated with urban and integrated watersheds (Sandstrom and Madison, 2003). A maximum fipronil water concentration of 0.117 µg/L was detected in the integrated (mixed land use) watersheds. These detections may be associated with the above-ground uses of fipronil in turf for fire ant control in urban environment.

Preliminary results from registrant sponsored monitoring data in NC, FL, and TX show fipronil (applied as Chipco Topchoice®) concentrations in runoff from turf areas immediately post-application during high rainfall events. The maximum total fipronil water concentrations was 0.47 µg/L in an estuary at Gulf Breeze, FL. Fipronil residue concentrations in sediment were ≤ 0.1 µg/kg.

USGS monitoring studies in the southwestern LA rice growing region indicate that fipronil residues accumulated in bed sediment as fipronil sulfide (0.636 to 24.8 µg/kg), desulfiny fipronil (0.55 to 7.01 µg/kg), fipronil sulfone (ND to 10.5 µg/kg). Water concentrations of fipronil residues ranged from 0.829 to 5.29 µg/kg, which corresponded with the release of rice field water. (USGS, 2003)

Based on preliminary data from the Louisiana Department of Agriculture and Forestry from 23 monitoring sites in Calcasieu, Jefferson-Davis, Allen, Evangeline, Acadia, and Vermilion Parishes, the maximum water concentration of fipronil residues was 8.41 ug/l for fipronil, 1.96 ug/L for MB46513, 0.50 ug/L for MB46136, and 0.32 ug/L for MB45950 from March 6, 2000 to May 15, 2000. The detections frequencies (number of detection/total number of samples) were 85% for fipronil, 32% for MB46513, 11.7% for MB46136, and 6.9% for MB45950. Because the monitoring data were derived from presentation materials, the level of detail is insufficient to assess data quality.

The registrant (Aventis) has submitted surface water monitoring data for the Mermentau River and Lake Arthur (MRID 453499-01). The Mermentau River drains a large portion of the rice acreage in southern Louisiana from the mouths of Bayou Plaquemine and Bayou Nezpique. It should be noted this area does not have any community water systems using surface source water. The monitoring program was designed to provide a snapshot of concentrations on May 11, 1999 from 0-to-1 feet and 4 to 6 feet depth. Low rainfall was observed (0.5 inches) from March 14 to May 9, 1999. Point samples were taken using a 1 L beaker for surface samples at depth of 1 feet and PVC tube sample at 5.5 feet depth Samples were taken from 14 sampling points from the north to south including the mouth of the Bayou Plaquemine, mouth of the Bayou Nezpique, 10,8,6,4,2,1 miles north of Lake Arthur Bridge; Lake Arthur Bridge, and 1,2,3,4, and 5 miles south of Lake Arthur Bridge. The reviewer notes that sample preparation (e.g. filtering) is not described in the submission. Concentrations of Fipronil, MB46513, MB45950, and MB46136 in water were determined by LC/MS/MS method. The limit of detection (LOD) and limit of quantification (LOQ) were 0.004 ug/L and 0.010 ug/L, respectively. Recoveries from spiked water samples at 0.10 ug/L ranged from 86.4 to 105.4%.

The maximum water concentration of fipronil residues at the mouth of the Bayou Plaquemine were 2.118 ug/L for fipronil in the 4 to 6 feet sample, 1.004 ug/L for MB46513 in the 0 to 1 feet sample, 0.269 ug/L for MB45950 in the 0 to 1 feet sample, and 0.270 ug/L for MB46136 in the 0 to 1 feet sample. The maximum total fipronil residue (summation of fipronil,MB46513, MB45950, and MB46136) concentration was 3.509 ug/L. There was a slight decrease in concentration downstream from the mouth of Plaquemine river to 5 miles south of Lake Arthur (18 miles downstream); concentrations were 1.027 ug/L for fipronil, 0.343 ug/L for MB46513, 0.034 ug/L for MB45950, and 0.130 ug/L for MB46136.

Terrestrial Exposure Assessment

Terrestrial wildlife exposure estimates were calculated for birds and mammals using three methods.

The first method involves the calculation of mass of pesticide per square foot of treatment area. This approach assumes that exposure may occur through a variety of routes (e.g. dietary, inhalation, dermal, drinking water) and that all of the pesticide at the soil surface is bioavailable, emphasizing a dietary exposure route for uptake of pesticide active ingredients. These exposures were considered as surrogates for terrestrial-phase amphibians and reptiles. The estimated measure of fipronil exposure in this situation was calculated as follows and assumes 1% of applied pesticide at the soil surface for an in-furrow application:

$$((0.13 \text{ lb/acre} * 453592.4 \text{ mg/lb})/43560 \text{ ft}^2\text{/acre})\ 0.01 = 0.0135 \text{ mg/ft}^2$$

The degradates MB45950, MB46136, and MB46513 have been observed in treated soils at 5%, 24%, and 43% of the applied fipronil rate , respectively. Therefore, effective application rates for the two degrades may be conservatively estimated as follows:

$$\text{MB45950 mg/ft}^2 = (0.0135 \text{ mg/ft}^2)(0.05) = 0.000675 \text{ mg/ft}^2$$
$$\text{MB46136 mg/ft}^2 = (0.0135 \text{ mg/ft}^2)(0.24) = 0.00324 \text{ mg/ft}^2$$
$$\text{MB46513 mg/ft}^2 = (0.0135 \text{ mg/ft}^2)(0.43) = 0.00581 \text{ mg/ft}^2$$

The second approach involved estimation of pesticide concentrations in wildlife food items focusing on quantifying possible dietary ingestion of residues on vegetative matter and insects. The residue estimates were based on a nomogram that relates food item residues to pesticide application rate. The nomogram is based on an EPA database called UTAB (Uptake, Translocation, Accumulation, and Biotransformation), and is incorporated into the Agency model TREX, which serves as the basis for residue calculations, oral doses, and RQs. Because the use of fipronil involves an at-plant application scenario with in-furrow methods that minimize drift, the avian food items were limited primarily to seeds and insects present in the fields at the time of application. The following table provides the estimated concentrations in pertinent wildlife dietary sources:

Fipronil Concentrations in Wildlife Dietary Items Directly within Spray Zone on Field at Application Time (UTAB-based residue assumptions as indicated by TREX)

Application rate (lb ai/acre)	Wildlife food item	Upper bound Estimate of Pesticide Residue at 1 lb ai /acre (mg/kg-fw)	Upper Bound Estimate of Pesticide Residue at Application Rate (mg/kg-fw)*
0.13	Seeds, Large Insects	15	1.95
	Small Insects	135	17.55

* estimated residue @ 1 lb/acre X application rate = residue @ application rate

Additional exposure assessments for incidental ingestion of pesticide residues in soil and ingestion of pesticide accumulated in soil invertebrates are presented as part of the risk discussion in this risk assessment and are used to provide additional information relative to the exposures expressed as mass per unit area exposure model presented above.

Effects Characterization

Available Avian Effects Data

The following tables summarize the submitted acute and chronic toxicity data for avian wildlife. It should be noted that all studies are registrant submissions and found to be either acceptable or supplemental and therefore suitable for use in the risk assessment.

Comparison of parent fipronil and degradate single oral dose endpoints for the bobwhite quail suggests that the photodegradate MB46513 may be more toxic than the parent and that the other two major environmental degradates MB46136 and MB45950 are less toxic that parent fipronil. There is no evidence that formulated products are more toxic, on an active ingredient adjusted basis, that technical fipronil.

On first inspection the available acute oral dose data may suggest that fipronil is more toxic in gallinaceous birds (pheasants, quail grouse, etc.) than in other orders. However, the number of tested species within each order is very small (3 or less), precluding any definitive conclusion regarding any phylogenic relationship on sensitivity in birds.

Acute Oral Dose Toxicity Data for Birds				
Species	**Chemical**	**%A.I.**	**LD50 mg/kg-bw**	**MRID**
Northern bobwhite	fipronil	96	11.3	42918617
Mallard	fipronil	96.8	>2150	42918616
Pigeon	fipronil	97.7	>500	42918613
Red-legged partridge	fipronil	95.4	34	42918614
Pheasant	fipronil	95.4	31	42918615
House sparrow	fipronil	96.7	1000	42918618
Northern bobwhite	MB46513	99.7	5	43776601
Mallard duck	MB46513	98.6	420	43776602
Northern bobwhite	fipronil (1.6 WG)	1.6	1065	42918619

Dietary Acute Toxicity Data for Birds				
Species	**Chemical**	**%A.I.**	**LC50 mg/kg-diet**	**MRID**
Northern bobwhite	fipronil	95	48	42918620
Mallard duck	fipronil	95	>5000	42918621
Northern bobwhite	MB46513	97.8	119.2	45259201
Northern bobwhite	MB46513	97.8	<178	44920701
Northern bobwhite	MB46136	99.7	84	44890301
Northern bobwhite	MB45950	98.8	114	44890302

Reproduction Toxicity Data for Birds					
Species	**Chemical**	**%A.I.**	**LOEC mg/kg-diet**	**NOEC mg/kg-diet**	**MRID**
Northern bobwhite	fipronil	96.7	>10	10	42918622
Mallard duck	fipronil	96.7	>1000	1000	42918623

A search of the ECOTOX database identified additional data for fipronil administered via the diet to male red-winged blackbirds (*Agelaius phoeniceus* L) male and female brown-headed cowbirds (*Molothrus ater* Boddaert), and female boat-tailed grackles (Q*uiscalus major* Viellot) (Avery et al. 1998). Fipronil was added to a rice seed medium at 0, 325, and 500 mg a.i./kg. Birds were allowed to feed at will from open cups of the treated diet. No adverse toxicological effects were noted and no reduction in food consumption (p>0.05) was noted for any species and any dose group.

Calculation of Acute LD50 or Acute LC50 Ratios and Other Extrapolation Factors for Aquatic Organisms

From the data above it is evident that acute single oral dose studies are not available for MB45950 and MB46136. For the purposes of evaluating risks for these degradates, estimates for single oral dose LD50 values are necessary. EFED evaluated the relationship of the acute effects data (LD50:LC50) for bobwhite quail, the most sensitive species tested (LD50:LC50). The ration of LD50 to LC50 from these data is 0.235 (11.3/48). This value will be used to estimate LD50 values for MB45950 and MB46136, using the following equation LC50*0.235=Estimated LD50.

Available Mammalian Effects Data

The following table presents the available mammalian toxicity data for fipronil for acute oral dose and for reproduction endpoints

Toxicity Data for Mammals			
Species	**% AI**	**LD_{50} (mg/kg-bw)**	**MRID**
Rat	93%	LD_{50} (mg/kg-bw) 97 reproduction NOEC 30 mg/kg-diet effects: litter size and number of matings reproduction NOEL 2.64 mg/kg-bw	42918628 42918647
Rat	MB45950	LD_{50} (mg/kg-bw) 83	HED memo*
Rat	MB46513	LD_{50} (mg/kg-bw) 16	43235402
Rat	MB46136 (98%)	LD_{50} (mg/kg-bw) 218	42918675
Rat	1.6(form.) EXP60655A	LD_{50} (mg/kg-bw)>5000	42918636
Rat	0.25(form.) RM1601c	LD_{50} (mg/kg-bw)>5000	43121104

*Fipronil - Review of toxicity studies (28-day studies with fipronil and metabolite RPA 200766, a developmental neurotoxicity study with fipronil and a paper on the toxicological significance of fipronil and its metabolites). From V.A. Dobozy (Registration Branch 1/HED) to M. Johnson (RD), 8/6/1997.

Other Available Terrestrial Vertebrate Effects Data

Fipronil was administered by gavage or by contaminated diet in a single exposure event at 30 mg ai/kg body weight (Peveling and Demba 2003). By four weeks post treatment, 62.5% of the lizards feed treated diet and 42% of gavaged lizards died. In both tests survivors showed reduced feeding activity, food consumption, body weight, and liver or fat to body weight ratios. It is notable that these values suggest an LD50 on the order of 30 mg/kg-bw which is bracketed by available LD50 values for birds.

Available Terrestrial Invertebrate Data

The registrant submitted a summary of an extended laboratory contact toxicity test to evaluate the toxicity of fipronil residues on foliage to honeybees (MRID 44884101). Honeybees were exposed to bean cuttings treated with 25 g of fipronil 80wg for 72 hours. By 72 hours, mortality in treatments was 100% compared to 5 to 8.35 in controls.

Available Terrestrial Plant Effects Data

Currently, terrestrial plant testing is not required for pesticides other than herbicides except on a case-by-case basis (*e.g.*, labeling shows phytotoxicity warnings, incident data, or literature that demonstrate phytotoxicity). Continuous seedling exposure to fipronil (up to 25 days) at 4000 mg/L did not affect rice (*Oryza sativa*) seedling growth, but that 4-day exposure to 200 mg/L did produce reductions in seed germination (Stevens et al. 1999). Other data from the literature showed fipronil having no effect on biomass of peanuts (*Arachis hypogaea*) treated with fipronil at a rate of 0.025 lb/acre (Mulder 1997). This later study expresses effects information in units consisted with terrestrial plant exposure modeling and served as the basis for terrestrial plant risk assessment.

Available Aquatic Organism Effects Data

Freshwater and Estuarine/Marine Laboratory Studies

The next two tables present the available acute and chronic effects data for fipronil, formulated products and degradates for freshwater and estuarine/marine invertebrates and fish. The data include studies originating as registrant submitted studies in compliance with 40 *CFR* Section 158 (identifiable as studies with MRID reference numbers). In addition effects data identified from the publicly available literature (ECOTOX database studies identifiable as studies with Author citations) are also included. All MRID-based data have been described in previous risk assessments and those appearing in the next two tables meet either the Agency acceptable or supplemental criteria. Studies identified from the ECOTOX summary of available literature have been evaluated by the Office of Research and Development as suitable for ECOTOX inclusion and have undergone EFED evaluation for inclusion in the risk assessment for possible quantitative evaluation. The following are short summaries of studies extracted from the ECOTOX search of available literature. A listing of studies identified for fipronil but not included in the Database or this risk assessment contemporaneous to this risk assessment may be found in the February 2007 combined risk assessment for fipronil (DP Barcodes: 331595, 331519, 331593, 329522, 314530, 332424, 325983, 326009, 326000, 325999, 325997, 325990, 326003, 331867, 314530, 322414, 314197, 331714, 331713, 313295, 331872, 335805)

Acute Effects Studies

Analytical grade fipronil, (>98% purity) was tested for acute toxicity using 5th instar black fly larvae (*Simulium vittatum*), a native emergent aquatic insect species of the United States

(Overmyer et al. 2005). Six concentrations of fipronil, a solvent control (equivalent to highest solvent in all fipronil treatments), and a test water control were included. Test concentrations of fipronil were measured at the start and termination of the 48-hour exposure period. The study was conducted three times with one replicate at each control and test concentration. Medial lethal concentrations and corresponding probit slope estimates were reported: test 1 LC50 0.19 ug/L slope 2.25; test 2 LC50 0.19 ug/L slope 2.43; test 3 0.29 ug/L slope 1.21. The geometric mean of these values is LC50 0.22 ug/L with a slope of 2.20.

Fipronil (99.9% purity) toxicity was tested in six aquatic invertebrate species (Chaton et al. 2002). Studies were preformed in triplicate with 20 individuals per replicate. Controls were performed in test water, which was de-chlorinated tap water. The following results were reported in nominal concentration units:

Species	48-h LC50 ug/L	Probit Slope
Cladocerans		
Daphnia pulex	>highest dose	
Copepods		
Acanthocyclops robustus	84.8	4.8
Diaptomus castor	3.4	4.7
Ostracods		
Eucrypris virens	>highest dose	
Dipterans		
Chaoborus crystallinus	646	1.5
Chironomus annularis	2.4	1.2

Fipronil (97.1% purity) was tested in 4th instar larvae of 6 species of mosquitoes and two species of field collected chironomid midges (Ali et al. 1998). The assays involved 20 larvae in each of three replicates for six or seven test concentrations of fipronil. Tap water served as a diluent and control. The results in nominal units were reported as follows:

Species	48-h LC50 ug/L	Probit Slope
Mosquitoes		
Aedes aegypti	1.54	4.28
Aedes albopictus	23	1.95
Aedes taeniorhynchus	0.43	4.19
Anopheles quadrimaculatus	0.43	2.51
Culex nigripalpus	0.87	3.16
Culex quinqefasciatus	7.3	5.46
Midges		
Chironomus crassicaudatus	0.42	2
Glyptendipes paripes	0.42	2.18

Konwick et al. (2005) evaluated the acute enantioselective toxicity of fipronil and its desulfinyl photoproduct (MB46513) to the cladoceran *Ceriodaphnia dubia*. Neonates of less than 24 hours age were introduced by pipet to 30 mL polypropylene cups containing moderately hard water (control), a 0.1 % acetone solution in moderately hard water (vehicle control), or fipronil compound dissolved in acetone and diluted with moderately hard water. No feeding took place over the course of the study. Two series of tests were conducted for each fipronil enantiomer and for the racemic mixture. The first test series occurred under a normal photoperiod (16:8 light:dark fluorescent light source). The other test series was conducted dark conditions. For the desulfinyl product, only a 16:8 photoperiod test was conducted. Three replicate tests were conducted for each compound under each photoperiod (except as noted for desulfinyl product). A total of 15 neonates (3 cups of 5) were exposed at all controls and test chemical exposure levels. Mortality was assessed by response to a probe. At 48 hours test conditions (dissolved oxygen and pH) were measured with results ranging from 7.80-8.38 mg/L and 8.3-8.46, respectively. Control survival acceptability criteria was set and attained at >90%. All LC50 values are reported on the basis of measured water concentrations of test chemical 9i.e, adjust of nOminal by observed nominal-measured relationship for low and high doses). The following 48-h LC50 results were reported:

	Ceriodaphnia dubia Mean 48-h LC50 (ug/L)	
Test compound	Light	Dark
fipronil (+) enantiomere	11.3 ±2.0	9.4 ±0.7
fipronil (-) enantiomere	35.4 ±2.6	28.4 ±2.4
fipronil racemic	17.9 ±2.7	17.5 ±1.3
desulfinyl product (MB46513)	355 ±9.3	

The toxicity of fipronil to three aquatic invertebrates (giant river prawn (*Macrobrachium rosenbergii),* oriental river shrimp (*Macrobrachium nipponensis),* and Chinese mitten crab (*Eriocheir sinensis*)) was determined under semi-static conditions (Shan et al. 2003). Test water consisted of aerated tap water (ph 7.1) and test temperature was 20 ±1 C. Test chambers consisted of 25 l glass containers filled with 20 L of test solution. Fipronil material consisted of a 5% suspension provided by Aventis CropScience (no other information on the content of the suspension was provided). A total of 10 test organisms were added to each test container with average loading ranging from 0.5 to 1.15 g organism/L. Test solution was replaced very 24 hours. Mortality and any observations of abnormal behavior were recorded each 24 hours. All Lc50s were reported as nominal concentrations:

	Acute LC50 (ug/L)			
Species	24 h	48h	72h	96h
Macrobrachium rosenbergii	6.41	2.24	1.63	0.98
Macrobrachium nipponense	>25.7	11.61	7.02	4.32
Eriocheir sinensis	57.83	22.57	12.44	8.56

Stark and Vargas (2005) evaluated the acute toxicity of fipronil to *Daphnia pulex.* Regent 4Sc formulation of fipronil was serially diluted in reconstituted dilution water. Batches of 5 neonates (3rd filial generation <24 hours of age) were introduced to 30 mL plastic cups containing 25 mL of each of five to eight logarithmically spaced fipronil concentrations and a water only control. Test conditions were static non renewal. Mortality of test subjects was evaluated based on movement under mechanical stimulation. The experiment was conducted three times with three different generations of test animals. The LC50 was expressed as nominal fipronil active ingredient and reported as 15.6 ug/L (95% CI 0.88- 83) with a slope of 0.93 (± 0.26).

The toxicity of fipronil to the crayfish *Procambarus clarkii* was evaluated using static renewal (48 h interval) methods (Biever et al. 2003). Testing was conducted with the formulation ICON 6.2 FS diluted in well water (pH 6.9, hardness 38 mg/L as $CaCO_3$). Test concentrations were performed in duplicate and each chamber consisted of 21 L aquaria filled with 15 L of test solution maintained at 22 ±1 C. Crayfish were observed very 24 hours for mortality. The fipronil nominal 96-hr LC50 was reported as 180 ug/L.

Fipronil as Rhone-Poulenc "suspensible" concentrate EXP 60145A (200g ai/L) was tested for acute toxicity in the final larval instar of the midge *Chironomus tepperi*. Ten larvae were added to 25 ml glass specimen tubes containing 20 mL of fipronil solution or untreated controls. Photoperiod was maintained at 15;9 (light:dark). The bioassays were run in triplicate and replicated 4 times with different larvae cultures all under static conditions. Mortality was assessed as response to manipulation by forceps. The mean 24-hr LC50 was reported by the authors to be 0.43 ug/L (95% limits 0.39-0.47) with a mean slope of 3.29 ± 0.44.

Field collected grass shrimp, *Palaemonetes pugio*, were evaluated for acute toxic response to fipronil (Stevens et al. 1998). One study involved the use of 10 adult shrimp housed in 4 L glass jars filled with 2 L of test media or control. There were two replicates per treatment. A second study involved the use of 10 larvae (one to two days old) per 600 ml beaker filled with 400 ml of media, three replicates per treatment. A third study involved the use of embryos in 24-well microtiter plates, one stage IV embryo/ 2 mL well. The control and each test concentration were allocated to a single plate for a total of 24 organisms per treatment. Pesticide grade acetone (0.1%) was used as a carrier solvent in all treatments and controls. The following 96-hr LC50 values were reported:

Life Stage	96-hr LC50 (ug/l0 *Palaemonetes pugio*
Adult	0.32
larvae	0.68
embryo	>512

A 96-hr acute toxicity study with the adult copepod *Amphiascus tenuiremis* was conducted using 98% fipronil (Chandler 2004). Adult male and female organisms were exposed to four nominal concentrations of fipronil (4.3, 7.2, 12.0, and 20 ug/L) and an acetone control in artificial seawater. Four replicates per treatment level were employed and the test chambers consisted of 50 mL glass crystallizing dishes filled with 30 mL of test solution. Twenty organisms (evenly distributed between males and females) were introduced to each replicate, which were then incubated at 20 C for 96 hours in a 12:12 light:dark photoperiod. The LC50 for combined sexes was 6.8 ug/L, with a male LC50 of 3.5 ug/L and a female LC50 of 13.0 ug/L.

Early Life Stage and Reproduction Studies

Chandler et al. (2004) conducted a life cycle study (21 days) with the estuarine copepod *A. tenuiremis* exposed to fipronil (98% technical) at measured concentrations of 0.16, 0.22, and 0.42 ug/L in seawater.. The study was conducted in 96-well microtiter plates. One hundred forty-four test microwells for each treatment and or control were distributed over three microplates per treatment or control. One animal per treatment well was introduced to a treatment or control solution volume of approximately 200 uL for portions of the experiment involving observed copepod rearing (endpoints specific to copepod survival and development). Alternating rows were evaluated for sexually mature copepod pairing and mating and involved two animals (male and female) per cell. The animals were fed with 2 uL of mixed algal cell suspension. All plates were maintained covered at 25C with a photoperiod of 12:12 light:dark. Treatment or control solution was renewed every 3 days and food was introduced every 6 days. There were no adverse effects on copepod survival observed at either day 12 or day 21 of the study (NOEC for survival 0.42 ug/L). Copepod development from stage 1 to adult was significantly (p<0.01) delayed for treatment groups 0.22 and 0.42 ug/L (NOEC for delayed development 0.16 ug/L, LOEC 0.22 ug/L). Developmental delays were observed to range from 1.5 to 2.4 days at the LOEC of 0.22 ug/L. The number of mature adults at day 12 was also reduced at 0.22 ug/l , with controls averaging 97.8 adults and 0.22 ug/l averaging 85.6 adults. Fipronil significantly reduced (p<0.010 the incidence of female egg production at the 0.22 and 0.42 ug/L by 71% and 94% , respectively (NOEC for incidence of female egg production 0.16 ug/L LOEC 0.22 ug/L). The most sensitive endpoint from this study was time from mating to female egg extrusion. Reproductively successful females took statistically longer than controls to extrude eggs at 0.16 and 0.22 ug/L (p<00.05) than controls by average margins of 1.9 and 2.3 days, respectively (NOEC for time to egg production <0.16 ug/L, LOEC o.16 ug/L).

Volz et al. (2003) examined the response of grass shrimp *Palaemonetes pugio* exposed to nominal concentrations of fipronil (technical 98%) at 0, 0.1 and 0.2 ug/L in seawater. Test chambers consisted of 70 L aquaria p[retreated for three weeks with test solutions. A total of 34 adult shrimp (17 male and 167 female) were assigned to each control and treatment chamber (three replicate chambers per treatment level). Measured concentrations of fipronil averaged 0.0979 ug/L (SD 0.02084) and 0.14298 ug/L (SD 0.04052) for the 0.1 and 0.2 ug/L treatment groups. Fipronil significantly (p=0.01) reduced adult survival at 0.14298 ug/L, with an observed 19.6% decrease relative to controls (survival NOEC 0.0979 ug/l, LOEC 0.14298 ug/l)). Among surviving shrimp, no significant (p 0.05) effects on the numbers of gravid females, female grass shrimp egg production, vitellogenin, cholesterol, and ecdysteroids were observed at any treatment level (NOEC 0.14298 ug/L).

Aquatic Animal Acute Toxicity data

Species	Chemical	%A.I.	LC50 or EC50 ug/L	MRID or Reference
Freshwater Acute Invertebrate Toxicity Data				
Daphnia magna	fipronil	100	190	42918625
Ceriodaphnia dubia		98 (racemic)	17.9 (light condition) 17.5 (dark condition0	Konwick et al. 2005
Ceriodaphnia dubia		98.1 (-) enantiomere	35.4 (light condition) 28.4 (dark condition)	Konwick et al. 2005
Ceriodaphnia dubia		97.3 (+) enantiomer	11.3 (light condition) 9.4 (dark condition)	Konwick et al. 2005
Corbicula fluminea		95	>2000	46329904
Lumbriculus variegatus		99.7	>1900	46329903
Simulium vittatum		>98	0.22	Overmyer et al. 2005

Aquatic Animal Acute Toxicity data				
Species	**Chemical**	**%A.I.**	**LC50 or EC50 ug/L**	**MRID or Reference**
Acanthocyclops robustus		99.9	84.8	Chaton et al. 2002
Diaptomus castor		99.9	3.4	Chaton et al. 2002
Chaoborus crystallinus		99.9	646	Chaton et al. 2002
Giant river prawn *Macrobrachium rosenbergii*		5	24h - 6.41 48h - 2.24 72h - 1.63 96h - 0.98	Shan et al. 2003
Oriental river shrimp *Macrobrachium nipponense*		5	24h - >25.70 48h - 11.61 72h - 7.02 96h - 4.32	Shan et al. 2003
Chinese mitten crab *Eriocheir sinensis*		5	24h - >57.83 48h - 22.57 72h - 12.44 96h - 8.56	Shan et al. 2003
Procambarus clarkii		--	14.3 (96-h)	Schlenk et al. 2001
Procambarus zonangulus		--	19.5 (96-h)	Schlenk et al. 2001
Chironomus annularis		99.9	2.4	Chaton et al. 2002
Chironomus crassicaudatus		97.1	0.42	Ali et al. 1998
Glyptendipes paripes		97.1	0.42	Ali et al. 1998
Chironomus tentans		98.3	0.41	45878001 (Water-based endpoint)
Hexagenia sp.		99.7	0.44	46329902
Aedes aegypti		97.1	1.54	Ali et al. 1998
Aedes albopictus		97.1	23	Ali et al. 1998
Aedes taeniorhynchus		97.1	0.43	Ali et al. 1998
Anopheles quadrimaculatus		97.1	0.43	Ali et al. 1998
Culex nigripalpus		97.1	0.87	Ali et al. 1998
Culex quinqefasciatus		97.1	7.3	Ali et al. 1998
Culex quinqefasciatus		--	350	Ali et al. 1999
Daphnia magna	RPA 10461	94.7	100,000	43291719
Chironomus riparius	RPA 200766	99.8	430	46376701
Daphnia magna	MB46136	100	29	42918671
Chironomus tentans		99.1	0.72	45175901 (Water-based endpoint)
Daphnia magna	MB45950	100	100	42918669

Aquatic Animal Acute Toxicity data				
Species	**Chemical**	**%A.I.**	**LC50 or EC50 ug/L**	**MRID or Reference**
Chironomus tentans		99.5	2.13	45084801 (Water-based endpoint)
Ceriodaphnia dubia	MB46513	97.8	355	Konwick et al. 2005
Chironomus tentans		99.1	200	45375901 (Water-based endpoint)
Procambarus clarkii	ICON 6.2 FS	56.02	174	45029601
Procambarus clarkii	ICON 6.2 FS	--	180	Biever et al. 2003
Daphnia pulex	Regent 4SC	--	15.6	Stark and Vargas 2005
Chironomus tepperi	RP EXP 60145a	20% (adjusted)	0.43 (24 hr study)	Stevens et al. 1998
Freshwater Acute Fish Toxicity Data				
Onchorynchus mykis	fipronil	100	246	42977902
Lepomis macrochirus		100	83	42918624
Ictalurus punctatus		97	560	44299401
Onchorynchus mykis	MB46136	99.2	39	42918673
Lepomis macrochirus		99.2	25	42918674
Lepomis macrochirus	MB46513	No data	20	43279702
Onchorynchus mykis		94.7	>100,000	43291718
Onchorynchus mykis		100 94.7	>100,000	43279703
Onchorynchus mykis	RPA104615	94.7	>100,000	43291718
Estuarine/Marine Acute Invertebrate Toxicity Data				
Amphiascus tenuiremis	fipronil	98	(96 hr study) 6.8 combined 3.5 male 13.0 female	Chandler et al. 2004
Palaemonetes pugio		--	adult 0.32 larvae 0.68 embryo >512	Key et al. 2003
Crassostrea virginianus		96.1	770	43291701
Americamysis bahia		96.1	0.14	43279701
Americamysis bahia	MB46513	97.8	1.5	45120001
Americamysis bahia	MB46136	99.7	0.56	45156301
Americamysis bahia	MB45950	99.7	0.077	45156302

Aquatic Animal Acute Toxicity data				
Species	**Chemical**	**%A.I.**	**LC50 or EC50 ug/L**	**MRID or Reference**
Estuarine/Marine Acute Fish Toxicity Data				
Cyprinodon variegatus	fipronil	96.1	130	43291702

Aquatic Animal Chronic Toxicity data				
Species	**Chemical**	**%A.I.**	**LOEC/ NOEC ug/L**	**MRID or Reference**
Freshwater Invertebrate Chronic Toxicity Data				
Daphnia magna	fipronil	100	20/9.8	42918626
Daphnia magna	MB46513	--	100/41	43279704, 44812801
Freshwater Fish Chronic Toxicity Data				
Oncorynchus mykis	fipronil	96.7	15/6.6	42818627
Estuarine/Marine Invertebrate Chronic Toxicity Data				
Americamysis bahia	fipronil	97.7	0.005/not determined	43681201
Palaemonetes pugio		98	*adult survival* 0.14298/0.0979 *reproduction* >0.14298/0.14298	Volz et al. 2003
Amphiascus tenuiremis		98	*Survival* 0.22/0.16 *Time to adult* 0.22/0.16 *Incident of female egg production* 0.22/0.16 *Time from mating to egg production* 0.16/<0.16	Chandler et al. 2004
Americamysis bahia	MB45950	99.5	0.0087/0.0046	45259202
Americamysis bahia	MB46136	99	0.0026 /< 0.0026	45259203
Estuarine/Marine Fish Chronic Toxicity Data				
Cyprinodon variegatus	fipronil	95 97	*full life cycle* 1.7/0.85 early life stage *0.41/0.24*	45265101 44605502

Aquatic Plant Toxicity data					
Species Tested	**Chemical**	**% A.I.**	**5 Day EC50 (μg/L)**	**NOEC (μg/L)**	**MRID or Reference**
Navicula pelliculosa (FW diatom)	fipronil	96.1	>120	120	42918658

Lemna gibba (Duckweed)		96.1	>100	100	42918656
Selenastrum capricornutum (FW green alga)		96.1	140	<140	42918660
Skeletonema costatum (marine diatom)		96.1	>140	140	42918659
Anabaena flos aquae (FW Blue-green alga)		96.1	>170	140	42918657
Selenastrum capricornutum (FW green alga)	MB46513	98.6	76	7.5	43279705

Sediment Toxicity Studies

The following table presents the results of sediment toxicity testing with fipronil and degradates.

Sediment Organism Toxicity Data

Species Tested	Chemical	% A.I.	10 Day LC50/EC50 (NOEC) µg/kg-sediment	10 Day LC50/EC50 (NOEC) µg/l pore water	MRID
Chironomus tentans	fipronil	98.3	mortality 30.7(16)	Mortality 0.41(0.24)	45878001
	MB46513	97.8-99.6	mortality 1300(200) growth 520(<200)	Not available Not available	45375901
	MB46136	99.01	mortality 44.8(14) growth 34.8(9.1)	mortality 0.72(0.35) growth 0.41(0.41)	45175901
	MB45950	99.5	mortality 116.9(29) growth 50.9(54)	mortality 2.13(0.35) growth 0.66 (0.94)	45084801

Mesocosm, Microcosm, and Field Studies

Wirth et al. (2004) evaluated the effects of fipronil (purity not stated) upon estuarine mesocosms. Each mesocosm chamber consisted of an aerated tank with a simulated diurnal tidal volume 551 to 250 L. Each tank consisted of 2 plots of low marsh, 2 plots of mid marsh, and a simulated stream. Natural seawater and unspecified sediment were used. Three replicate mesocosm chambers were used for a control, and 0.150, 0.355, and 5.00 ug/L nominal additions of fipronil. Dosing occurred in the seawater sump approximately one hour prior to flood tide, avoiding a plume event. Test organisms were acclimated in the mesocosms three days prior to dosing. The community consisted of 24 6 month grass shrimp (*P. pugio, 16 males 8 females*) , 30 oysters (*C. virginica*), 30 juvenile clams (*Mercenaria mercenaria*), and 25 fish(*C. variegaus*). Exposure duration was for 28 days, evaporative loss in each chamber was offset through deionized water addition. Clams exhibited no adverse effects at all exposure levels. There were no significant ($p=0.33$) effects on oyster survival or oyster weight ($p=0.38$), but height of oysters was slightly reduced ($p=0.01$) at the highest dose tested. Grass shrimp exhibited reduced survival ($p<0.05$) at the middle dose. Grass shrimp also exhibited a dose dependent reduction in number off oviparous females, though without statistical significance. Fish exhibited no significant effects on survival, length or weight. Because concentrations of fipronil in the water column decreased substantially over the course of the study the NOEC and LOEC for this study can be expressed both as nominal concentration (NOEC 0.150 ug/L, LOEC 0.355 ug/L) and as a 28-day average measured concentration (NOEC 0.076 ug/L, LOEC 0.148 ug/L). No monitoring of sediments nor for degradates was conducted in the study. Consequently the disappearance of fipronil parent from the water column cannot be reliably attributed to any particular fate or dissipation process.

Shan et al. (2003) explored the potential effects of fipronil in rice paddy drainage water upon freshwater crustaceans. An experimental rice paddy was treated with fipronil (5% fipronil suspension) by spray application of 45 g ai./hectare. Water drawn from the experimental paddy was introduced to a fishpond (concrete lined with mud and planted with "water grass") that contained 80 *M. rosenbergii*, 50 *M. nipponensis*, and 80 *E. simensis*. At 24 hours post fipronil application to the paddy draw water from the paddy was introduced to the pond in a 50% volumetric mixture with existing pond water. *E. simensis,* immediately after application of paddy water, showed signs of intoxication (convulsion and arched bodies). Within 10 days there was complete mortality of this species as compared to 50% mortality in an untreated control pond. The other test species also exhibited signs of agitation and complete mortality by 7 days (*M. nipponensis*) or 3 days (*M. rosenbergii*) compared to controls where mortality was 345 and 13.85, respectively. Fipronil concentration in the fish ponds, upon application of treated paddy water was a measured 3.48 ug/L and declined to 2.6 ug/L 30 days later. Traces of MB046136 were detected, while the other two degradates were negligible.

Bayer Crop Science submitted to the Agency an evaluation of fipronil effects on the fauna of outdoor simulated ponds (MRID46733901). Fipronil, as Chipco TopChoice, was used in the experiment. Eight outdoor ponds were used in the study (four replicates for treatment and control). Fipronil was introduced to pond surface water at a nominal initial concentration of 0.4 ug/L. The time-weighted average concentration of fipronil in treated mesocosms from initiation of biological exposure out to 84 days (holding non-detects at half detection limit) was 0.042 ug/L. Biological sampling commenced two weeks prior to test substance treatment and continued for approximately 12 weeks after application. There were no statistically significant ($P>0.05$) differences in phytoplankton (determined by phaeophytin, chlorophyll, and total pigment analysis) between control and treatment. Mean arthropod abundance was lower in the treatment than control at day 7 (52% of control), and Day 14 (61% of control) This trend reversed for days 21, 28, 42, and 56, where treatments showed increases in abundance relative to controls ranging from 0.5% to 183 %. None of the overall arthropod effects, though marked were statistically significant ($P>0.05$). Within the arthropods, certain copepod species (M*esocyclops edax* and *Tropocyclops prasinus*) showed statistically significant ($p\leq0.05$) reductions in abundance in treatment relative to control. Treatment abundances ranged from 65 to 365 of control values. By day 21 (the last day of analysis at species resolution) these reductions were not statistically significant, but were still markedly reduced 14% to 60% of controls. Hester-Dendy sampling results for clitellora (worms and leeches) showed statistically significant increase in treatments relative to control for sampling days 8, and 14, and 56 (increases greater than 200%). Gastropods (snails) showed similar increases in abundance, though not statistically significant, in treatments relative to control. Evaluation of total macroinvertebrate insect abundance showed mixed results as the study progressed. Reductions in total abundance were statistically significant ($P<0.5$) for fipronil treatment at day 8, with reductions still evident at day 28 and 56, though not statistically significant. Benthic sampling for mayfly juveniles showed significant reductions in the presence of fipronil ($p<0.05$) at days 8, 14, 28, and 56 of the study. Juvenile chironomids were also reduced significantly ($p<0.05$) by fipronil at day 8, though these effects were largely reversed by day 56 of the study. Numbers of emergent insects were too small in the study to make definitive statistically supported statements about individual taxonomic groups. However, total emergent insects were lower in the fipronil treatment than in control for all sampling days of the study.

The registrant has submitted an interim report on the effects of in place sediment concentrations of fipronil on the re-colonization of natural streams (MRID 46936104). The objective of the study was to evaluate the long-term effects of fipronil on benthic macroinvertebrates in freshwater ecosystems. A total of eight separate surface water sites were considered in this evaluation. Surficial sediments were collected from each test site. These sediments were untreated (control), or treated with fipronil as a low dose 0.75 ug/kg (wet) or high dose 1.5 ug/kg (wet) and replicates of control and fipronil doses (3 each) were placed prepared using the aforementioned sediment placed into 700 ml trays. These trays were then reintroduced to the test sites. The study reports have not been completed at the time of the drafting of this risk assessment.

Calculation of Acute to Chronic Ratios and Other Extrapolation Factors for Aquatic Organisms

Chronic toxicity data are available for but a subset of the freshwater invertebrate species tested in acute toxicity studies. In order to capture the potential for interspecies differences in sensitivity observed in the acute studies, an assumption was made that such differences are conserved in chronic effects. The following acute:chronic ratios (ACRs) for fipronil are available from the data set:

Species	Invert or Fish	Freshwater or Estuarine/marine	Acute LC50	Chronic NOEC	ACR
D. magna	invertebrate	freshwater	190	9.8	19.39
O. mykis	fish	freshwater	246	6.6	37.27
A. bahia	invertebrate	estuarine/marine	0.14	<0.005	>28.00
P. Pugio	invertebrate	estuarine/marine	0.32	0.0979	3.26
A. tenurans	invertebrate	estuarine/marine	6.8	<0.16	>42.50
C. variegates	fish	estuarine/marine	130	0.85	<152.9
				0.24	<541.7

For the purposes of extrapolating acute freshwater invertebrate results to an estimated chronic effects NOEC when chronic data are unavailable, this risk assessment uses the single ACR for *D. magna* (19.39), where the resulting chronic NOEC estimate will be made using the calculation: $LC50/ACR=NOEC_{est}$. For estuarine/marine invertebrates, extrapolations of acute to chronic effects endpoints would employ the ACR for *A. bahia,* where the resulting chronic NOEC estimate will be made using the calculation: $LC50/ACR=NOEC_{est}$. The selection of *A. bahia* was made because most acute testing available for degradates uses the same species and such extrapolations within the species have the least uncertainty.

There are data gaps for the degradates concern the available acute toxicity data for estuarine/marine fish. To address these gaps this risk assessment assumed the relationship between freshwater species sensitivities for parent fipronil and degradates are conserved. The following relationships can be calculated with available data

Species	Fipronil LC50	MB46136 LC50	Ratio Parent to Degradate
O. mykis	246	39	6.3
L. macrochirus	83	25	3.3

Species	Fipronil LC50	MB46513 LC50	Ratio Parent to Degradate
O. mykis	246	>100,00	<.00246
L. macrochirus	83	20	4.15

Incidents

There are few incidents in the Agency database for effects on non-target organisms associated with the labeled use of fipronil. The degree to which the low number of years of outdoor use contributes to a lack of incidents is unknown.

Incident number I009142001 is a report of crayfish mortality following use of fipronil as a seed treatment on rice in Louisiana. The database classifies this incident as highly probable. In March of 1999 Louisiana Department of Agriculture and Safety issued a stop order to prevent the use of fipronil on rice seed in Allen, Calcasieu, Cameron, Lafayette, St. Martin, Iberia, St. Mary, St. Landry, Beauregard, Vermillion, Evangeline, Acadia, and Jefferson Davis Parishes. Fipronil was detected in 3 of 9 crawfish samples (mean detection 0.04 ug/kg). Fipronil was detected in water samples from 8 of 16 ponds (average 2,08 ug/L, high 6.09 ug/L), in all samples of the Mermentau River (average 1.67 ug/L, high 3.16 ug/L), and 14 of 17 other water monitoring sites (average 0.84 ug/L, high 5.33 ug/L). the registrant (Rhone-Poulenc reported that 17 crawfish growers had reported to them observations of crawfish at the edges of ponds bordering rice fields planted with fipronil-treated rice. The LA department of Agriculture was investigating 31 reported incidents pf crawfish kills on rice. Among the department and registrant reports there were 45 total incidents. The Louisiana state university Agricultural center conducted a survey and several experiments which substantiated the link between fipronil-treated rice seed and reduced survival of crawfish under hot dry weather conditions. Fipronil is no longer registered for rice seed treatment.

There are two reports of corn crop damage (I011723098 300 acres in North Dakota, and I013103054300 550 acres in Idaho) following use of fipronil Regent SC. These incidents are classified in the database as possible (Idaho incident) and probable (North Dakota). In neither incident report are there any confirmatory residue analyses.

One other probable incident, outside the United States, is also reported in the Agency database. It involves locust control efforts on the island of Madagascar (I010380001). The incident was summarized in a BBC news article. The article refers to survey results citing declines in the Madagascar bee eater and a kestrel species. In addition, surveys of termite colonies showed a 90% elimination rate ten months after spraying. There are no confirmatory analytical data reported in the incident summary.

Effects Endpoints Used in the Risk Assessment

The following tables summarize the acute and chronic endpoints quantitatively used in this risk assessment for fipronil and degradates.

Terrestrial Organism Toxicity Endpoints Used in the Pest Risk Assessment				
Chemical	**Acute Toxicity Threshold**	**Chronic Toxicity Threshold**	**Acute Threshold Origin**	**Chronic Threshold Origin**
Birds				
Fipronil	LD_{50} 11.3 mg/kg-bw LC_{50} 48 mg/kg-diet	NOEC 10 mg/kg-diet	1	1
MB46136	LD50 19.7 mg-bw LC_{50} 84mg/kg-diet	NOEC 10 mg/kg-diet	3 1	2
MB46513	LD_{50} 5 mg/kg-bw LC_{50} 119.2 mg/kg-diet	NOEC 10 mg/kg-diet	1	2
MB45950	LD50 26.79 mg/kg-bw LC_{50} 114 mg/kg-bw	NOEC 10 mg/kg-diet	3 1	2
Mammals				
Fipronil	LD_{50} 97 mg/kg-bw	NOEC 30 mg/kg-diet NOEL 2.64 mg/kg-bw	1	1
MB46136	LD_{50} 218 mg/kg-bw	NOEC 30 mg/kg-diet NOEL 2.64 mg/kg-bw	1	2
MB46513	LD_{50} 16 mg/kg-bw	NOEC 30 mg/kg-diet NOEL 2.64 mg/kg-bw	1	2
MB45950	LD_{50} 83 mg/kg-bw	NOEC 30 mg/kg-diet NOEL 2.64 mg/kg-bw	1	2
Plants				
Fipronil	0.025 lb/acre (NOEC)	Not applicable	1	Not applicable
MB46136	0.025 lb/acre (NOEC)	Not applicable	2	Not applicable
MB46513	0.025 lb/acre (NOEC)	Not applicable	2	Not applicable
MB45950	0.025 lb/acre (NOEC)	Not applicable	2	Not applicable

1 most sensitive species tested
2 assumed to be equivalent to parent fipronil
3 estimated by multiplying available LC50 by parent fipronil LD:LC50 ratio
* photodegradate toxicity endpoints provided for background information only as this degradate is not expected to appreciably occur in terrestrial systems due to the low photolysis half-life of fipronil and field study analyses

Aquatic Organism Toxicity Endpoints Used in the Pest Risk Assessment				
Chemical	**Acute Toxicity Threshold ug/L**	**Chronic Toxicity Threshold ug/L**	**Acute Threshold Origin**	**Chronic Threshold Origin**
Freshwater Fish				
Fipronil	83	6.6	1	1
MB46136	25	0.67	1	2
MB46513	20	0.59	1	2
MB45950	83	6.6	3	3
Estuarine/Marine Fish				
Fipronil	130	0.24	1	1
MB46136	21	0.039	4	5
MB46513	31	0.057	4	5
MB45950	130	0.24	3	3
Freshwater Invertebrates				
Fipronil	0.22	0.011	1	6
MB46136	0.72	0.037	1	6
MB46513	200	10.31	1	6
MB45950	2.13	0.11	1	6
Estuarine/Marine Invertebrates				
Fipronil	0.14	<0.005	1	1
MB46136	0.56	<0.0026	1	1
MB46513	1.5	0.054	1	7
MB45950	0.077	0.0046	1	1
Freshwater Plants (endpoints non-listed/listed plants)				
Fipronil	Unicellular 140/<140 Vascular >100/100	Not applicable	1	Not applicable
MB46136	Unicellular 140/<140 Vascular >100/100	Not applicable	3	Not applicable
MB46513	Unicellular 140/<140 Vascular >100/100	Not applicable	3	Not applicable
MB45950	Unicellular 140/<140 Vascular >100/100	Not applicable	3	Not applicable
Estuarine/Marine Plants				
Fipronil	>140/140	Not applicable	1	Not applicable
MB46136	>140/140	Not applicable	3	Not applicable
MB46513	>76/7.5	Not applicable	1	Not applicable
MB45950	>140/140	Not applicable	3	Not applicable

1 most sensitive species tested
2 most sensitive species tested acute value divided by *O. mykis* acute:chronic ratio of parent fipronil
3 assumed to be equivalent to parent fipronil
4 estimated based on estuarine/marine value for parent fipronil divided by largest freshwater fish acute parent to degradate ratio
5 estimated by dividing acute value by parent acute to chronic ratio for estuarine/marine fish
6 lowest acute value divided by parent fipronil acute:chronic ratio for *D. magna*
7 lowest acute value divided by parent fipronil acute:chronic ratio of *A. bahia*

V. RISK CHARACTERIZATION

Risk Estimation

The following sections of this screening-level risk assessment present the results of the risk quotient calculations for terrestrial and aquatic organisms.

Terrestrial Wildlife Risk Quotients

Risk quotients calculated using the mass per unit area exposure estimate are presented in the following table. It is important to note that the mass per unit area RQ calculation is only used for acute effects assessment.

Terrestrial Vertebrate Acute Risk Quotients for Fipronil Use Based on Mass Per Unit Area Exposure Estimates

Exposure Estimate mg ai/ft^2	Effects Endpoint LD50 mg/kg-bw	Animal Type	Animal Body Weight g	Body Weight Adjusted Effects Endpoint* mg/kg-bw	Effects Endpoint mg/animal**	RQ
Fipronil						
0.013	11.3	Bird	20	8.4	0.17	<0.1
			100	10.36	1.04	<0.1
			1000	14.64	14.64	<0.1
	97	Mammal	15	213.19	3.20	<0.1
			35	172.49	6.04	<0.1
			1000	74.61	74.61	<0.1
MB45950						
0.000675	114	Bird	20	82.13	1.64	<0.1
			100	104.55	10.46	<0.1
			1000	147.65	147.65	<0.1
	83	Mammal	15	182.42	2.74	<0.1
			35	147.59	5.17	<0.1
			1000	63.84	63.84	<0.1
MB46136						

Exposure Estimate mg ai/ft^2	Effects Endpoint LD50 mg/kg-bw	Animal Type	Animal Body Weight g	Body Weight Adjusted Effects Endpoint* mg/kg-bw	Effects Endpoint mg/animal**	RQ
0.00324	84	Bird	20	60.52	1.21	<0.1
			100	77.04	7.70	<0.1
			1000	108.82	108.82	<0.1
	218	Mammal	15	479.13	7.19	<0.1
			35	387.66	13.57	<0.1
			1000	167.69	167.69	<0.1
MB46513						
0.00581	5	Bird	20	3.71	0.074	<0.1
			100	4.58	0.458	<0.1
			1000	6.47	6.47	<0.1
	16	Mammal	15	35.17	0.53	<0.1
			35	28.40	0.99	<0.1
			1000	12.31	12.31	<0.1

* scaling to achieve adjusted toxicity endpoints uses the following approaches described in TREX v 1.22 documentation:
LD50 Assessed bird = Test bird LD50(assessed body weight /tested body weight)$^{0.15}$
LD50 Assessed mammal = Test mammal LD50(tested body weight/assess body weight)$^{0.25}$
** effects endpoint mg/animal=(body weight adjusted effects endpoint)(body weight/1000)
*** RQ= exposure estimate/effects endpoint mg/animal

Risk quotients for birds consuming terrestrial invertebrates and seeds in the field at the time of application are presented in the table below. These are calculated using the estimated fipronil concentration in food items as the exposure estimate and effects endpoints expressed as dietary concentrations. The acute listed species and restricted use levels of concern are exceeded for birds consuming small insects. The chronic level of concern for listed and non-listed species is exceeded.

Bird Risk Quotients for Fipronil Based on Residues in Terrestrial Invertebrates and Seeds Present at Time of Application (concentration-based RQs)

Food Item	Fipronil Food Item Concentration mg ai/kg-fw	Acute Effects Endpoint LC50 mg/kg-diet	Chronic Effects Endpoint NOEC mg/kg-diet	Acute RQ	Chronic RQ
Birds					
Seeds, large insects	1.95	48	10	<0.1	<1

Food Item	Fipronil Food Item Concentration mg ai/kg-fw	Acute Effects Endpoint LC50 mg/kg-diet	Chronic Effects Endpoint NOEC mg/kg-diet	Acute RQ	Chronic RQ
Small insects	17.55			**0.37**	**1.76**
Mammals					
Seeds, large insects	1.95	NA	30	NA	<1
Small insects	17.55			NA	<1

RQ = Estimated daily dose/effects endpoint values in bold exceed one or more Agency levels of concern
where acute RQ ≥ 0.5 acute non-listed effects concerns
0.1 acute listed species effects concern
chronic RQ ≥1 listed and non-listed effects concern

The following table provides RQ calculations for birds and mammals consuming terrestrial invertebrates and seeds present in the field at the time of application. Unlike the table above, this approach converts pesticide concentration in wildlife food items to an ingested dose in the food item consumers. The advantage of this approach is that the effect of wildlife feeding rate for differing body sizes can be considered in the exposure assessment. The listed species and restricted use acute levels of concern are exceeded for 20 g birds and the listed species level of concern is exceeded for 100 g birds. Chronic RQs for insectivorous small mammals are the only quotients that exceed levels of concern.

Bird and Mammal Risk Quotients for Fipronil Based on Residues in Terrestrial Invertebrates and Seeds Present at Time of Application (daily ingested dose-based RQs)

Food Item	Fipronil Food Item Concentration mg ai/kg-fw	Body weight g	Estimated Daily Dose mg/kg-bw	Weight Adjusted Acute Effects Endpoint LD50** mg/kg-bw	Weight Adjusted Chronic Effects Endpoint NOEL** mg/kg-bw	Acute RQ ****	Chronic RQ
Birds							
Seeds, large insects	1.95	20	2.22	8.4	NA***	**0.26**	NA
		100	1.27	10.36	NA	**0.12**	NA
		1000	0.57	14.64	NA	<0.1	NA
Small insects	17.55	20	19.99	8.4	NA	**2.38**	NA
		100	11.40	10.36	NA	**1.10**	NA
		1000	5.10	15.64	NA	**0.33**	NA
Mammals (Insectivores)							

Food Item	Fipronil Food Item Concentration mg ai/kg-fw	Body weight g	Estimated Daily Dose mg/kg-bw	Weight Adjusted Acute Effects Endpoint LD50** mg/kg-bw	Weight Adjusted Chronic Effects Endpoint NOEL** mg/kg-bw	Acute RQ ****	Chronic RQ
Large insects	1.95	15	1.86	213.19	5.80	<0.1	<1
		35	1.28	172.49	4.69	<0.1	<1
		1000	0.30	74.61	2.03	<0.1	<1
Small insects	17.55	15	16.73	213.19	5.80	<0.1	**2.88**
		35	11.56	172.49	4.69	<0.1	**2.46**
		1000	2.68	74.61	2.03	<0.1	**1.32**
Mammals (Granivores)							
Seeds	1.95	15	0.41	213.19	5.80	<0.1	<1
		35	0.29	172.49	4.69	<0.1	<1
		100	0.07	74.61	2.03	<0.1	<1

*estimated daily dose calculated as per TREX v 1.22
** scaling to achieve adjusted toxicity endpoints as per TREX v 1.22
Endpoint Assessed Bird = Test Bird Endpoint (assessed body weight /tested body weight)$^{0.15}$
Endpoint Assessed Mammal = Test Mammal Endpoint (tested body weight/assess body weight
***NA no dose conversions available for chronic avian endpoints, study design limitation
****RQ = Estimated daily dose/effects endpoint values in bold exceed one or more Agency levels of concern
where acute RQ ≥ 0.5 acute non-listed effects concerns
0.1 acute listed species effects concern
chronic RQ ≥1 listed and non-listed effects concern

Aquatic Organism Risk Quotients

The acute and chronic risk quotients (RQ) for freshwater and estuarine organisms based on technical fipronil are summarized in Tables VV below. The application scenarios are based on a single 10 ha application with a 1.27 cm soil incorporation depth at 0.13 lbs ai/acre for single row cropping. Fipronil RQs exceed the acute non-listed and listed and chronic levels of concern. Risk quotients for MB46136 exceed the acute listed species and chronic levels of concern.

Acute and Chronic Risk Quotients for Freshwater Invertebrates for Fipronil and its Degradation Products in the Standard Pond From In-furrow Fipronil Application for Turnips and Rutabagas

Chemical	Acute EEC ug/L	Chronic EEC ug/L	Acute Toxicity Endpoint ug/L	Chronic Toxicity Endpoint ug/L	Acute RQ	Chronic RQ	Identified concerns
Fipronil	0.357	0.258	0.22	0.011	1.62	23.45	A,RU,LS,C
MB46513[2]	0.006	0.005	200	10.31	<0.05	<1.0	None
MB46136[2]	0.061	0.035	0.72	0.037	0.08	<1.0	LS
MB45950[2]	0.014	0.008	2.13	0.11	<0.05	<1.0	None

2-Indicates year to year correlation prevented calculation of a 1 in 10 year concentration. Reported concentrations represent the concentrations in the first simulation year (1961).
A= Acute LOC, RU= Restricted Use LOC, LS = Listed Species LOC,, C=Chronic LOC, None= no LOC exceeded

Acute and Chronic Risk Quotients for Freshwater Fish for Fipronil and its Degradation Products in the Standard Pond From In-furrow Fipronil Application for Turnips and Rutabagas

Chemical	Acute EEC ug/L	Chronic EEC ug/L	Acute Toxicity Endpoint ug/L	Chronic Toxicity Endpoint ug/L	Acute RQ	Chronic RQ	Identified concerns
Fipronil	0.357	0.218	83	6.6	<0.05	<1	None
MB46513[2]	0.006	0.003	20	0.59	<0.05	<1	None
MB46136[2]	0.061	0.021	25	0.67	<0.05	<1	None
MB45950[2]	0.014	0.005	83	6.6	<0.05	<1	None

2-Indicates year to year correlation prevented calculation of a 1 in 10 year concentration. Reported concentrations represent the concentrations in the first simulation year (1961).
A= Acute LOC, RU= Restricted Use LOC, LS = Listed Species LOC,, C=Chronic LOC, None= no LOC exceeded

The EC_{50} for the aquatic plant species tested to date and the estimated aquatic concentrations from the proposed use on rutabagas and turnips will not exceed acute toxicity levels for aquatic plants.

The peak EEC for fipronil (0.357 ug/L) when compared with the EC50 and NOAEC values for vascular and non-vascular aquatic plants (a range of 100 to >140 ug/L) result in RQs that are well below 0.01.

Risk Description

As stated earlier in this document, the Agency relies on a suite of RQ interpretive values termed levels of concern (LOC), to evaluate the potential biological significance of RQ estimates. Risk quotient values below these LOCs do not indicate the absence of risk. Rather, RQ values below LOCs indicate that the Agency considers the risks to be low enough to preclude concerns for registration without the need for consideration of attendant benefits. In the case of Federally listed threatened and endangered species (listed species), RQ values below the listed species LOCs are interpreted as "no effect" scenarios. The following sections of this screening-level risk assessment provide comparisons of the estimated RQs with the Agency LOCs and discuss other lines of evidence and method and data uncertainties in the context of the screening-level risk assessments predictive ability

Terrestrial Animal Risks

When exposure estimates are expressed on a mass of pesticide or degradate per unit area, the resulting RQ values are universally below OPP acute levels of concern for listed (RQ 0.1 and greater) and non-listed birds and mammals (RQ 0.5 and greater). However, this method of exposure and risk estimation is not instructive for assessing reproduction risks for birds and mammals.

To more fully evaluate risks from consumption of wildlife dietary materials that might be present on the field at the time of application of the pesticide to the furrow, the risk assessment considered wildlife consumption of fipronil residues in seeds and insects at the time of application. These exposures are compared to both acute lethality and reproduction endpoints for birds and mammals. When exposures are expressed on a dietary concentration basis, the avian RQ based on small insect residues exceed the listed-species level of concern (RQ 0.1 and greater) and the listed and non-listed reproduction effects level of concern RQ 1.0 and greater). The same dietary-concentration exposure based RQs exceed the mammalian reproduction level of concern (RQ 1.0 and greater) as well. The ingested dose-base RQs derived from this process for mammals did not exceed any acute (listed and non-listed species) level of concern. However, chronic dose-based RQs for mammalian insectivores exceed the OPP level of concern (RQ 1.0 and greater) for both listed and non-listed species in one food item class the small insect category (food item residues for this category of insect-based diet are based on observed residues for fruits and seeds of similar size) and for all body weight classes evaluated. Dose-based RQs for granivorous small mammals did not exceed any acute or reproduction level of concern. Dose based RQs for birds consuming seeds and insects indicate that concentrations of parent fipronil on seeds and large insects exceed the OPP acute levels of concern for non listed species (small insects food item for birds in the 20 and 100g bodyweight classes) and the listed species acute level of concern for both modeled food items in all bird weight classes (20, 100, and 100g).

If mean residues instead of upper bound residues of fipronil are assumed immediately after application, overall exposure model results are lower than those based on upper bound residue assumptions. The following table shows the results of dietary based RQs for birds and mammals. The table shows that an assumption of mean residues reduces all RQs below Agency LOCs, except listed bird acute effect concerns for insectivores.

Bird Risk Quotients for Fipronil Based on Mean Residues in Terrestrial Invertebrates and Seeds Present at Time of Application (concentration-based RQs)

Food Item	Fipronil Food Item Concentration mg ai/kg-fw	Acute Effects Endpoint LC50 mg/kg-diet	Chronic Effects Endpoint NOEC mg/kg-diet	Acute RQ	Chronic RQ
Birds					
Seeds, large insects	0.91	48	10	<0.1	<1
Small insects	5.85			**0.12**	<1
Mammals					
Seeds, large insects	0.91	NA	30	NA	<1
Small insects	5.85			NA	<1

The following table presents RQs calculated on a daily dose basis using mean dietary item residue assumptions at the time of application. When this mean residue assumption is employed, exposures for birds would still exceed listed and non-listed levels of concern for acute effects, but non-listed concerns would be confined to smaller birds consuming a largely insect diet. No acute nor chronic concerns would be evident for mammals.

Bird and Mammal Risk Quotients for Fipronil Based on Mean Residues in Terrestrial Invertebrates and Seeds Present at Time of Application (daily ingested dose-based RQs)

Food Item	Fipronil Food Item Concentration mg ai/kg-fw	Body weight g	Estimated Daily Dose mg/kg-bw	Weight Adjusted Acute Effects Endpoint LD50** mg/kg-bw	Weight Adjusted Chronic Effects Endpoint NOEL** mg/kg-bw	Acute RQ ****	Chronic RQ
Birds							
Seeds, large insects	0.91	20	1.04	8.14	NA***	**0.13**	NA
		100	0.59	10.36	NA	<0.1	NA
		1000	0.26	14.64	NA	<0.1	NA
Small insects	5.85	20	6.67	8.4	NA	**0.79**	NA
		100	3.80	10.36	NA	**0.37**	NA
		1000	1.70	15.64	NA	**0.11**	NA
Mammals (Insectivores)							
Large	0.91	15	0.86	213.19	5.80	<0.1	<1

Food Item	Fipronil Food Item Concentration mg ai/kg-fw	Body weight g	Estimated Daily Dose mg/kg-bw	Weight Adjusted Acute Effects Endpoint LD50** mg/kg-bw	Weight Adjusted Chronic Effects Endpoint NOEL** mg/kg-bw	Acute RQ ****	Chronic RQ
		35	0.60	172.49	4.69	<0.1	<1
		1000	0.14	74.61	2.03	<0.1	<1
Small insects	5.85	15	5.56	213.19	5.80	<0.1	<1
		35	3.86	172.49	4.69	<0.1	<1
		1000	0.88	74.61	2.03	<0.1	<1
Mammals (Granivores)							
Seeds	0.91	15	0.19	213.19	5.80	<0.1	<1
		35	0.14	172.49	4.69	<0.1	<1
		100	0.03	74.61	2.03	<0.1	<1

*estimated daily dose calculated as per TREX v 1.22
** scaling to achieve adjusted toxicity endpoints as per TREX v 1.22
Endpoint Assessed Bird = Test Bird Endpoint (assessed body weight /tested body weight)$^{0.15}$
Endpoint Assessed Mammal = Test Mammal Endpoint (tested body weight/assess body weight
***NA no dose conversions available for chronic avian endpoints, study design limitation
****RQ = Estimated daily dose/effects endpoint

Although the standard terrestrial exposure assessment assumes foliar deposition on different non-target crops, it may not be completely applicable because fipronil use on rutabagas is strictly limited to in-furrow application. This type of application is expected to cause direct deposition on soil and limit direct foliar deposition. The following equations and input values were used to establish depth averaged fipronil concentrations in 1 and 15 cm depth soil profiles.

Scenario 1: 15 " row spacing has 34,848 row ft per acre.

Calculation of estimated fipronil mass in furrow

0.13 lbs of fipronil/acre is label maximum rate.

@ 0.13 lbs/A/ 34,848 row ft/A= 3.730E-6 lbs of fipronil/ row ft * 454 gram/lb= 0.001693 grams per ft or 1,693 ug per ft

Calculation of Mass of Treated soil (@ soil bulk density=1.3 g/cm3)

15 " row spacing and 1 cm depth: 4 " (10 cm) x 12 " (30.48 cm) x 1 cm = 304.8 cm3 * 1.3 g/cm3 = 396 grams of soil in 1 cm furrow depth
15" row spacing and 15 cm depth: 4 " (10 cm) x 12" (30.48 cm) x 15 cm=4572 cm3 * 1.3 g/cm3= 5943 grams of soil in 15 cm furrow depth

Estimated Soil Concentrations

1 cm depth = 1693 ug/396 g of soil= 4.27 ug/g or 4.27 ppm
15 cm depth= 1693 ug/5943 g of soil= 0.284 ug/g or 0.284 ppm

Scenario 2: 20 " row spacing has 26,133 row ft per acre.

Calculation of estimated fipronil mass in furrow

0.13 lbs of fipronil/acre is maximum rate.

@ 0.13 lbs/A/ 26133 row ft/A= 4.9745X 10-6 lbs of fipronil/ row ft * 454 gram/lb= 0.002258 grams per ft or 2,258 ug per ft

Calculation of Mass of Treated soil (@ soil bulk density=1.3 g/cm3)

20 " row spacing and 1 cm depth: 4" (10 cm) x 12 " (30.48 cm) x 1 cm = 304.8 cm3 * 1.3 g/cm3 = 396 grams of soil in 1 cm furrow depth
20" row spacing and 15 cm depth: 4" (10 cm) x 12" (30.48 cm) x 15 cm=4572 cm3 * 1.3 g/cm3= 5943 grams of soil in 15 cm furrow depth

Estimated Soil Concentrations

1 cm depth = 2258 ug/396 of soil= 5.70 ug/g or 5.70 ppm
15 cm depth= 2258 ug/5943 g of soil= 0.380 ug/g or 0.380 ppm

The depth averaged soil concentrations of fipronil from a single in furrow application could range from 4.27 to 5.7 mg/kg over a 1 depth and 0.284 to 0.380 mg/kg over a 15 cm depth. This concentration range accounts for application efficiency from the in furrow application process. These estimates are applicable only to soil particles and potential food sources in or surrounding furrows where ground sprays are applied. As nozzles will concentrate residues in small bands within the application site, residues on soil are expected to be limited to the immediate target zone of the spray.

The following table summarizes the estimated immediate post-treatment soil concentrations of fipronil and fipronil degradates (MB45950 and MB46136) as a result of in-furrow application.

Estimated Soil Concentrations for Fipronil and Degradates In-Furrow Application (One Annual Application)

Chemical	Soil Concentration (mg/kg) ca 1 cm	Soil Concentration (mg/kg) ca 15 cm
fipronil	4.27 to 5.7	0.284 to 0.380
MB45950*	0.214 to 0.285	0.014 to 0.019
MB46136**	1.025 to 1.368	0.068 to 0.091

* assumes a 5% conversion efficiency
** assumes a 24% conversion efficiency

In-furrow spray application of fipronil to rutabaga and turnip field soils is an application scenario not normally covered by routine exposure/risk assessment methods employed by EFED. Such a spray application does not involve application of active ingredient as a granule, precluding the use of the granular pesticide assessment methodology. Similarly, the extremely limited zone of spray application, restricted to individual furrows, would not involve general application across a field with concomitant residues on bare ground, foliage, etc. This would suggest that the use of Fletcher (1994) spray application residue values, except food items present in a pre-plant field, may not be completely reflective of such sprays applied to soil within individual furrows. Because the in furrow spray application is not completely compatible with these routine methods of risk assessment for terrestrial receptors, EFED considered an alternative approach for evaluating the exposure to terrestrial birds and mammals potentially foraging in fields treated with fipronil by this in furrow spray method.

Terrestrial wildlife foraging in or near application furrows may be exposed to residues adsorbed to soil particles or accumulated in soil organisms. Under the alternative exposure scenario for the in-furrow spray, exposures to wildlife were calculated as an oral dose (average mg/kg-bw./day) from consumption of fipronil and degradate residues accumulated in soil invertebrates and from incidental consumption of treated soil. The assessment of risk was based on comparison to oral toxicity thresholds for the most sensitive species tested.

An estimation of fipronil and its degradate concentrations potentially accumulated in the tissues of earthworms was calculated using a fugacity-based (equilibrium partitioning) approach based on the work of Trapp and McFarlane (1995) and Mackay and Paterson (1981). Earthworms dwelling within the soil are exposed to contaminants in both soil pore water and via the ingestion of soil (Belfroid et al. 1994). The concentrations of fipronil and its degradates in earthworms were calculated as a combination of uptake from soil pore water and gastrointestinal absorption from ingested soil:

$C_{earthworm} = [(C_{soil})(Z_{earthworm}/Z_{soil})]+[(C_{soil\ water})(Z_{earthworm}/Z_{water})]$

where: C_{soil} is the concentration of chemical in bulk soil (note: a chemical concentration averaged over a 15 cm soil depth was used to reflect a concentration across the earthworm occupied area of soil)

$Z_{earthworm}$ is the fugacity capacity of chemical in earthworms =
Z_{soil} is the fugacity capacity of chemical in soil = $(K_d)(\rho_{soil})/H$
Z_{water} is the fugacity capacity of chemical in water = $1/H$
$C_{soil\ water}$ is the concentration of chemical in soil water = C_{soil}/K_{bw}
K_{bw} is the bulk soil-to-water partitioning coefficient =
$(\rho_{soil})(K_d)+\theta+(\varepsilon-\theta)(K_{aw})$
K_{aw} is the air-to-water partitioning coefficient = H/RT
H = Henry's Constant specific to fipronil or degradate
R = universal gas constant, 8.31 Joules-m^3/mol-^oK
T = temperature ^oK, assumed to be 298 ^oK
K_d = soil partitioning coefficient =
(chemical K_{oc})(0.02 assumed fraction of soil organic carbon)
ρ_{soil} = bulk density of soil, assumed to be 1.3 g/cm^3
θ = volumetric fraction of the soil, assumed to be 0.30
ε = volumetric total porosity of the soil, assumed to be 0.50
lipid = fraction of lipid in organism 0.01 (Cobb et al. 1995)
K_{ow} = fipronil or degradate octanol to water partitioning coefficient
$\rho_{earthworm}$ = the density of the organism g/cm^3, assumed to be 1 g/cm^3

The following summarizes the model inputs and exposure estimates. For this alternative exposure approach.

Model Input Parameters and Dietary Exposure Estimates for Avian and Mammalian Receptors (for Soil Concentrations Immediately Post-Treatment, lowest estimated soil concentrations)

Parameter	Fipronil	MB45950	MB46136
C_{soil} (mg/kg @ 15 cm depth)*	0.284 to 0.380	0.014 to 0.019	0.068 to 0.091
Henry's Constant (Pa-m^3/mole)	4.406E-01	6.37E-03	1.315E-01
R universal gas constant (Joules-m^3/mol-^oK)	8.314	8.314	8.314
T ^oK	298	298	298
K_{ow}	10570	6310	2818
K_d (L/kg)	14.54	84.12	54.36
Z_{water} (1/H or moles/Pa-m^3)	2.269632	156.9859	7.604563
Z_{soil} (($K_\bullet \bullet \rho_{soil}$)/H)	42.90059	17167.35	537.3992
$Z_{earthworm}$ ((lipid$\bullet K_{ow} \bullet \rho_{earthworm}$)/H)	239.9001	9905.181	214.327
$C_{soil\ water}$ (mg/L)	0.0148 to 0.0198	0.000128 to 0.000173	0.000958 to 0.00128
ρ_{soil} (g/cm^3)	1.3	1.3	1.3
$\rho_{earthworm}$ (g/cm^3)	1	1	1
θ (unitless)	0.3	0.3	0.3
ε (unitless)	0.5	0.5	0.5
K_{aw} (H/RT)	0.000178	0.0000026	0.000053
K_{bw} (($\rho_{soil} \bullet$Kd)+θ+(ε-θ)(K_{aw}))	19.20204	109.656	70.96801
Earthworm Concentration (mg/kg)	3.15 to 4.22	0.016 to 0.022	0.054 to 0.072

Comparing these concentrations to the concentrations of fipronil used in the RQ calculations reveals that fipronil concentrations modeled in earthworms as a result of accumulation from soil would be between the two concentrations assumed to occur in terrestrial invertebrates at the time of application with the TREX residue model. The fipronil concentrations are more than 10 fold lower than the subacute dietary LC50 for birds and are well under the avian and mammalian reproduction NOAEC values. When the estimated earthworm fipronil concentrations are substituted in the TREX model for insects the resulting daily dose-based exposures would more than a tenth of the LD50 (greater than the listed species LOC for RQ screening purposes) for all but 1000 g birds. All estimated fipronil doses for mammals would be below acute LD50 and reproduction NOAEL for mammals.

The concentrations of MB45950 in earthworms, when converted to daily dose exposures, would be less than one tenth of the acute LD50 for all birds (a value that under normal RQ calculations that would be below concerns for listed wildlife). Similarly, the concentration of MB46136 in earthworms, expressed on a daily dose basis, would be less than a tenth of the avian LD50 for birds. These findings, if evaluated under normal RQ calculation methods, would not exceed concern for acute effects in listed and non-listed birds.

Finally, fipronil and the soil degradates may also be incidentally consumed as a part of feeding and preening behavior. Soil probing birds may consume soil at rates as high as 17% of daily dietary intake (dry) and common mammals of agricultural areas are reported to have such incidental soil ingestion rates as high a 9% of daily dietary intake (dry) (Beyer et al. 1994). The TREX model assumes that birds may consume 5, 13, and 58 g of dry mass food per day for 20, 100, and 1000 g birds, respectively. Applying an upper bound percentage of 17% to that value would yield incidental soil ingestion values of 0.9, 2.1, and 9.9 g for these birds. Using the 1 cm soil concentrations of fipronil and soil degradates above and the following equation

daily soil route dose mg/kg/day = (soil concentration (mg/kg) X soil ingestion kg/day) bird weight (kg)

yields exposures for birds summarized in the following table.

Incidental Soil Ingestion Exposure for Avian Wildlife

Bird Weight (g)	Soil Route Daily Dose mg//kg/day
Fipronil	
20	1.425
100	0.741
1000	0.3306
MB45950	
20	0.07125
100	0.03705
1000	0.01653
MB46136	
20	0.342

Bird Weight (g)	Soil Route Daily Dose mg/kg/day
100	0.17784
1000	0.079344

When compared to weight scaled bird LD50 values for the three compounds the exposures would be below the toxicity endpoints by factors well below those considered a concern for acute effects to listed and non-listed avian species. The sole exception to this finding is in the case of 20g birds where the ratio of exposure to effects endpoint:

(daily exposure 1.425 mg/kg/ 8.4 mg/kg LD50 = 0.169)

would exceed the acute toxicity endpoint by a factor above the concern level for listed species. The two degradates would not be of concern via the soil ingestion route as the exposures are much less than parent fipronil and the acute toxicity endpoints are much greater. Substituting the estimated bird exposures as surrogates for mammals (a conservative approach given the lower dietary intakes for mammals versus birds) and comparing those daily exposures with acute toxicity thresholds for mammals, results in ratios of exposure to effects endpoint well below level triggering concern for both listed and non-listed species.

On the basis of the screening RQ calculations and the results of soil invertebrate bioaccumulation and soil ingestion modeling, it is expected that concerns for any risks to birds and mammals from the dietary route of exposure will be limited to exposures from consumption of directly treated insects and seeds at the time of application, with a single exception. That exception would be small (ca 20 g) bird exposure to fipronil accumulated in soil invertebrates and exposure to incidentally ingested soil residues.

In summation a consideration of the available effects, environmental fate, and use scenario information, when evaluated in accordance with screening-level risk assessment methods, *does not provide evidence to refute* the hypothesis that fipronil use in accordance with the proposed Section 18 label will cause adverse effects on avian survival and fecundity. These concerns seem to be most apparent for small to medium non-listed and listed insectivorous birds feeding on food organisms treated in the field at the time of application, and perhaps for those feeding on soil invertebrates accumulating fipronil from the soil. Concerns for effects on birds also extends to listed species of larger body weight (ca 1kg) and for those feeding upon seeds and large insects. Similarly the assessment indicates that the available information and analyses *do not provide evidence to refute* the hypothesis that reproduction effects in mammals of all size classifications modeled will result from the proposed fipronil use.

The models for chronic exposure estimates conservatively assume that receptor organisms feed only in treated fields and consequently receive all incidental soil invertebrate prey exposure from the treated fields. The dietary exposure models assumed a depth-integrated concentration of fipronil or degradate at 15 cm as the appropriate interval for soil invertebrate exposure. In addition, soil ingestion of these compounds was assumed to occur with soils at a 1 cm depth; fipronil and degradate concentrations at this depth were factored into models of the incidental soil ingestion exposure route. Uncertainties associated with the percentage of prey and foraging occurring in treated fields cannot be quantified as many site specific factors (e.g., field size and geographical distribution) are likely to greatly influence the frequency and intensity of the use of treated turnip fields as habitat.

It should be emphasized that the dietary exposure estimates for avian and mammalian receptors are for the first year of treatment only. The environmental stability of fipronil degradates suggests that there will be carry-over of annual application residues from year to year. Preliminary evaluation of the accumulation potential of fipronil degradates from multiyear applications of fipronil to corn fields in Illinois, Ohio, Nebraska, Washington, Texas, and Mississippi suggests that MB46136 and MB45950 accumulate in the 15 cm soil profile, reaching an asymptotic maximum approximately 10 times higher than initial application period concentrations with this plateau reached within two to three years.

No target Beneficial Insect Risk

The Agency cannot quantitatively characterize the risk of adverse impacts to beneficial insects from application of fipronil insecticide products. The pesticide is very toxic to honeybees. However, given the nature of the application scenario employed for turnip treatment (in furrow spray), the extent of exposure to honeybees is assumed to be low.

Aquatic Organism Risk

As was stated in the problem formulation section of this risk assessment, habitats supporting estuarine and marine organisms are not expected to be significantly exposed to fipronil and degradates from the turnip use because the counties involved in the regulatory action are not contiguous with estuarine and marine habitats.

The acute and chronic levels of concern are exceeded by the calculated RQ for fipronil and MB46136 for freshwater invertebrates. Therefore the available information and risk assessment do not provide evidence to refute the hypothesis that freshwater invertebrates (listed and non-listed) are will exhibit survival and reproduction effects from the proposed use of fipronil. Because the risk assessment uses endpoints from freshwater invertebrates that include benthic macroinvertebrates, the potential risks may extend to infaunal species as well. The risk assessment does provide evidence to refute the hypothesis that the proposed use of fipronil will directly produce adverse effect in freshwater fish and aquatic plants as no RQ values exceed Agency concern levels.

Evaluation of Distribution of RQs, Run-Off Buffer Effects, and Alternative Application Rates

EFED conducted an analysis of risk quotients fusing the total time series of data from the PRZM/EXAMS modeling runs using an assumption of application of fipronil to the target use site once every three years.

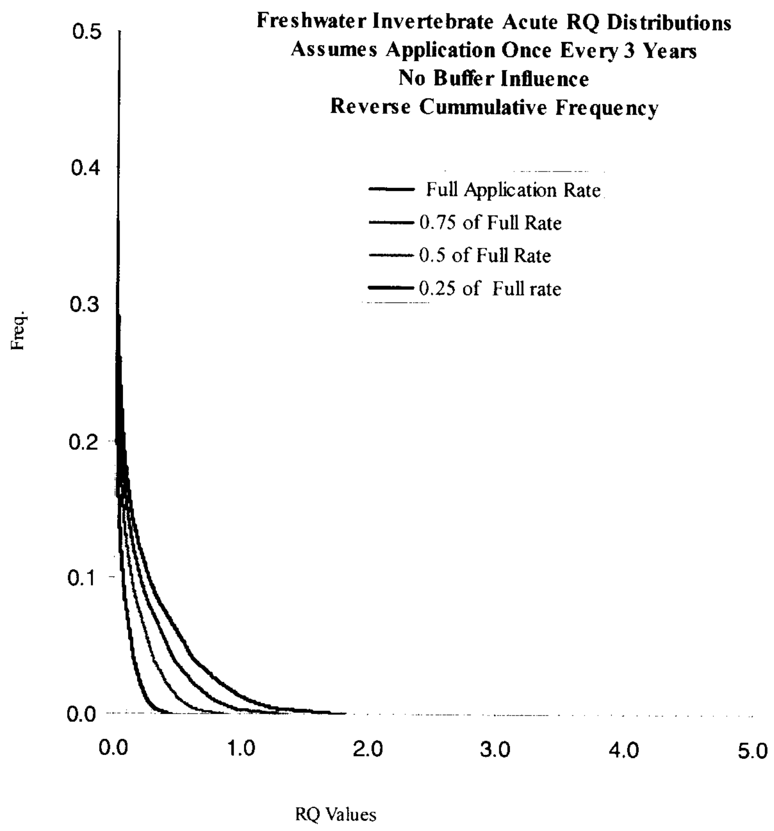
In addition to the analysis of total time series of predicted concentrations, the PRZM/EXAMS model can account for buffers directly as a part of spray drift assumptions used in the model. The Agency and registrant have negotiated placement on the label a 15 foot buffer (e.g., fire ant and leafcutter ant uses near freshwater systems) or a 60 foot buffer (corn, potato/sweet potato, pine tree uses and fire ant and leafcutter ant uses near estuarine systems) for the purposes reducing runoff loading of fipronil to surface waters. Because these buffers are not spray drift buffers they were not incorporated directly into PRZM/EXAMS runs. To evaluate the potential effects of runoff buffers on the risk conclusions, an analysis was conducted of available registrant submissions concerning buffer runoff mitigation efficiency. The following list presents the efficiency findings:

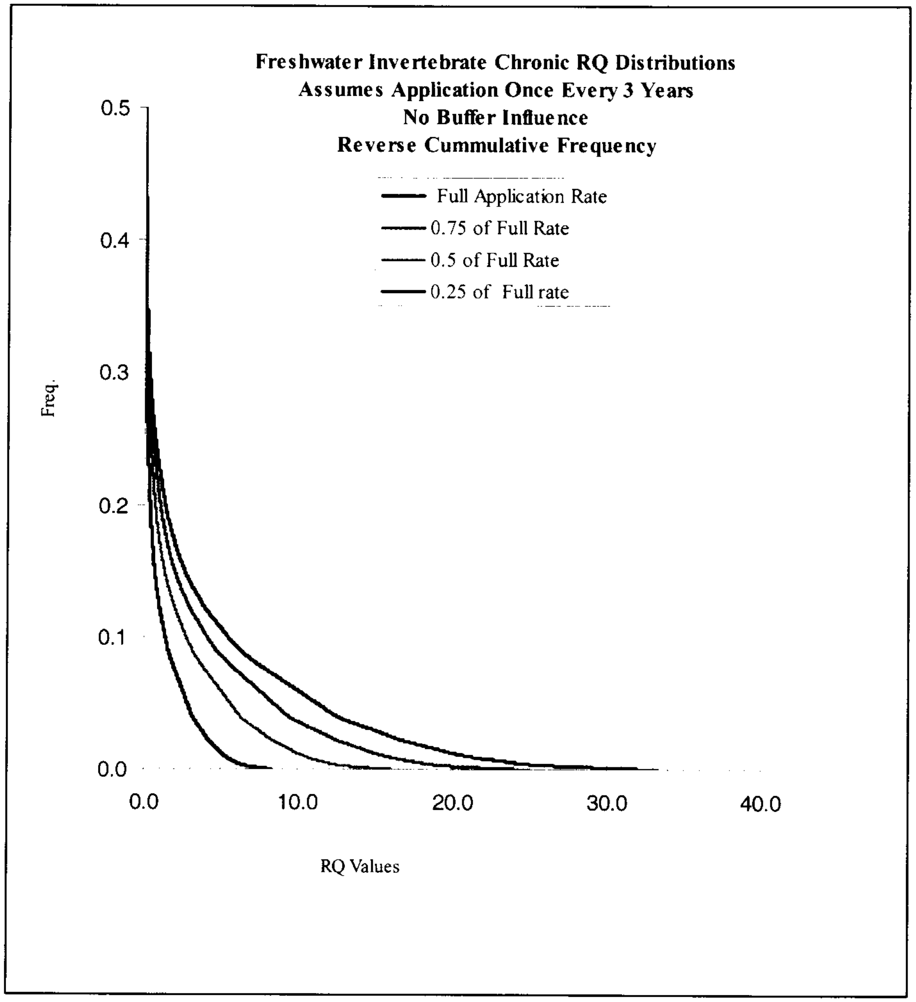
MRID	Removal Efficiency %
46490301	61-71
46490303	33-44
46490301	62-75

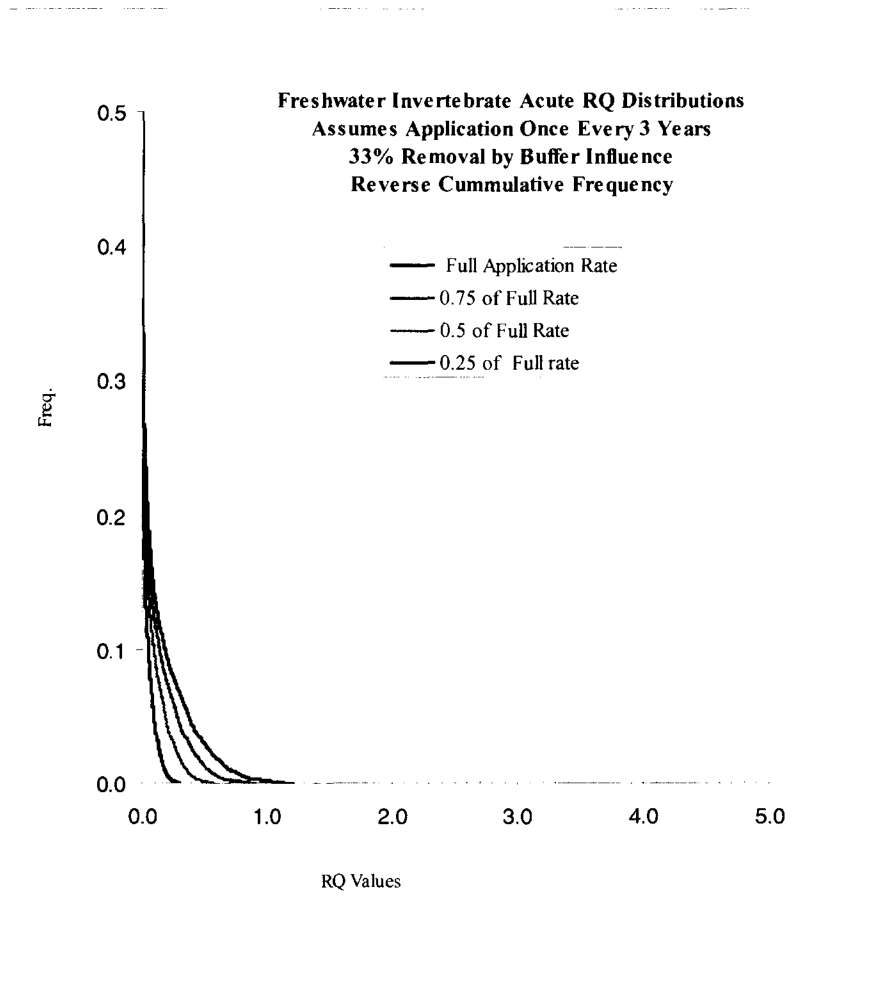
These results provide a distribution of removal efficiency of 33 to 75 percent. To evaluate the effect of these removal efficiencies the RQs were multiplied by factors of 0.67 or 0.25 and the results compared to the Agency Levels of Concern.

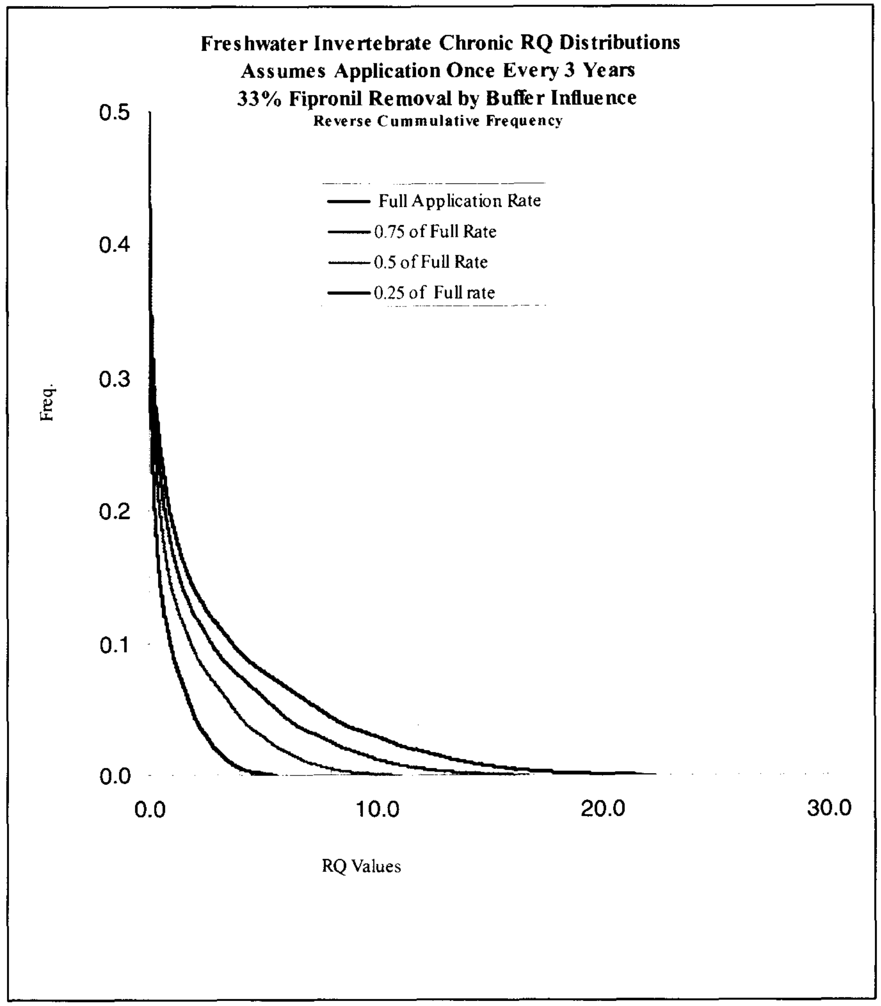
Finally, EFED assessed the effects of alternative application rate assumptions on the distribution of freshwater invertebrate acute and chronic RQ values.

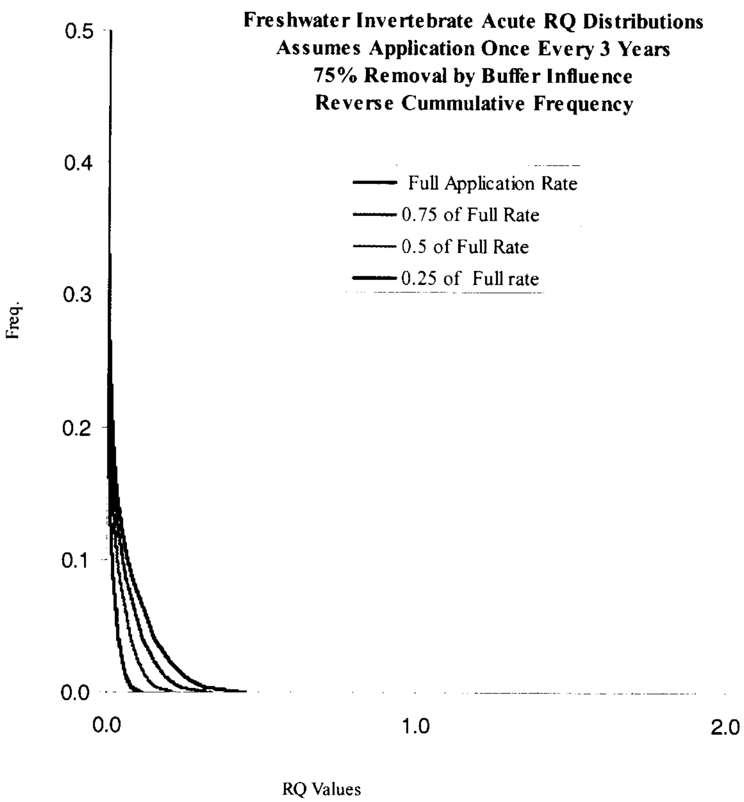
The following figures present the results of the combined effects of buffers and alternative application rates on the distribution of risk quotients for the total time series of PRZM/EXAMS model runs. These are reverse cumulative distributions and the interpolation of X-axis RQ value on the Y-axis is interpreted as the fraction of all predicted EECs that meet or exceed the selected X-axis value.

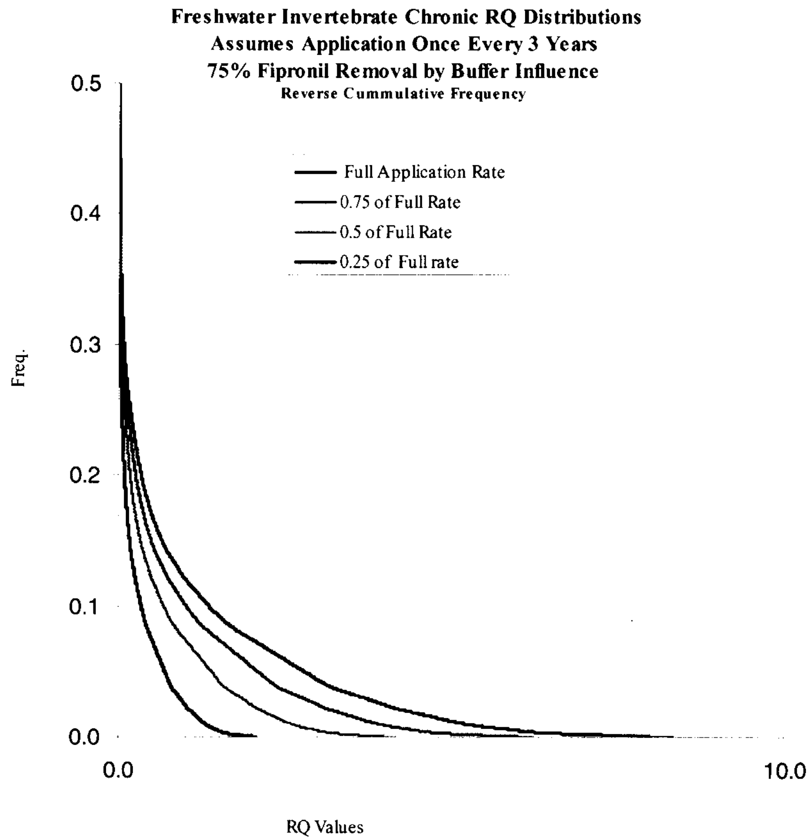

Freshwater Invertebrate Acute RQ Distributions
Assumes Application Once Every 3 Years
No Buffer Influence
Reverse Cummulative Frequency
Full Application Rate
0.75 of Full Rate
0.5 of Full Rate
0.25 of Full rate
Freq.
0.5
0.4
0.3
0.2
0.1
0.0
0.0
1.0
2.0
3.0
4.0
5.0
RQ Values


Freshwater Invertebrate Chronic RQ Distributions
Assumes Application Once Every 3 Years
No Buffer Influence
Reverse Cummulative Frequency
Full Application Rate
0.75 of Full Rate
0.5 of Full Rate
0.25 of Full rate
Freq.
0.5
0.4
0.3
0.2
0.1
0.0
0.0
10.0
20.0
30.0
40.0
RQ Values


Freshwater Invertebrate Acute RQ Distributions
Assumes Application Once Every 3 Years
33% Removal by Buffer Influence
Reverse Cummulative Frequency
Full Application Rate
0.75 of Full Rate
0.5 of Full Rate
0.25 of Full rate
Freq.
0.5
0.4
0.3
0.2
0.1
0.0
0.0
1.0
2.0
3.0
4.0
5.0
RQ Values


Freshwater Invertebrate Chronic RQ Distributions
Assumes Application Once Every 3 Years
33% Fipronil Removal by Buffer Influence
Reverse Cummulative Frequency
Full Application Rate
0.75 of Full Rate
0.5 of Full Rate
0.25 of Full rate
Freq.
0.5
0.4
0.3
0.2
0.1
0.0
0.0
10.0
20.0
30.0
RQ Values


Freshwater Invertebrate Acute RQ Distributions
Assumes Application Once Every 3 Years
75% Removal by Buffer Influence
Reverse Cummulative Frequency
Full Application Rate
0.75 of Full Rate
0.5 of Full Rate
0.25 of Full rate
Freq.
0.5
0.4
0.3
0.2
0.1
0.0
0.0
1.0
2.0
RQ Values


Freshwater Invertebrate Chronic RQ Distributions
Assumes Application Once Every 3 Years
75% Fipronil Removal by Buffer Influence
Reverse Cummulative Frequency
Full Application Rate
0.75 of Full Rate
0.5 of Full Rate
0.25 of Full rate
Freq.
0.5
0.4
0.3
0.2
0.1
0.0
0.0
10.0
RQ Values

Endangered Species Concerns

Direct Effects

The assessment for potential direct effects on listed species relies on the taxonomic-based risk assessment, incorporating a lower set of LOCs than employed for non-listed species. The taxonomic groups identified as being of concern for potential direct toxic effects include granivorous and insectivorous birds, insectivorous mammals, and freshwater invertebrates.

Dose Response Analyses

With the exception of the acute effects endpoint for freshwater invertebrates, there was insufficient information to establish a definitive slope for acute toxicity studies supplying endpoints for the calculation of risk quotients. An assumed typical probit slope of 4.5 and an assumed range of 2 to 9 for this slope estimate were used to estimate of individual mortality at when exposures for a taxa are at the listed species LOC. Data for freshwater invertebrates provided both a geometric mean slope and a range of measured values. These were used to estimate the changes of individual morality for the freshwater invertebrate taxonomic group.

Table 44. Slopes for fipronil animal endpoints and associated chance of individual mortality associated with RQ = Acute Listed Species LOC

Taxa/acute study	**Study reference**	**Slope**	**Chance of Individual Mortality at RQ= Listed Species LOC**	**Confidence Intervals Assumed slopes use slope interval 2 to 9 Measured slopes use measured range**
Bird oral dose	42918617	Assume 4.5	1 in 2.94E+05	1 in 4.40E+01 to <1 in 1.0 E+16
Bird dietary	42918620	Assume 4.5	1 in 2.94E+05	1 in 4.40E+01 to <1 in 1.0 E+16
Mammal oral dose	42918628	Assume 4.5	1 in 2.94E+05	1 in 4.40E+01 to <1 in 1.0 E+16
Freshwater fish	42918624	Assume 4.5	1 in 4.18E+08	1 in 2.16E+02 to <<1 in 1.0 E+16
Freshwater invertebrate	Overmyer et al. 2005	2.20 (range 1.21-2.43)	1 in 4.75E+02	1 in 1.73E+01 to 1 in 1.27E+03
Estuarine/marine fish	43291702	Assume 4.5	1 in 4.18E+08	1 in 2.16E+02 to <<1 in 1.0 E+16
Estuarine/marine invertebrate	43279701	Assume 4.5	1 in 4.18E+08	1 in 2.16E+02 to <<1 in 1.0 E+16

Indirect Effects

The risk assessment process evaluates the Federal action's potential for indirect effects on listed species . The potential for such indirect effects arises when RQS exceed the listed species LOCs from one or more taxonomic groups evaluated in the screening assessment process. This concern is not limited to the listed species covered by the taxonomic group with RQS in excess of LOCs. Rather, a potential concern of indirect effects to any listed species in any taxonomic group that

(1) has a dependency on the taxa for which the RQ is in excess and (2) there is an indication of potential co-location between individuals of the listed species and the action area for the Federal action. Indirect effects may minimally include impacts to food supply, important biologically mediated habitat characteristics, or other important resources necessary for completion of the listed species life cycle.

The screening risk assessment has identified direct effects concerns for birds, mammals, and freshwater invertebrates. The extent to which other listed species rely on these organisms as a resource or as a biological mediator of important habitat characteristics and the extent to which there is overlap between the locations of those listed species and the expected area where indirect effects would be of concern serve as the means to discriminate concern for indirect effects for this Federal action.

Action Area

At the screening level, the risk assessment evaluates impacts to listed and non-listed species that are on or immediate to the treatment area and are assumed to reside exclusively in this area. For terrestrial species this is the treated field and immediate field margins. For aquatic organisms this is a surface water body adjacent to the treated field. It is assumed that exposures, and so risks, are maximal in these areas and downwind and downstream exposures would be either equivalent or lower. If screening level assumptions result in no identifiable concerns for direct effects, no further analysis is needed and a no effect determination could be made. If screening levels identify concerns for direct effects on one or more taxa, then the assessment may proceed further to determine the degree to which listed species locations overlap with expected areas of pesticide use and the areas or impacts associated with those uses that may be farther from the field than initial assumptions.

For this risk assessment, because direct effects concerns were triggered for at least one taxonomic group, a determination of listed species co-location with expected use areas was initiated at a county level of resolution. Locates version 2.9.7 was used as the tool, and every taxonomic group was searched for the counties proposed for the Section 18 registration of fipronil on turnips. The Section 18 is limited to Clackamas, Marion, Multnomah, and Umatilla counties of Oregon. The results of the search show the following county-level collocations:

Taxa/Species	Counties
Birds	
bald eagle	All
northern spotted owl	Clackamas, Marion, Multnomah
Mammals	
Columbia white tail deer	Multnomah
Fish	
Oregon chub	Clackamas, Marion
Chinook salmon (lower Columbia)	Clackamas, Multnomah
Chinook salmon (upper Willamette)	Clackamas, Marion, Multnomah
Chinook salmon (Snake, fall and spring/summer)	Multnomah, Umatilla
chum salmon (Columbia)	Multnomah
steelhead (lower Columbia)	Clackamas, Marion, Multnomah,

steelhead (middle Columbia)	Multnomah, Umatilla
steelhead (upper Columbia)	Multnomah, Umatilla
steelhead (upper Willamette)	Clackamas, Marion, Multnomah
steelhead (Snake)	Multnomah, Umatilla
sockeye salmon (Snake)	Umatilla
bull trout	Clackamas, Multnomah, Umatilla
bull trout (Klamath)	Multnomah, Umatilla

Notes on Specific Species

It is not likely that Columbia white-tailed deer will be exposed to fipronil or degradates through seeds and insect dietary items. The organism is a browser and grazer, feeding on leafy vegetation and grasses according to the US Fish and Wildlife Service recovery plan for the species (http: //ecos.fws.gov/species_profile/servlet/gov.doi.species_profile.servlets.Species_FRDoc#top). Effects on the northern spotted owl my be limited to concerns for indirect effects through impact on mammalian prey. However, the US Fish and Wildlife Service Species profile for the owl (http://www.fws.gov/cno/arcata/es/birds/ns_owl.html) indicates that the species is a predator of old growth late successional forests with a primary prey base of forest-dwelling small mammals. The likelihood that it will actively rely on a small mammal prey base in turnip fields is extremely limited. Effects on bald eagles and the various species of fish listed in the co-location analysis may possibly include indirect effects on energy transfer and food availability in aquatic systems, owing to the potential for fipronil use to directly affect aquatic invertebrates.

Critical Habitat Assessment

In the evaluation of pesticide effects on designated critical habitat, consideration is given to the physical and biological features (constituent elements) of a critical habitat identified by the US Fish and Wildlife and National Marine Fisheries Services as essential to the conservation of a listed species and which may require special management considerations or protection. The evaluation of impacts for a screening level pesticide risk assessment focuses on the biological features that are constituent elements and is accomplished using the screening-level taxonomic analysis (risk quotients, RQS) and listed species levels of concern (LOCs) that are used to evaluate direct and indirect effects to listed organisms.

The screening-level risk assessment has identified potential concerns for indirect effects on listed species for those organisms dependant upon aquatic invertebrates, mammals and birds. For the species co-occurring with the proposed Section 18 counties, the northern spotted owl, bull trout and salmonid species have designated critical habitats. In light of the potential for indirect effects, the next step for EPA and the Service(s) is to identify which listed species and critical habitat are potentially implicated. Analytically, the identification of such species and critical habitat can occur in either of two ways. First, the agencies could determine whether the action area overlaps critical habitat or the occupied range of any listed species. If so, EPA would examine whether the pesticide's potential impacts on non-endangered species would affect the listed species indirectly or directly affect a constituent element of the critical habitat. Alternatively, the agencies could determine which listed species depend on biological resources, or have constituent elements that fall into, the taxa that may be directly or indirectly impacted by the pesticide. Then EPA would determine whether use of the pesticide overlaps the critical habitat or the occupied range of those listed species. At present, the information reviewed by EPA does not permit use of either analytical approach to make a definitive identification of species that are potentially impacted indirectly or critical habitats that is potentially impacted directly by the use of the pesticide. EPA and the Service(s) are working together to conduct the necessary analysis.

This screening-level risk assessment for critical habitat provides a listing of potential biological features that, if they are constituent elements of one or more critical habitats, would be of potential concern. These correspond to the taxa identified above as being of potential concern for indirect effects and include the following (enter the taxonomic groups for which listed species LOCs are exceeded). This list should serve as an initial step in problem formulation for further assessment of critical habitat impacts outlined above, should additional work be necessary"

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APPENDIX A -- Aquatic Exposure Assessment

FIPRONIL

```
orswcorn.inp
"Oregon sweet corn Marion County MLRA 2; Metfile: W24232.dvf (old: Met2.met), Kevin
Costello 8/22/01"
*** Record 3:
    0.74    0.15       0      15       1       1
*** Record 6 -- ERFLAG
       4
*** Record 7:
    0.33    1.34       1      10               2       6     354
*** Record 8
       1
*** Record 9
       1    0.25      90     100       1  91   85  87       0     244
*** Record 9a-d
       1      29
0101 1601 0102 1602 0103 1603 0104 0504 1504 1604 2004 0105 1605 0106 1606 0107
.241 .259 .277 .295 .314 .337 .352 .453 .506 .510 .528 .511 .419 .235 .139 .099
.014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014
1607 0108 1608 0109 1009 1509 1609 0110 1610 0111 1611 0112 1612
.099 .100 .101 .256 .306 .377 .390 .396 .384 .378 .383 .395 .405
.014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014
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      30
*** Record 11
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  100562  210862  100962       1
  100563  210863  100963       1
  100564  210864  100964       1
  100565  210865  100965       1
  100566  210866  100966       1
  100567  210867  100967       1
  100568  210868  100968       1
  100569  210869  100969       1
  100570  210870  100970       1
  100571  210871  100971       1
  100572  210872  100972       1
  100573  210873  100973       1
  100574  210874  100974       1
  100575  210875  100975       1
  100576  210876  100976       1
  100577  210877  100977       1
  100578  210878  100978       1
  100579  210879  100979       1
  100580  210880  100980       1
  100581  210881  100981       1
  100582  210882  100982       1
  100583  210883  100983       1
  100584  210884  100984       1
  100585  210885  100985       1
  100586  210886  100986       1
  100587  210887  100987       1
  100588  210888  100988       1
  100589  210889  100989       1
  100590  210890  100990       1
*** Record 12 -- PTITLE
Fiproniil - 1 applications @ 0.1456 kg/ha
*** Record 13
      10       1       0       0
*** Record 15 -- PSTNAM
Fiproniil
*** Record 16
```

```
  250561  0 5  1.30.1456    1    0
  250564  0 5  1.30.1456    1    0
  250567  0 5  1.30.1456    1    0
  250570  0 5  1.30.1456    1    0
  250573  0 5  1.30.1456    1    0
  250576  0 5  1.30.1456    1    0
  250579  0 5  1.30.1456    1    0
  250582  0 5  1.30.1456    1    0
  250585  0 5  1.30.1456    1    0
  250590  0 5  1.30.1456    1    0
*** Record 17
       0       0        0
*** Record 19 -- STITLE
Woodburn silt loam
*** Record 20
     203           0    0    1    0    0    0    0    0    0
*** Record 26
       0       0        0
*** Record 30
       4     727
*** Record 33
       7
       1      10    1.44   0.301        0        0        0
        0.0054150.005415       0
             0.1   0.301   0.134     1.86        0
       2      13    1.44   0.301        0        0        0
        0.0054150.005415       0
               1   0.301   0.134     1.86        0
       3      20    1.53    0.35        0        0        0
        0.0054150.005415       0
               2    0.35   0.153     0.56        0
       4      40    1.45   0.388        0        0        0
        0.0054150.005415       0
               2   0.388   0.177      0.3        0
       5      50    1.44   0.394        0        0        0
        0.0054150.005415       0
               5   0.394   0.185    0.112        0
       6      40    1.37   0.418        0        0        0
        0.0054150.005415       0
               5   0.418   0.173     0.07        0
       7      30    1.37   0.404        0        0        0
        0.0054150.005415       0
              10   0.404   0.156     0.06        0
***Record 40
       0
          YEAR       10             YEAR       10             YEAR       10    1
       1
       1   -----
       7    YEAR
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    RUNF    TSER    0    0
    INFL    TSER    1    1
    ESLS    TSER    0    0   1.0E3
    RFLX    TSER    0    0   1.0E5
    EFLX    TSER    0    0   1.0E5
    RZFX    TSER    0    0   1.0E5
```

FIPRONIL OUTPUT

WATER COLUMN DISSOLVED CONCENTRATION (PPB)

YEAR	PEAK	96 HOUR	21 DAY	60 DAY	90 DAY	YEARLY
1961	.196	.185	.148	.120	.097	.026
1962	.139	.131	.106	.074	.060	.019
1963	.000	.000	.000	.000	.000	.000
1964	.263	.253	.215	.174	.117	.029
1965	.199	.189	.154	.107	.085	.026
1966	.000	.000	.000	.000	.000	.000
1967	.278	.268	.221	.187	.157	.039
1968	.141	.134	.128	.098	.080	.025
1969	.000	.000	.000	.000	.000	.000
1970	.292	.278	.255	.198	.163	.044
1971	.179	.170	.144	.104	.085	.027
1972	.000	.000	.000	.000	.000	.000
1973	.417	.396	.340	.242	.186	.050
1974	.136	.130	.108	.079	.065	.021
1975	.000	.000	.000	.000	.000	.000
1976	.042	.039	.031	.022	.017	.005
1977	.033	.032	.027	.019	.016	.006
1978	.000	.000	.000	.000	.000	.000
1979	.407	.390	.336	.260	.207	.059
1980	.140	.134	.119	.088	.072	.023
1981	.000	.000	.000	.000	.000	.000
1982	.226	.215	.191	.135	.099	.025
1983	.137	.133	.115	.081	.065	.020
1984	.000	.000	.000	.000	.000	.000
1985	.362	.333	.239	.142	.108	.050
1986	.070	.068	.063	.051	.042	.013
1987	.000	.000	.000	.000	.000	.000
1988	.000	.000	.000	.000	.000	.000
1989	.000	.000	.000	.000	.000	.000
1990	.319	.298	.258	.220	.169	.042

SORTED FOR PLOTTING

PROB	PEAK	96 HOUR	21 DAY	60 DAY	90 DAY	YEARLY
.032	.417	.396	.340	.260	.207	.059
.065	.407	.390	.336	.242	.186	.050
.097	.362	.333	.258	.220	.169	.050
.129	.319	.298	.255	.198	.163	.044
.161	.292	.278	.239	.187	.157	.042
.194	.278	.268	.221	.174	.117	.039
.226	.263	.253	.215	.142	.108	.029
.258	.226	.215	.191	.135	.099	.027
.290	.199	.189	.154	.120	.097	.026
.323	.196	.185	.148	.107	.085	.026
.355	.179	.170	.144	.104	.085	.025
.387	.141	.134	.128	.098	.080	.025
.419	.140	.134	.119	.088	.072	.023
.452	.139	.133	.115	.081	.065	.021
.484	.137	.131	.108	.079	.065	.020
.516	.136	.130	.106	.074	.060	.019
.548	.070	.068	.063	.051	.042	.013
.581	.042	.039	.031	.022	.017	.006
.613	.033	.032	.027	.019	.016	.005
.645	.000	.000	.000	.000	.000	.000

.677	.000	.000	.000	.000	.000	.000
.710	.000	.000	.000	.000	.000	.000
.742	.000	.000	.000	.000	.000	.000
.774	.000	.000	.000	.000	.000	.000
.806	.000	.000	.000	.000	.000	.000
.839	.000	.000	.000	.000	.000	.000
.871	.000	.000	.000	.000	.000	.000
.903	.000	.000	.000	.000	.000	.000
.935	.000	.000	.000	.000	.000	.000
.968	.000	.000	.000	.000	.000	.000
1/10	.357	.330	.258	.218	.168	.049

MEAN OF ANNUAL VALUES = .018

STANDARD DEVIATION OF ANNUAL VALUES = .018

UPPER 90% CONFIDENCE LIMIT ON MEAN = .024

MB950

```
orswcorn.inp
"Oregon sweet corn Marion County MLRA 2; Metfile: W24232.dvf (old: Met2.met), Kevin
Costello 8/22/01"
*** Record 3:
    0.74    0.15       0      15       1       1
*** Record 6 -- ERFLAG
      4
*** Record 7:
    0.33    1.34       1      10               2       6     354
*** Record 8
      1
*** Record 9
      1    0.25      90     100       1  91  85  87       0     244
*** Record 9a-d
      1      29
0101 1601 0102 1602 0103 1603 0104 0504 1504 1604 2004 0105 1605 0106 1606 0107
.241 .259 .277 .295 .314 .337 .352 .453 .506 .510 .528 .511 .419 .235 .139 .099
.014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014
1607 0108 1608 0109 1009 1509 1609 0110 1610 0111 1611 0112 1612
.099 .100 .101 .256 .306 .377 .390 .396 .384 .378 .383 .395 .405
.014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014
*** Record 10 -- NCPDS, the number of cropping periods
     30
*** Record 11
  100561  210861  100961       1
  100562  210862  100962       1
  100563  210863  100963       1
  100564  210864  100964       1
  100565  210865  100965       1
  100566  210866  100966       1
  100567  210867  100967       1
  100568  210868  100968       1
  100569  210869  100969       1
  100570  210870  100970       1
  100571  210871  100971       1
  100572  210872  100972       1
  100573  210873  100973       1
  100574  210874  100974       1
  100575  210875  100975       1
  100576  210876  100976       1
  100577  210877  100977       1
  100578  210878  100978       1
```

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  100579  210879  100979       1
  100580  210880  100980       1
  100581  210881  100981       1
  100582  210882  100982       1
  100583  210883  100983       1
  100584  210884  100984       1
  100585  210885  100985       1
  100586  210886  100986       1
  100587  210887  100987       1
  100588  210888  100988       1
  100589  210889  100989       1
  100590  210890  100990       1
*** Record 12 -- PTITLE
MB45950 - 1 applications @ 0.0072 kg/ha
*** Record 13
      10       1       0       0
*** Record 15 -- PSTNAM
MB45950
*** Record 16
  250561  0 5  1.30.0072    1    0
  250564  0 5  1.30.0072    1    0
  250567  0 5  1.30.0072    1    0
  250570  0 5  1.30.0072    1    0
  250573  0 5  1.30.0072    1    0
  250576  0 5  1.30.0072    1    0
  250579  0 5  1.30.0072    1    0
  250582  0 5  1.30.0072    1    0
  250585  0 5  1.30.0072    1    0
  250590  0 5  1.30.0072    1    0
*** Record 17
       0       0       0
*** Record 19 -- STITLE
Woodburn silt loam
*** Record 20
     203           0   0   1   0   0   0   0   0   0
*** Record 26
       0       0       0
*** Record 30
       4    3911
*** Record 33
       7
       1      10    1.44   0.301       0       0       0
         0.00099 0.00099       0
             0.1   0.301   0.134    1.86       0
       2      13    1.44   0.301       0       0       0
         0.00099 0.00099       0
               1   0.301   0.134    1.86       0
       3      20    1.53    0.35       0       0       0
         0.00099 0.00099       0
               2    0.35   0.153    0.56       0
       4      40    1.45   0.388       0       0       0
         0.00099 0.00099       0
               2   0.388   0.177     0.3       0
       5      50    1.44   0.394       0       0       0
         0.00099 0.00099       0
               5   0.394   0.185   0.112       0
       6      40    1.37   0.418       0       0       0
         0.00099 0.00099       0
               5   0.418   0.173    0.07       0
       7      30    1.37   0.404       0       0       0
         0.00099 0.00099       0
              10   0.404   0.156    0.06       0
***Record 40
       0
          YEAR      10            YEAR      10            YEAR      10   1
       1
       1  -----
```

7	YEAR			
PRCP	TCUM	0	0	
RUNF	TCUM	0	0	
INFL	TCUM	1	1	
ESLS	TCUM	0	0	1.0E3
RFLX	TCUM	0	0	1.0E5
EFLX	TCUM	0	0	1.0E5
RZFX	TCUM	0	0	1.0E5

MB950 OUTPUT

WATER COLUMN DISSOLVED CONCENTRATION (PPB)

YEAR	PEAK	96 HOUR	21 DAY	60 DAY	90 DAY	YEARLY
1961	.014	.012	.008	.005	.004	.001
1962	.012	.011	.010	.009	.008	.007
1963	.012	.011	.011	.010	.010	.009
1964	.037	.035	.024	.018	.015	.010
1965	.028	.028	.024	.022	.021	.020
1966	.025	.025	.023	.022	.022	.021
1967	.032	.031	.028	.025	.024	.021
1968	.036	.035	.032	.030	.029	.028
1969	.031	.030	.030	.029	.029	.028
1970	.044	.039	.036	.034	.032	.028
1971	.042	.041	.039	.037	.037	.036
1972	.039	.038	.037	.036	.036	.035
1973	.058	.055	.051	.047	.043	.035
1974	.060	.059	.054	.050	.050	.047
1975	.046	.046	.046	.046	.045	.044
1976	.043	.043	.043	.042	.042	.041
1977	.047	.047	.045	.042	.041	.040
1978	.044	.044	.043	.042	.042	.041
1979	.049	.048	.046	.045	.044	.040
1980	.054	.052	.050	.048	.047	.046
1981	.048	.048	.047	.046	.046	.045
1982	.055	.053	.052	.047	.045	.043
1983	.057	.056	.054	.053	.053	.050
1984	.049	.049	.049	.049	.049	.047
1985	.051	.051	.049	.048	.047	.046
1986	.056	.055	.054	.051	.051	.049
1987	.050	.050	.049	.049	.049	.047
1988	.046	.046	.046	.045	.045	.044
1989	.042	.042	.042	.042	.042	.041
1990	.047	.046	.045	.043	.042	.039

SORTED FOR PLOTTING

PROB	PEAK	96 HOUR	21 DAY	60 DAY	90 DAY	YEARLY
.032	.060	.059	.054	.053	.053	.050
.065	.058	.056	.054	.051	.051	.049
.097	.057	.055	.054	.050	.050	.047
.129	.056	.055	.052	.049	.049	.047
.161	.055	.053	.051	.049	.049	.047
.194	.054	.052	.050	.048	.047	.046
.226	.051	.051	.049	.048	.047	.046
.258	.050	.050	.049	.047	.046	.045
.290	.049	.049	.049	.047	.045	.044
.323	.049	.048	.047	.046	.045	.044

.355	.048	.048	.046	.046	.045	.043
.387	.047	.047	.046	.045	.044	.041
.419	.047	.046	.046	.045	.043	.041
.452	.046	.046	.045	.043	.042	.041
.484	.046	.046	.045	.042	.042	.040
.516	.044	.044	.043	.042	.042	.040
.548	.044	.043	.043	.042	.042	.039
.581	.043	.042	.042	.042	.041	.036
.613	.042	.041	.039	.037	.037	.035
.645	.042	.039	.037	.036	.036	.035
.677	.039	.038	.036	.034	.032	.028
.710	.037	.035	.032	.030	.029	.028
.742	.036	.035	.030	.029	.029	.028
.774	.032	.031	.028	.025	.024	.021
.806	.031	.030	.024	.022	.022	.021
.839	.028	.028	.024	.022	.021	.020
.871	.025	.025	.023	.018	.015	.010
.903	.014	.012	.011	.010	.010	.009
.935	.012	.011	.010	.009	.008	.007
.968	.012	.011	.008	.005	.004	.001
1/10	.056	.055	.053	.050	.050	.047

MEAN OF ANNUAL VALUES = .034

STANDARD DEVIATION OF ANNUAL VALUES = .014

UPPER 90% CONFIDENCE LIMIT ON MEAN = .038

MB136

```
orswcorn.inp
"Oregon sweet corn Marion County MLRA 2; Metfile: W24232.dvf (old: Met2.met), Kevin
Costello 8/22/01"
*** Record 3:
    0.74    0.15       0      15       1       1
*** Record 6 -- ERFLAG
      4
*** Record 7:
    0.33    1.34       1      10               2       6     354
*** Record 8
      1
*** Record 9
      1    0.25      90     100       1  91   85  87       0     244
*** Record 9a-d
      1      29
0101 1601 0102 1602 0103 1603 0104 0504 1504 1604 2004 0105 1605 0106 1606 0107
.241 .259 .277 .295 .314 .337 .352 .453 .506 .510 .528 .511 .419 .235 .139 .099
.014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014
1607 0108 1608 0109 1009 1509 1609 0110 1610 0111 1611 0112 1612
.099 .100 .101 .256 .306 .377 .390 .396 .384 .378 .383 .395 .405
.014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014
*** Record 10 -- NCPDS, the number of cropping periods
     30
*** Record 11
  100561  210861  100961       1
  100562  210862  100962       1
  100563  210863  100963       1
  100564  210864  100964       1
  100565  210865  100965       1
  100566  210866  100966       1
  100567  210867  100967       1
  100568  210868  100968       1
  100569  210869  100969       1
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  100570  210870  100970       1
  100571  210871  100971       1
  100572  210872  100972       1
  100573  210873  100973       1
  100574  210874  100974       1
  100575  210875  100975       1
  100576  210876  100976       1
  100577  210877  100977       1
  100578  210878  100978       1
  100579  210879  100979       1
  100580  210880  100980       1
  100581  210881  100981       1
  100582  210882  100982       1
  100583  210883  100983       1
  100584  210884  100984       1
  100585  210885  100985       1
  100586  210886  100986       1
  100587  210887  100987       1
  100588  210888  100988       1
  100589  210889  100989       1
  100590  210890  100990       1
*** Record 12 -- PTITLE
MB46136 - 1 applications @ 0.0349 kg/ha
*** Record 13
      10       1       0       0
*** Record 15 -- PSTNAM
MB46136
*** Record 16
  250561  0 5  1.30.0349    1     0
  250564  0 5  1.30.0349    1     0
  250567  0 5  1.30.0349    1     0
  250570  0 5  1.30.0349    1     0
  250573  0 5  1.30.0349    1     0
  250576  0 5  1.30.0349    1     0
  250579  0 5  1.30.0349    1     0
  250582  0 5  1.30.0349    1     0
  250585  0 5  1.30.0349    1     0
  250590  0 5  1.30.0349    1     0
*** Record 17
       0       0       0
*** Record 19 -- STITLE
Woodburn silt loam
*** Record 20
     203           0    0    1    0    0    0    0    0    0
*** Record 26
       0       0       0
*** Record 30
       4    4208
*** Record 33
       7
       1      10    1.44   0.301       0       0       0
         0.00099 0.00099       0
             0.1   0.301   0.134    1.86       0
       2      13    1.44   0.301       0       0       0
         0.00099 0.00099       0
               1   0.301   0.134    1.86       0
       3      20    1.53    0.35       0       0       0
         0.00099 0.00099       0
               2    0.35   0.153    0.56       0
       4      40    1.45   0.388       0       0       0
         0.00099 0.00099       0
               2   0.388   0.177     0.3       0
       5      50    1.44   0.394       0       0       0
         0.00099 0.00099       0
               5   0.394   0.185   0.112       0
       6      40    1.37   0.418       0       0       0
         0.00099 0.00099       0
```

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            5   0.418   0.173    0.07        0
     7     30    1.37   0.404       0        0        0
       0.00099 0.00099      0
           10   0.404   0.156    0.06        0
***Record 40
     0
          YEAR      10             YEAR      10             YEAR      10   1
     1
     1  -----
     7    YEAR
  PRCP    TCUM   0   0
  RUNF    TCUM   0   0
  INFL    TCUM   1   1
  ESLS    TCUM   0   0  1.0E3
  RFLX    TCUM   0   0  1.0E5
  EFLX    TCUM   0   0  1.0E5
  RZFX    TCUM   0   0  1.0E5
```

MB136 OUTPUT

WATER COLUMN DISSOLVED CONCENTRATION (PPB)

YEAR	PEAK	96 HOUR	21 DAY	60 DAY	90 DAY	YEARLY
1961	.061	.054	.035	.021	.016	.004
1962	.053	.049	.043	.038	.036	.029
1963	.053	.051	.047	.044	.043	.040
1964	.163	.154	.105	.076	.063	.045
1965	.125	.121	.105	.097	.092	.084
1966	.109	.107	.099	.092	.092	.087
1967	.137	.133	.118	.104	.099	.085
1968	.152	.149	.135	.125	.121	.115
1969	.129	.128	.125	.123	.121	.116
1970	.184	.161	.147	.137	.128	.113
1971	.175	.168	.160	.152	.151	.146
1972	.159	.157	.151	.148	.147	.140
1973	.240	.228	.207	.191	.171	.140
1974	.252	.244	.220	.203	.201	.187
1975	.184	.183	.181	.181	.180	.173
1976	.166	.166	.165	.165	.164	.159
1977	.184	.180	.170	.160	.155	.152
1978	.170	.168	.163	.161	.159	.152
1979	.189	.184	.176	.169	.165	.148
1980	.209	.203	.189	.180	.178	.171
1981	.183	.181	.175	.172	.171	.165
1982	.209	.202	.193	.175	.167	.157
1983	.216	.213	.207	.201	.198	.187
1984	.184	.183	.182	.181	.180	.174
1985	.190	.188	.180	.175	.171	.165
1986	.211	.207	.198	.187	.184	.175
1987	.185	.183	.179	.176	.175	.168
1988	.164	.163	.162	.161	.160	.154
1989	.146	.146	.146	.145	.145	.139
1990	.168	.163	.155	.151	.144	.131

SORTED FOR PLOTTING

PROB	PEAK	96 HOUR	21 DAY	60 DAY	90 DAY	YEARLY
.032	.252	.244	.220	.203	.201	.187
.065	.240	.228	.207	.201	.198	.187
.097	.216	.213	.207	.191	.184	.175
.129	.211	.207	.198	.187	.180	.174

.161	.209	.203	.193	.181	.180	.173
.194	.209	.202	.189	.181	.178	.171
.226	.190	.188	.182	.180	.175	.168
.258	.189	.184	.181	.176	.171	.165
.290	.185	.183	.180	.175	.171	.165
.323	.184	.183	.179	.175	.171	.159
.355	.184	.183	.176	.172	.167	.157
.387	.184	.181	.175	.169	.165	.154
.419	.184	.180	.170	.165	.164	.152
.452	.183	.168	.165	.161	.160	.152
.484	.175	.168	.163	.161	.159	.148
.516	.170	.166	.162	.160	.155	.146
.548	.168	.163	.160	.152	.151	.140
.581	.166	.163	.155	.151	.147	.140
.613	.164	.161	.151	.148	.145	.139
.645	.163	.157	.147	.145	.144	.131
.677	.159	.154	.146	.137	.128	.116
.710	.152	.149	.135	.125	.121	.115
.742	.146	.146	.125	.123	.121	.113
.774	.137	.133	.118	.104	.099	.087
.806	.129	.128	.105	.097	.092	.085
.839	.125	.121	.105	.092	.092	.084
.871	.109	.107	.099	.076	.063	.045
.903	.061	.054	.047	.044	.043	.040
.935	.053	.051	.043	.038	.036	.029
.968	.053	.049	.035	.021	.016	.004
1/10	.216	.213	.206	.191	.184	.175

MEAN OF ANNUAL VALUES = .130

STANDARD DEVIATION OF ANNUAL VALUES = .049

UPPER 90% CONFIDENCE LIMIT ON MEAN = .145

MB513

```
orswcorn.inp
"Oregon sweet corn Marion County MLRA 2; Metfile: W24232.dvf (old: Met2.met), Kevin
Costello 8/22/01"
*** Record 3:
    0.74    0.15       0      15       1       1
*** Record 6 -- ERFLAG
       4
*** Record 7:
    0.33    1.34       1      10               2       6     354
*** Record 8
       1
*** Record 9
       1    0.25      90     100       1  91  85  87       0     244
*** Record 9a-d
       1      29
0101 1601 0102 1602 0103 1603 0104 0504 1504 1604 2004 0105 1605 0106 1606 0107
.241 .259 .277 .295 .314 .337 .352 .453 .506 .510 .528 .511 .419 .235 .139 .099
.014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014
1607 0108 1608 0109 1009 1509 1609 0110 1610 0111 1611 0112 1612
.099 .100 .101 .256 .306 .377 .390 .396 .384 .378 .383 .395 .405
.014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014 .014
*** Record 10 -- NCPDS, the number of cropping periods
      30
*** Record 11
  100561  210861  100961       1
  100562  210862  100962       1
  100563  210863  100963       1
  100564  210864  100964       1
```

```
  100565  210865  100965        1
  100566  210866  100966        1
  100567  210867  100967        1
  100568  210868  100968        1
  100569  210869  100969        1
  100570  210870  100970        1
  100571  210871  100971        1
  100572  210872  100972        1
  100573  210873  100973        1
  100574  210874  100974        1
  100575  210875  100975        1
  100576  210876  100976        1
  100577  210877  100977        1
  100578  210878  100978        1
  100579  210879  100979        1
  100580  210880  100980        1
  100581  210881  100981        1
  100582  210882  100982        1
  100583  210883  100983        1
  100584  210884  100984        1
  100585  210885  100985        1
  100586  210886  100986        1
  100587  210887  100987        1
  100588  210888  100988        1
  100589  210889  100989        1
  100590  210890  100990        1
*** Record 12 -- PTITLE
MB46513 - 1 applications @ 0.0014 kg/ha
*** Record 13
      10       1       0       0
*** Record 15 -- PSTNAM
MB46513
*** Record 16
  250561  0 5  1.30.0014    1    0
  250564  0 5  1.30.0014    1    0
  250567  0 5  1.30.0014    1    0
  250570  0 5  1.30.0014    1    0
  250573  0 5  1.30.0014    1    0
  250576  0 5  1.30.0014    1    0
  250579  0 5  1.30.0014    1    0
  250582  0 5  1.30.0014    1    0
  250585  0 5  1.30.0014    1    0
  250590  0 5  1.30.0014    1    0
*** Record 17
       0       0       0
*** Record 19 -- STITLE
Woodburn silt loam
*** Record 20
     203            0    0    1    0    0    0    0    0    0
*** Record 26
       0       0       0
*** Record 30
       4    1290
*** Record 33
       7
       1      10    1.44   0.301       0       0       0
         0.00105 0.00105       0
             0.1   0.301   0.134    1.86       0
       2      13    1.44   0.301       0       0       0
         0.00105 0.00105       0
               1   0.301   0.134    1.86       0
       3      20    1.53    0.35       0       0       0
         0.00105 0.00105       0
               2    0.35   0.153    0.56       0
       4      40    1.45   0.388       0       0       0
         0.00105 0.00105       0
               2   0.388   0.177     0.3       0
```

```
       5       50     1.44    0.394        0        0        0
         0.00105 0.00105         0
                5    0.394    0.185    0.112        0
       6       40     1.37    0.418        0        0        0
         0.00105 0.00105         0
                5    0.418    0.173     0.07        0
       7       30     1.37    0.404        0        0        0
         0.00105 0.00105         0
               10    0.404    0.156     0.06        0
***Record 40
       0
             YEAR       10              YEAR       10              YEAR       10    1
       1
       1   -----
       7     YEAR
    PRCP     TCUM    0    0
    RUNF     TCUM    0    0
    INFL     TCUM    1    1
    ESLS     TCUM    0    0   1.0E3
    RFLX     TCUM    0    0   1.0E5
    EFLX     TCUM    0    0   1.0E5
    RZFX     TCUM    0    0   1.0E5
```

MB513 OUTPUT

WATER COLUMN DISSOLVED CONCENTRATION (PPB)

YEAR	PEAK	96 HOUR	21 DAY	60 DAY	90 DAY	YEARLY
1961	.006	.006	.005	.003	.002	.001
1962	.005	.005	.005	.004	.004	.004
1963	.004	.004	.004	.004	.004	.004
1964	.014	.014	.011	.008	.006	.004
1965	.013	.013	.012	.011	.011	.009
1966	.009	.009	.009	.009	.009	.008
1967	.015	.014	.014	.012	.011	.009
1968	.015	.015	.014	.014	.014	.013
1969	.012	.012	.012	.012	.012	.012
1970	.019	.018	.017	.016	.015	.012
1971	.019	.019	.018	.018	.017	.016
1972	.015	.015	.015	.015	.015	.015
1973	.025	.024	.023	.022	.019	.015
1974	.022	.022	.022	.021	.021	.020
1975	.019	.019	.019	.019	.019	.018
1976	.017	.017	.017	.017	.017	.017
1977	.018	.018	.017	.017	.017	.017
1978	.016	.016	.016	.016	.016	.016
1979	.021	.021	.021	.020	.019	.016
1980	.022	.022	.021	.021	.021	.020
1981	.019	.019	.019	.019	.018	.018
1982	.023	.023	.022	.020	.019	.017
1983	.023	.023	.022	.022	.022	.020
1984	.019	.019	.019	.019	.019	.019
1985	.022	.022	.021	.021	.020	.019
1986	.022	.022	.022	.021	.021	.020
1987	.020	.020	.019	.019	.019	.019
1988	.018	.018	.018	.018	.018	.017
1989	.017	.017	.017	.017	.016	.016
1990	.020	.020	.020	.019	.018	.016

SORTED FOR PLOTTING
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PROB	PEAK	96 HOUR	21 DAY	60 DAY	90 DAY	YEARLY
.032	.025	.024	.023	.022	.022	.020
.065	.023	.023	.022	.022	.021	.020
.097	.023	.023	.022	.021	.021	.020
.129	.022	.022	.022	.021	.021	.020
.161	.022	.022	.022	.021	.020	.019
.194	.022	.022	.021	.021	.019	.019
.226	.022	.022	.021	.020	.019	.019
.258	.021	.021	.021	.020	.019	.018
.290	.020	.020	.020	.019	.019	.018
.323	.020	.020	.019	.019	.019	.017
.355	.019	.019	.019	.019	.019	.017
.387	.019	.019	.019	.019	.018	.017
.419	.019	.019	.019	.019	.018	.017
.452	.019	.019	.018	.018	.018	.016
.484	.019	.018	.018	.018	.017	.016
.516	.018	.018	.017	.017	.017	.016
.548	.018	.018	.017	.017	.017	.016
.581	.017	.017	.017	.017	.016	.016
.613	.017	.017	.017	.016	.016	.015
.645	.016	.016	.016	.016	.015	.015
.677	.015	.015	.015	.015	.015	.013
.710	.015	.015	.014	.014	.014	.012
.742	.015	.014	.014	.012	.012	.012
.774	.014	.014	.012	.012	.011	.009
.806	.013	.013	.012	.011	.011	.009
.839	.012	.012	.011	.009	.009	.008
.871	.009	.009	.009	.008	.006	.004
.903	.006	.006	.005	.004	.004	.004
.935	.005	.005	.005	.004	.004	.004
.968	.004	.004	.004	.003	.002	.001
1/10	.023	.023	.022	.021	.021	.020

MEAN OF ANNUAL VALUES = .014

STANDARD DEVIATION OF ANNUAL VALUES = .005

UPPER 90% CONFIDENCE LIMIT ON MEAN = .016