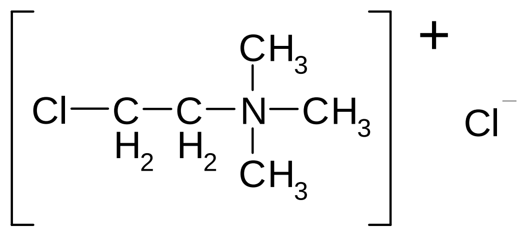
Office of Prevention, Pesticides, and Toxic Substances

# Environmental Fate and Ecological Risk Assessment for the Reregistration of Chlormequat Chloride



**Cycocel®**

**CAS No. 00999-81-5 PC Code 018101**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# I. EXECUTIVE SUMMARY

The intent of this document is to review the environmental fate and potential ecological effects associated with the outdoor uses of chlormequat chloride on bedding plants and containerized nursery crops (Cycocel®; EPA Reg. No. 241-74).

## A. Nature of the Chemical Stressor

Chlormequat chloride is also registered for use on indoor greenhouse ornamental crops, but these uses are not evaluated in this assessment. Chlormequat chloride, the sole active ingredient in Cycocel®, is a plant growth regulator (PGR) applied as a drench or spray to greenhouse plants and proposed outdoor spray on containerized ornamentals.

## B. Conclusions – Exposure Characterization

Chlormequat chloride is expected to be moderately mobile to mobile (FAO classification scheme) in the environment. Major routes of dissipation in the environment include microbial degradation in soils and aquatic systems; however, the extent to which the chemical is subject to abiotic routes of degradation is unknown since no data are currently available. There is uncertainty regarding chlormequat chlorides' persistence in the environment. In aerobic soil metabolism studies, chlormequat chloride degraded with half-lives ranging from 4-6 weeks. But there were significant unidentified residues in these studies. Including the unidentified residues in the half-life estimates increases them to ~ 1-4 months. In aquatic environments, chlormequat chloride was short-lived, degrading with half-lives of ~ 1 week. However, significant non-extractable residues were detected in these studies and it is uncertain whether or not they consist of parent chlormequat chloride and/or residues of risk concern.

## C. Conclusions – Effects Characterization

For aquatic organisms on an acute exposure basis, chlormequat chloride is classified as practically non-toxic to freshwater and estuarine/marine fish, slightly toxic to freshwater and estuarine/marine invertebrates, and moderately toxic to aquatic plants. For terrestrial organisms, chlormequat chloride is categorized as slightly toxic to birds, moderately toxic to mammals and practically non-toxic to honeybees on an acute exposure basis. Chronic toxicity endpoints for birds and mammals include decreases in weight gain. Sublethal effects in birds also included eggshell thinning and decreased testicular weight, effects often associated with endocrine-mediated processes. Sensitive terrestrial plants can be adversely affected by chlormequat chloride.

## D. Potential Risks to Non-target Organisms

Based on this screening-level assessment, the proposed new use of chlormequat chloride could result in acute and chronic risk to terrestrial animals, risk to terrestrial plants and Federally-listed threatened and endangered (listed) aquatic vascular plant species. Adverse effects to terrestrial or aquatic plants could affect primary productivity in their respective ecosystems, leading to effects on higher trophic levels. The acute risk level of concern (LOC) is exceeded for birds foraging on short grass, tall grass and broadleaf plants/small insects and for small-sized (20g) birds foraging on fruits/pods/seeds/large insects (RQs 0.45-6.9). The listed species LOC is also exceeded for small- and medium-sized (100g) birds foraging on fruits/pods/large insects. While a NOAEC was not determined for birds, using the lowest dietary concentration tested indicates potential chronic risk to birds in all forage classes. There is potential acute risk to mammals foraging on short grass, tall grass and broadleaf plant/small insects (RQs 0.45-2.2), and the listed species LOC is exceeded for small (15g) and medium size (35g) classes foraging on fruits/pods/large insects. Potential chronic risk to mammals is indicated for all size classes for the short grass, tall grass and broadleaf plant/small insect forage classes. **Table 1** summarizes the listed taxa potentially at risk from direct and/or indirect effects due to the outdoor applications of chlormequat chloride.

### E. Data Gaps and Uncertainties

There are several data gaps that increase the uncertainty of this assessment. There are currently no acceptable data for hydrolysis, photolysis, anaerobic soil metabolism or terrestrial field dissipation. In the absence of data, it was assumed that chlormequat chloride is stable to hydrolysis, photolysis and anaerobic metabolism. In the aerobic soil and aerobic aquatic metabolism studies all transformation products greater than 10% of the applied may not have been identified. A total residue approach was used for calculating the aerobic soil metabolism half-life for exposure modeling.

There are currently no data regarding the toxicity of chlormequat chloride to freshwater fish on a chronic exposure basis. Although use of the acute to chronic ratio for daphnids suggests the likelihood of chronic risk to freshwater fish is low, potential for risk is presumed. Additionally, there are no data available to evaluate the potential chronic risk to estuarine/marine organisms.

The avian reproduction study with chlormequat chloride did not determine the necessary NOAEC due to significant treatment-related effects at all treatment levels. The terrestrial plant seedling emergence study also did not establish a NOEC, also due to effects at all treatment levels. These deficiencies increase the uncertainty in the assessment.

Since there are no specific nursery scenarios for aquatic exposure modeling, surrogate scenarios were used. The turf scenarios were chosen as surrogates because they consist of high organic matter top soil layers that are similar to soils used for bedding plants in nurseries. However, the extent to which the meteorologic, edaphic and agronomic characteristics of the surrogate scenarios are representative of actual use sites in nurseries is uncertain.

**Table 1**. Listed species risks associated with potential direct or indirect effects due to the proposed applications of chlormequat chloride in containerized ornamental production.

| Listed Taxon | Direct Effects Acute | Direct Effects Chronic | Indirect Effects |
|---|---|---|---|
| Terrestrial and semi-aquatic plants - monocots | Yes | - | Yes[1] |
| Terrestrial and semi-aquatic plants - dicots | Yes | - | Yes[1] |
| Insects | No | - | Yes[1] |
| Birds | Yes | Yes | Yes[1] |
| Terrestrial phase amphibians | Yes | Yes | Yes[1] |
| Reptiles | Yes | Yes | Yes[1] |
| Mammals | Yes | Yes | Yes[1] |

| | | | |
|---|---|---|---|
| Aquatic plants | Yes | - | Yes[1] |
| Freshwater fish | No | No data[2] | Yes[1] |
| Aquatic phase amphibians | No | No data | Yes[1] |
| Freshwater invertebrates | No | No | Yes[1] |
| Mollusks | No data | No data | Yes[1] |
| Marine/estuarine fish | No | No data | Yes[1] |
| Marine/estuarine crustaceans | No | No data | Yes[1] |

[1]Unlisted LOC exceeded for terrestrial and aquatic vascular plants, therefore there is potential for adverse effects to those species that rely either on a specific plant species or multiple plant species. Plant indirect effects may include general habitat modification, host plant loss, and food supply disruption.
[2]When data are unavailable, risk is presumed.

# II. PROBLEM FORMULATION

## A. Stressor Source and Distribution

### 1. Source and Intensity

This screening-level environmental fate and ecological risk assessment evaluates the potential risk to non-target organisms from the outdoor use of chlormequat chloride as a backpack or ground spray on containerized ornamentals and bedding plants in nurseries, shadehouses and other non-enclosed structures. Chlormequat chloride, the sole active ingredient in Cycocel®, is a plant growth regulator (PGR) registered for application as a drench or spray to greenhouse plants. For outdoor use of chlormequat chloride, the compound can be applied at a maximum rate of 33.3 lbs ai/A/year. Greenhouse uses were not considered since aquatic and terrestrial exposures are expected to be minimal due to the closed-system nature of their operations and discharges from greenhouses must be regulated in accordance with a NPDES permit under the Clean Water Act.

According to the product labels, a primary use of chlormequat chloride is as a tank mix with another PGR, B-nine® (daminozide; EPA Reg. No. 400-69).

### 2. Physical/Chemical/Fate and Transport Properties

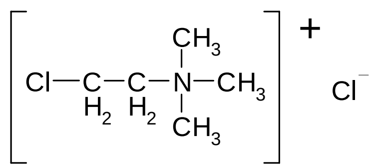
Chlormequat chloride is the salt of a quaternary ammonium cation, a diverse group of molecules commonly known as "quats". More specifically, chlormequat chloride has been classified according to the Agency's PR Notice 88-2 (February 26, 1988) as a Group I, alkyl or hydroxyalkyl (straight chain) substituted quaternary ammonium compounds. Another Group I quaternary ammonium salt, didecyldimethylammonium chloride (DDAC) was recently reregistered by the Antimicrobials Division (USEPA D325481, 2006). The quaternary ammonium cations are permanently charged, independent of the pH of solution.

Chlormequat chloride is expected to be moderately mobile to mobile (FAO classification scheme) in the environment. The major route of dissipation in the environment appears to be microbial degradation in both soil and aquatic systems. There is uncertainty regarding chlormequat chloride's persistence in the environment.

### 3. Pesticide Type, Class, and mode of Action

#### *a) Chemical Profile*

Chemical name: 2-chloro-N,N,N-trimethylethylethanammonium chloride salt
Common name: Chlormequat chloride
Chlorocholine chloride (CCC)
CAS No. 000999-81-5
Chemical structure:




#### *b) Mode of Action*

Chlormequat chloride is used as a plant growth regulator (PGR), reducing internodal elongation and delaying flowering. The physiological causes of these effects on the plant are not well documented.

### 4. Usage Overview

Chlormequat chloride is currently registered for application to greenhouse ornamentals. The first outdoor use of this chemical was registered in November, 2006; therefore there are no available data on current usage for this risk assessment.

## B. Receptors

Ecological effect endpoints are derived from registrant-submitted guideline studies as required for registration under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA; 40 CFR Part 158), as well as a review of data available through acceptable open literature (ECOTOX; www.epa.gov/ecotox), when available. The most sensitive endpoints (described below) from testing of surrogate species are used to estimate risk to the taxonomic group(s) represented by the surrogate tested. Toxicity data reported in this document are intended to represent all terrestrial and aquatic organisms. However, only a few surrogate species for both freshwater fish and birds are used to represent all freshwater fish (2000+) and bird (680+) species in the United States. In addition, neither reptiles nor amphibians are tested. Birds are used as surrogates for reptiles and terrestrial-phase amphibians; fish are used as surrogates for aquatic-phase amphibians. The Norway rat is typically the surrogate for all mammals.

## C. Assessment Endpoints

Assessment endpoints are defined, per Agency guidelines, as "explicit expressions of the actual environmental value that is to be protected" which are "operationally defined by an ecological entity and its attributes" (USEPA, 2004). The ecological entity can be a species, a functional group of species, a community, an ecosystem, or another entity of importance or concern. An attribute is the characteristic of the entity that is important to protect and is potentially at risk.

Defining an assessment endpoint involves two steps: 1) identifying the valued attributes of the environment that are considered to be at risk, and 2) operationally defining the assessment endpoint in terms of an ecological entity (*e.g.*, a community of fish and aquatic invertebrates) and its attributes (*i.e.*, survival and reproduction). Therefore, selection of the assessment endpoints is based on valued entities (*i.e.*, ecological receptors), the ecosystems potentially at risk and the routes by which ecological receptors are exposed to pesticide-related contamination. The selection of clearly defined assessment endpoints is important because they provide direction and boundaries in the risk assessment for addressing risk management issues of concern.

Typical assessment endpoints for screening-level pesticide ecological risk assessments include reduced survival and/or reproductive impairment for both aquatic and terrestrial animal species from direct acute or direct chronic exposures. Aquatic animal groups that are typically characterized in the risk assessment include: freshwater fish and invertebrates and estuarine/marine fish and invertebrates. Terrestrial animal groups include birds, mammals, and beneficial insects. All assessment endpoints are characterized at the individual level in order to protect threatened and endangered species. However, risks to higher biological levels (*i.e.*, populations and communities) can be inferred from this approach (*e.g.*, pesticide effects on individual survival and fecundity may impact population stability, growth, and/or habitat carrying capacity). A species-specific assessment containing characterization of indirect effects to listed species and critical habitat is the next step following completion of the screening-level risk assessment.

For terrestrial and semi-aquatic plants, the screening assessment endpoint is the perpetuation of populations of non-target species (crops and non-crop plant species). Existing testing requirements only evaluate the seedling emergence and vegetative vigor of annuals. Although it is recognized that the endpoints of seedling emergence and vegetative vigor may not address all terrestrial and semi-aquatic plant life cycle components, it is assumed that impacts on plant emergence and/or on active growth have the potential to impact individual competitive ability and reproductive success, from which population effects can be inferred.

For aquatic plants, the assessment endpoint is the maintenance and growth of standing crop or biomass. Measurement endpoints for this assessment focus on nonvascular, *e.g.*, algae, and vascular plants, *e.g.*, duckweed (*Lemna gibba*), growth rates and biomass measurements.

The ecological relevance of the assessment endpoints assumes that complete exposure pathways exist for these receptors, that the receptors may be sensitive to pesticides in affected media and/or forage items and that the receptors could potentially inhabit areas where pesticides are applied, or areas where runoff and/or spray drift may impact the sites because suitable habitat is available.

Ecological measurement endpoints for this screening-level risk assessment are based on a suite of registrant-submitted toxicity studies performed on a limited number of organisms, supplemented by the open literature where applicable, in the following broad groupings:

1. Birds, *e.g.,* Japanese quail (*Coturnix coturnix japonica*) and mallard duck (*Anas platyrhynchos*), also used as surrogate species for terrestrial-phase amphibians and reptiles,
2. Mammals, *e.g.*, laboratory rat (*Rattus norvegicus*),
3. Freshwater Fish *e.g.*, rainbow trout (*Oncorhynchus mykiss*), also used as a surrogate for aquatic-phase amphibians,
4. Freshwater invertebrates, *e.g.*, waterflea (*Daphnia magna*),

5. Estuarine/marine fish,
6. Estuarine/marine invertebrates,
7. Terrestrial plants,
8. Vascular and nonvascular aquatic plants.

Within each of these broad taxonomic groups, an acute and chronic endpoint is selected from the available test data. The selection is made from the most sensitive species tested within a particular surrogate group. If additional toxicity data are available from other sources, the selection of an endpoint may not be limited to the surrogate species listed above, but may be expanded to include those data for other groups or species that have been deemed of sufficient quality by the Agency for use in the risk assessment.

## D. Conceptual Model

In order for a chemical to pose an ecological risk, it must reach ecological receptors in biologically significant concentrations. Exposure pathways are defined as the means by which a contaminant moves in the environment from a source to an ecological receptor. For an ecological exposure pathway to be complete, it must have a source, an environmental transport medium, a point of exposure for ecological receptors, and a feasible route of exposure.

### 1. Diagram

The conceptual model used to depict the potential ecological risk associated with the proposed use of chlormequat chloride (the stressor) assumes that as a pesticide, chlormequat chloride can adversely affect terrestrial and aquatic organisms (the receptors) if environmental concentrations exceed toxic thresholds as a result of application according to the label directions (Figure 1). Ecological receptors that may potentially be exposed to chlormequat chloride include terrestrial and semi-aquatic wildlife (*e.g.*, mammals, birds, amphibians and reptiles), terrestrial and semi-aquatic plants, terrestrial invertebrates (*e.g.*, honey bees), and terrestrial soil and aquatic sediment invertebrates. Additionally, aquatic organisms (*i.e.*, freshwater and estuarine/marine fish and invertebrates, amphibians, and aquatic plants) are potential receptors in adjacent water bodies through off-site transport of chlormequat chloride from the application site through runoff, erosion and/or spray drift.

Routes of exposure to terrestrial and aquatic organisms can occur from direct application, spray drift and/or runoff. Exposure may be through ingestion of contaminated food or water sources, dermal contact or absorption, and/or inhalation.

This assessment does not take into account potential atmospheric transport in estimating environmental concentrations, potential exposure via ground water, nor does it account for ingestion of chlormequat chloride residues by animals in contaminated grit, ingestion through preening activities, or uptake through inhalation or dermal absorption by terrestrial animals. Exposure to terrestrial animals is based primarily on dietary consumption of foliar (and insect) residues. Aquatic assessments assume that all potential routes of direct exposure are accounted for.

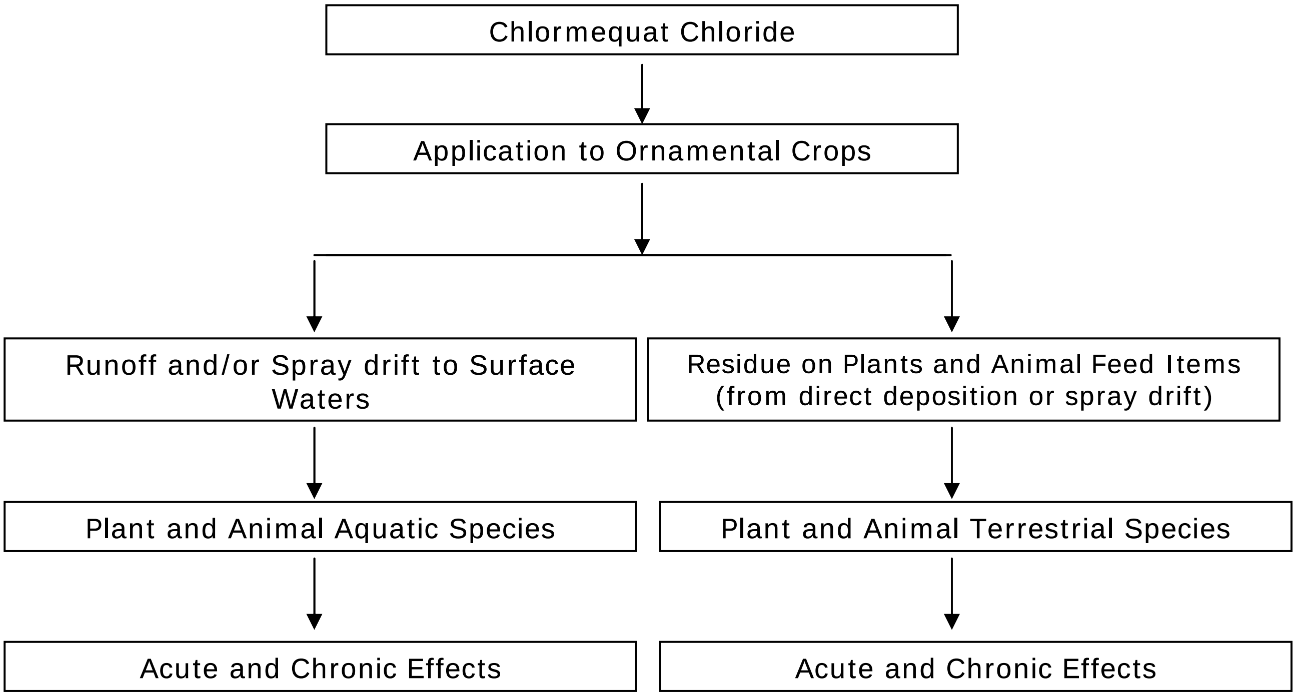


**Figure 1.** Conceptual Model for a Screening Level Assessment of Chlormequat Chloride on Ornamental Crops.

### 2. Risk Hypothesis

*The labeled outdoor uses of chlormequat chloride may pose risk of adverse effects to nontarget species in the environment.*

At maximum application rates for the outdoor uses of chlormequat chloride, exposure of terrestrial, aquatic and semi-aquatic wildlife and plants to chlormequat chloride may be of sufficient duration and intensity to result in direct effects (*e.g.*, mortality due to acute exposure or impaired reproduction, growth, or survival from chronic exposure). Additionally, species may be indirectly affected by chlormequat chloride due to a loss of food resources and/or changes to ecologically critical habitat resulting from proposed uses.

## E. Analysis Plan

The maximum outdoor label application rates for use of chlormequat chloride on bedding plants and containerized ornamentals were selected for modeling environmental concentrations for this screening-level deterministic (risk-quotient based) assessment, as the outdoor uses represent the greatest likelihood of non-target exposure. The most sensitive toxicity endpoints from surrogate test species are used to estimate treatment-related effects on growth and survival assessment endpoints. Estimated environmental concentrations (EECs) used in terrestrial and aquatic ecological risk assessments are based solely on chlormequat chloride parent compound.

A risk quotient-based approach is used in this assessment, comparing the ratio of exposure concentrations to effects endpoints with predetermined levels of concern (LOCs). The use, laboratory environmental fate, and laboratory ecological effects data, all of which provide the basis for these risk quotients, are characterized in the assessment. Although risk is often defined as the likelihood and magnitude of adverse ecological effects, the risk quotient-based approach does not provide a quantitative estimate of likelihood and/or magnitude of an adverse effect. At a screening level, RQs that fall below the Agency's LOC (for a given taxon) indicate a low potential for risk, while RQs greater than the LOC indicate there is a potential for ecological effects if a sufficient exposure threshold is reached.

## II. ANALYSIS

### A. Use Characterization

Chlormequat chloride is a plant growth regulator (PGR) for use on bedding plants and containerized ornamentals in shadehouses and nurseries as the formulated product Cycocel® (EPA Reg. No. 241-74). In open production areas not under cover, Cycocel® use is restricted to bedding plants and containerized ornamentals. Application to field-grown ornamentals is not allowed by the label. The label allows foliar spray applications and drench applications. Drench applications are only allowed for the indoor greenhouse uses. This assessment does not evaluate the indoor greenhouse uses because environmental exposures are expected to be limited to greenhouse discharge which is regulated under the National Pollutant Discharge Elimination System (NPDES). The registrant stated that a majority of the outdoor uses of chlormequat chloride would be in tank mix with B-nine® (daminozide; 035101), which provides greater PGR effect than either product alone (Latimer *et al*., 2001). Potential synergistic effects are not considered in this risk assessment, as there is no available ecological effects data on the possible tank mixes.

For the outdoor (shadehouse and nursery) uses, spray volume providing thorough plant coverage will vary with plant size and foliage coverage and application rates will vary according specific plant species. However, the label states that a single application cannot exceed a rate of 3.7 lbs. ai/A, and the total annual rate can not exceed 33.3 lbs ai/A/year. The label also limits the number of applications to 3 per crop cycle. For this assessment, 3 production cycles per year are considered, resulting in a maximum of 9 applications per year. The interval between repeat applications to the same crop can range from 5 to 21 days. The proposed label also states that applications by mechanical (tractor) multi-nozzle sprayers may not exceed one acre of plants per day, per mixer/loader/applicator. **Table 2** summarizes the maximum application rates used in this assessment. This assessment also assumes that chlormequat chloride will be applied by low-boom sprayer to bedding plants and by backpack sprayer to most containerized ornamentals.

**Table 2.** Proposed maximum use patterns of chlormequat chloride.

| Uses | App. Type | Max single app. rate (lbs ai/A) | Max # of app./ year | Max annual app. Rate (lbs ai/A/yr) | Min app. Interval (days) |
|---|---|---|---|---|---|
| Bedding plants, containerized ornamentals | Foliar spray; mechanized ground boom sprayer | 3.7 | 9 | 33.3 | 5 |

The USDA National Agriculture Statistics Service (NASS, 2006), which collects information on, among other things, the numbers of farms and acreages associated with agricultural practices, has 2002 statistics for "nursery, greenhouse, floriculture, mushrooms, sod, and vegetable seeds grown for sale". This category is further divided into "under glass or other protection" acres and "in the open". While it is not possible to determine the actual area likely to be treated with chlormequat chloride, the "in the open" category can provide a useful index of potential use area.

According to NASS, California (18,600 acres) and Florida (12,800 acres) dominate the category, with only two other states (Michigan and New Jersey) having more than 3,000 acres. However, all 50 states report at least some acreage in this category.

## B. Exposure Characterization

### 1. Environmental Fate and Transport Characterization

There are a number of data gaps in the chlormequat chloride environmental fate and transport dataset. In the absence of data, assumptions made regarding chlormequat chloride were compared to and supported by the environmental fate and transport data of DDAC (PC code 69149, CAS No. 007173-51-5). DDAC and chlormequat chloride are both quaternary ammonium compounds that have been classified according to the Agency's PR Notice 88-2 (February 26, 1988) as Group I, alkyl or hydroxyalkyl (straight chain) substituted quaternary ammonium compounds. Details of the environmental fate and transport studies can be found in Appendix I.

Chlormequat chloride has variable mobility in the environment. Batch equilibrium studies resulted in Freundlich sorption coefficients ranging 1.13 – 9.12 ml/g with corresponding 1/N values ranging 0.511 – 0.955 (MRIDs 46715228, 46715229). Even though chlormequat chloride is a cation, the correlation between cation exchange capacity (CEC) and sorption was not significant in the batch equilibrium studies. Chlormequat chloride is classified as moderately mobile to mobile, according to the FAO classification scheme. In an aged column leaching study 0.3-0.5 % of the applied radioactivity was found in the leachate after 48 hours of leaching with 4 pore volumes of 0.01 M $CaCl_2$ in a loamy sand soil (MRID 46715230). In another aged column leaching study 2.5% of the applied radioactivity was found in the leachate following 45 days of leaching with 0.5 inches of distilled water daily through a 15-inch column filled with a clay loam soil (MRID 124061). In an unaged column leaching study < 0.1 % of applied radioactivity was found in the leachate after leaching with 20 inches of distilled water at a rate not exceeding 1 inch/hour through a 15 inch column filled with a sand, sandy loam, silt loam and clay loam soil (MRID 124062). In both of these studies distilled water was used which could lead to dispersion of clays that could affect soil structure. Depending on soil, site and meteorological conditions chlormequat chloride may be transported off-site via runoff, leaching and/or erosion.

Overall, the major route of dissipation for chlormequat chloride appears to be microbial degradation. An aerobic soil metabolism study showed that chlormequat chloride degraded with half-lives of 30-43 d in two sandy loam and two silt loam soils (MRID 46715225). Soils were was sequentially extracted four times with methanol:water, then four times with acidified water (pH 2). Nonextractable residues increased from 0.9-6.0% at day 0 to 19.0-27.8% at 112 days. In the study, up to 43.7% and 10.7% of the applied radioactivity in the soil extracts was unaccounted for in two soils. No attempt was made to identify these transformation products and it is not known whether or not the residues consisted of one or more components. Consequently, all transformation products detected at >10% of the applied may not have been identified. Using a total residue approach that assumes all unidentified extractable residues are of equal toxicity to chlormequat chloride results in half-lives of 32 – 132 days.

An aerobic aquatic metabolism study showed that chlormequat chloride degraded with total system half-lives of 5-9 days in a river water-sandy loam sediment and pond water-silt loam sediment system (MRID 46715227). Even though sediments were sequentially extracted 1-3 times with methanol:acidified (pH 2) water, followed by 1-5 times with acidic (pH 2) water, nonextractable residues increased from 1.0-2.6% at time 0 to 49.0-59.2% at 30 days and were 27.7-31.3% at 105 study termination. The nonextractable residues are uncharacterized and it is uncertain whether or not they consist of parent chlormequat chloride and/or residues of risk concern.

There were no available acceptable data for degradation of chlormequat chloride by hydrolysis or photolysis. Comparison to DDAC data, however, suggests that chlormequat chloride may be hydrolytically and photolytically stable (MRID 411758-01, 411758-02). There are also no data for chlormequat chloride under anaerobic conditions. DDAC has, however, been shown to be persistent under anaerobic conditions (MRID 422538-02). **Table 3** summarizes the registrant-submitted environmental fate and transport properties of chlormequat chloride.

Major degradates (excluding $CO_2$) were not identified in the available metabolism studies. In the aerobic aquatic metabolism study, an unidentified polar compound reached a maximum of 4.8 and 13.4 % in the total systems. Choline-chloride was also detected in the aerobic aquatic metabolism study at a maximum of 2.0 and 5.5% in the total systems.

**Table 3.** Summary of environmental chemistry and fate properties of chlormequat chloride.

| Parameter | Value | Reference/Comments |
|---|---|---|
| | ***Selected Physical/Chemical Parameters*** | |
| PC code | 018101 | |
| CAS No. | 999-81-5 | |
| Physical state | Liquid | Product chemistry |
| Chemical name | 2-chloro-N,N,N-trimethylethylethanammonium chloride salt | Product chemistry |
| Chemical formula | $C_5H_{13}Cl_2N$ | Product chemistry |
| Molecular weight | 158.1 g/mol | Product chemistry |
| Water solubility | $10^6$ mg/L | Product chemistry |
| Density | 1.14 g/mL | Product chemistry |
| Boiling point | Not reported | Product chemistry |
| Vapor pressure (20 °C) | $7.5 \times 10^{-8}$ mm Hg | Product chemistry |
| log $K_{OW}$ | 2.51 | Product chemistry |
| | ***Persistence*** | |
| Hydrolysis $t_{1/2}$<br>pH 5<br>pH 7<br>pH 9 | No data | |
| Photolysis $t_{1/2}$in water | No data | |
| Photolysis $t_{1/2}$ in soil | No data | |
| Soil metabolism aerobic $t_{1/2}$<br>[Total residues][1] | 43.4, 29.7, 31.5, 43.0 d<br>[43.4, 32.9, 36.3, 132.3 d] | MRID 46715225 |
| Soil metabolism anaerobic $t_{1/2}$ | No data | |
| Aquatic metabolism aerobic $t_{1/2}$ | 4.9, 8.7 d | MRID 46715227 |
| Aquatic metabolism anaerobic $t_{1/2}$ | No data | |

| Parameter | Value | | | | Reference/Comments |
|---|---|---|---|---|---|
| | ***Mobility*** | | | | |
| Batch equilibrium | Soil Type | $K_f$[2] | 1/N | $K_{oc}$[3] | MRIDs 46715228, 46715229 |
| | Loamy sand | 1.25 | 0.511 | 55 | |
| | Sandy loam | 4.57 | 0.691 | 291 | |
| | Silt loam | 1.13 | 0.702 | 81 | |
| | Sand | 1.73 | 0.543 | 93 | |
| | Sandy loam | 2.14 | 0.768 | 89 | |
| | Loam | 9.12 | 0.849 | 912 | |
| | Silt loam | 8.08 | 0.955 | 385 | |
| Column leaching – aged residues | 0.3-0.5 % applied radioactivity in leachate after 48 hours of leaching with 4 pore volumes of 0.01 M $CaCl_2$ in a loamy sand soil;<br><br>2.5% of applied radioactivity in leachate following 45 days of leaching with 0.5 inches of distilled water daily in 15 inch column with a clay loam soil; | | | | MRID 46715230, AN124061 |
| Column leaching - unaged | < 0.1 % of applied radioactivity in leachate after leaching with 20 inches of distilled water in 15 inch column with a sand, sandy loam, silt loam and clay loam soil. | | | | AN124062 |
| Laboratory volatility | NA | | | | |
| | ***Field Dissipation*** | | | | |
| Terrestrial field dissipation | No data | | | | |
| Aquatic field dissipation | NA | | | | |
| | ***Bioaccumulation*** | | | | |
| Accumulation in fish, BCF | No data | | | | |

1. Total residue approach assumes uncharacterized extractable residues are of similar toxicity as parent chlormequat chloride.
2. Units of $(mg/kg)/(mg/L)^{1/N}$, where 1/N is the Freundlich exponent.
3. Approximation calculated from the Freundlich coefficient, per standard EFED guidance.

### 2. Aquatic Exposure

Tier II modeling for selected scenarios representing proposed outdoor uses was used to generate estimated environmental concentrations (EECs). No monitoring data were available for the proposed new uses of chlormequat chloride. For Tier II, two models are used in tandem: the Pesticide Root Zone Model, (PRZM, Carsel *et al*., 1997) and the Exposure Analysis Modeling System (EXAMS, Burns, 1997). PRZM (3.12 beta dated May 24, 2001) simulates fate and transport on the agricultural field, and EXAMS (2.98.04, dated July 18, 2002) simulates the fate and resulting daily concentrations in the water body. Simulations are carried out with the linkage program shell, PE4V01.pl (dated 8/13/2003), which incorporates the standard crop and orchard scenarios developed by EFED. Simulations are run for multiple (usually 30) years, and the EECs represent peak values that are expected once every ten years based on the thirty years of daily values generated during the simulation. Additional information on these models can be found at: http://www.epa.gov/oppefed1/models/water/index.htm.

For aquatic endpoints, the exposure is estimated for the maximum application pattern to a 10-ha field bordering a 1-ha pond, 2-m deep (20,000 $m^3$) with no outlet. Exposure estimates generated using this standard pond are intended to represent a wide variety of vulnerable water bodies that occur at the top of watersheds including prairie pot holes, playa lakes, wetlands, vernal pools, man-made and natural ponds, and intermittent and first-order streams. As a group, there are factors that make these water bodies more or less vulnerable than the standard surrogate pond. Static water bodies that have larger ratios of pesticide-treated drainage area to water body volume would be expected to have higher peak EECs than the standard pond. These water bodies will be either smaller in size or have large drainage areas. Smaller water bodies have limited storage capacity and thus may overflow and carry pesticide in the discharge, whereas the standard pond has no discharge. As watershed size increases beyond 10-ha, it becomes increasingly unlikely that the entire watershed is planted with a non-major single crop that is all treated simultaneously with the pesticide. Headwater streams can also have peak concentrations higher than the standard pond, but they likely persist for only short periods of time and are then carried and dissipated downstream.

OPP standard PRZM crop or orchard scenarios, which consist of location-specific soils, weather, and cropping practices, are used in the simulations to represent proposed labeled uses of Cycocel®. These scenarios are developed to represent high-end exposure sites in terms of vulnerability to runoff and erosion and subsequent off-site transport of pesticide. Cycocel® is being proposed for use on containerized ornamentals and bedding plants in nurseries and shade houses. There are currently no PRZM scenarios for these containerized uses. For use on ornamental trees, the applications will be likely applied by hand-held equipment (*e.g.*, backpack sprayer). Although residues may be washed from foliage following backpack sprayer application, the controlled and directed nature of this type of application would likely minimize both excess mass applied and spray drift. Therefore off-site transport resulting from these applications was not considered an exposure pathway for this assessment. It is assumed that applications made by tractor-pulled equipment will be limited to bedding plants. It is assumed that the EECs resulting from the tractor-pulled spray applications will be more conservative of applications made by hand-held equipment.

Because no specific nursery scenario has been developed, FL turf and PA turf were chosen as surrogate scenarios for the bedding plant use. The turf scenarios were chosen as surrogates because they consist of high organic matter top soil layers (designed to approximate a thatch layer in turf) that may be similar to soils used for bedding plants in nurseries. Additionally, the FL turf scenario results in the greatest upper-bound EECs because it is in a high rainfall area (1216 mm 30-year mean annual precipitation). However, the extent to which the meteorological and agronomic characteristics of the surrogate scenarios are representative of actual use sites in nurseries is uncertain. A summary of the crop scenarios used to estimate chlormequat chloride concentrations in the aquatic systems for ecological risk assessment are listed in **Table 4**.

**Table 4**. Summary of crop scenarios used in aquatic exposure modeling.

| Cycocel Use | Crop Scenario | MLRA/ Met Station | Scenario Characterization |
|---|---|---|---|

| Cycocel Use | Crop Scenario | MLRA/ Met Station | Scenario Characterization |
|---|---|---|---|
| Bedding plant | **FL turf**: Osceola County, Adamsville sand | MLRA 156A; W12834 | Surrogate for bedding plants in southeast |
| | **PA turf**: York County, Glenville silt loam | MLRA 148; W14737 | Surrogate for bedding plants in mid-Atlantic |

PRZM/EXAMS modeling was done using the proposed maximum label rate, maximum number of applications per year and the minimum application interval. Input parameters are listed in **Table 5**. Pesticide applications were simulated as foliar applications (PRZM chemical application method, CAM = 2), with an application efficiency and drift fractions equal to 0.99 and 0.01, respectively. The condition for disposition of the pesticide remaining on foliage after harvest (PRZM variable IPSCND) was set to 1 (pesticide remaining on foliage is converted to surface application), as a protective assumption. The first date of application was chosen to be in early spring (April $15^{th}$), although applications are expected anytime throughout the year.

Based on registrant-submitted data for chlormequat chloride, an aerobic soil metabolism and aerobic aquatic metabolism half-life of 100 and 12.6 d (the upper $90^{th}$ percentile confidence bound on the mean), respectively, were used for surface water modeling with PRZM/EXAMS. It was assumed that chlormequat chloride is stable to photolysis, hydrolysis, and anaerobic metabolism since there are no acceptable data for these parameters. A soil organic carbon partitioning coefficient ($K_{oc}$) of 272 ml/$g_{oc}$, the mean of seven soils, was used.

**Table 5.** PRZM/EXAMS input parameters for chlormequat chloride applied by ground spray

| Input Parameter | Value | Source | Comment |
|---|---|---|---|
| Application Rate in lbs a.i./A (kg a.i./ha) | 3.7 (4.15) | EPA Reg. No. 241-74 | |
| Applications per Year | 9 | EPA Reg. No. 241-74 | 3 applications per crop production; 3 crop productions per year |
| Application Intervals (d) | 5 | EPA Reg. No. 241-74 | |
| Date of Initial Application | April 15 | | |
| Chemical Application Method (CAM) | 2 | EPA Reg. No. 241-74 | Foliar application |
| IPSCND Input | 1 | | |
| Spray Drift Fraction | 0.01 | Input parameter guidance.[1] | Ground spray default |
| Application Efficiency | 0.99 | Input parameter guidance.[1] | Ground spray default |
| Molecular Mass (g/mol) | 158.1 | Product chemistry data. | |
| Vapor Pressure (Torr) | $7.5 \times 10^{-8}$ | Product chemistry | |
| Henry's Law Constant (atm-$m^3$/mol) | $1.6 \times 10^{-15}$ | Calculated | |
| Solubility in Water at 25°C (mg/L) | $10^6$ | Product chemistry data. | Not multiplied by 10 |
| Organic Carbon-Water Partition Coefficient ($K_{oc}$, ml/$g_{oc}$) | 272 | MRIDs 46715228, 46715229 | mean of seven values.[1] |
| Aerobic Soil Metabolism $t_{1/2}$ (d) | 100 | MRID 46715225 | $90^{th}$ percentile upper confidence bound on the mean (43.4, 32.9, 36.3, 132.3 d), based on total residues[2] |

| Input Parameter | Value | Source | Comment |
|---|---|---|---|
| Aerobic Aquatic Metabolism $t_{1/2}$ (d) | 12.6 | MRID 46715227 | $90^{th}$ percentile upper confidence bound on the mean (4.9, 8.7 d) |
| Anaerobic Aquatic Metabolism $t_{1/2}$ (d) | 0 | MRID 422538-02 | stable |
| Hydrolysis $t_{1/2}$ (d) | 0 | MRID 411758-01 | stable |
| Aqueous Photolysis $t_{1/2}$ (d) | 0 | MRID 411758-02 | stable |
| 1. EFED input parameter guidance is located at: http://www.epa.gov/oppefed1/models/water/input_guidance2_28_02.htm. 2. Total residue approach assumes all unidentified extractable residues are of similar toxicity to parent chlormequat chloride. | | | |

The EECs listed in **Table 6** reflect maximum 1-in-10 year upper-bound surface water concentrations based on the proposed maximum use rates for containerized ornamentals and bedding plants where ground spray applications are used.

**Table 6.** Tier II surface water 1-in-10-year estimated environmental concentrations (EECs) of chlormequat chloride from containerized nursery use (ppb).

| PRZM Scenario | App. Rate (lbs ai/A/yr) | Peak | 4-day | 21-day | 60-day |
|---|---|---|---|---|---|
| FL turf | 33.3 | 153 | 140 | 110 | 59 |
| PA turf | 33.3 | 144 | 135 | 93 | 55 |

### 3. Terrestrial Exposure

#### *a) Animals*

Terrestrial wildlife exposure estimates are typically calculated for birds and mammals emphasizing a dietary uptake of pesticide through residues on vegetative and insect forage items. Avian terrestrial EECs are considered representative of potential exposure for terrestrial-phase amphibians and reptiles as well, unless more appropriate data are available through ECOTOX. For exposure to terrestrial organisms, pesticide residues on food items are estimated, based on the assumption that organisms are exposed to a single pesticide residue in a given exposure scenario. Exposure was evaluated using EECs generated from a spreadsheet-based screening model (TREX v.1.2.3) that calculates the dissipation of a chemical applied to foliar surfaces for single or multiple applications. The terrestrial animal exposure assessment is based on the methods of Hoerger and Kenaga (1972) as modified by Fletcher *et al.* (1994). When data are absent, as in this case, EFED assumes a 35-day foliar dissipation half life. The predicted maximum residues of chlormequat chloride that may be expected to occur on selected avian or mammalian food items immediately following application at the maximum rate for a single growing cycle are presented in **Table 7**. Since three growing cycles per year are permitted by the label, these residues do not represent the maximum mass of chlormequat chloride potentially available for wildlife exposure on an annual basis. However, since new target plants would be present for each growing cycle, only non-target, presumably marginal forage items, such as weeds, would be potentially subject to multiple growing cycles. Further details of the model are presented in **Appendix III**.

**Table 7.** Dietary-based estimated environmental concentrations (EECs) on terrestrial animal forage items following applications of chlormequat chloride to a single growing cycle of ornamentals based on TREX (version 1.2.3).

| Application Rate | Food Items | Upper-bound EEC (ppm)[a] | Mean EEC (ppm)[a] |
|---|---|---|---|
| 3.7 lbs ai/A<br>3 applications<br>5 day interval | Short grass | 2421 | 857 |
| | Tall grass | 1110 | 363 |
| | Broadleaf plants/small insects | 1362 | 454 |
| | Fruits, pods, seeds, and large insects | 151 | 71 |

[a] Predicted residues based on Hoerger and Kenaga (1972) as modified by Fletcher et al. (1994).

### *b) Plants*

Exposure to upland and wetland plants is estimated using the TerrPlant (v1.2.1) screening model. TerrPlant estimates potential exposure from a single application using default assumptions for runoff and spray drift (**Table 8**). Multiple applications during a single growing cycle and multiple growing cycles are not taken into account. See **Appendix IV** for more information.

**Table 8.** Expected environmental concentrations (EEC) on plants following label-specified applications of chlormequat chloride determined using the TerrPlant model (lbs ai/A).

| Rate | Application Method | Adjacent Upland Loading[a] | Adjacent Wetland Loading | Drift Only |
|---|---|---|---|---|
| 3.7 lbs ai/A | Ground Spray | 0.22 | 1.89 | 0.04 |

[a]Loading is runoff plus drift (lbs ai/A)

## C. Ecological Effects Characterization

In screening-level ecological risk assessments, the effects characterization describes the types of effects a pesticide can potentially produce in an animal or plant. This characterization is generally based on registrant-submitted studies that describe acute and chronic effects information for various aquatic and terrestrial animals and plants; however, these data may also be supplemented by data reported in ECOTOX that have met Agency criteria for acceptability.

Toxicity testing reported in this section does not include all species of potentially affected by chlormequat chloride usage. Only a few surrogate species for both freshwater fish and birds are used to represent all freshwater fish (2000+) and bird (680+) species in the United States. For mammals, toxicity studies are limited to the laboratory rat. Also, neither reptiles nor amphibians are tested. The risk assessment assumes that avian and reptilian and terrestrial-phase amphibian toxicities are similar. Fish are considered reasonable surrogates for aquatic-phase amphibians. Terrestrial plant data are derived from the vegetative vigor and seedling emergence tests, typically on 10 agricultural plant species, and do not account for potential chronic or reproductive effects. Typically, five aquatic plant species are used to represent potential toxicity to all aquatic plant species.

### 1. Aquatic Effects

#### *a) Freshwater Fish*

Two acceptable guideline studies with the bluegill sunfish (*Lepomis macrochirus*; 001232-61) and rainbow trout (*Oncorhynchus mykiss*; 000374-33) indicate the 96-h median lethal concentration ($LC_{50}$) is >1000 mg ai/L. One supplemental subacute 21-day toxicity study following OECD 204 was reviewed (MRID 467152-17). The Agency has no provision for subacute fish studies, but they provide supplemental information useful in this risk assessment. In that study, rainbow trout were exposed to chlormequat chloride concentrations of 43, 100, 250, 590, 1400 and 3400 mg/L. By the sixth day of the study (guideline acute fish toxicity tests are 96h), 90% of the fish in the 3400 mg ai/L concentration were dead. No other treatment-related mortalities were observed. Therefore, the NOAEC for this study is 1400 mg ai/L and the $LC_{50}$ is >1400 mg ai/L, which results in chlormequat chloride being classified as practically non-toxic to freshwater fish on an acute exposure basis. Additionally, ECOTOX reports $LC_{50}$s of >100 mg ai/L for bluegill sunfish, fathead minnow (*Pimephales promelas*) and channel catfish (*Ictalurus punctatus*), also resulting in chlormequat chloride as being classified as practically nontoxic to freshwater fish. No studies are available regarding chronic toxicity of chlormequat chloride to freshwater fish.

#### *b) Freshwater Invertebrates*

A supplemental study assessing the acute toxicity of chlormequat chloride to *Daphnia magna* (MRID 001387-19) indicates chlormequat chloride is slightly toxic to freshwater invertebrates with an $EC_{50}$ of 16.9 mg ai/L. In a 21-day chronic toxicity study on the water flea, classified as supplemental, a NOAEC of 5.0 mg ai/L (MRID 467152-16) was reported based on a statistically significant 20% reduction in live offspring relative to the control.

#### *c) Estuarine/Marine Fish*

No acute or chronic studies regarding the toxicity of chlormequat chloride to estuarine/marine fish were submitted by the registrant. However, ECOTOX reports a study by Linden *et al.* (1979) which established an $LC_{50}$ for the bleak (*Alburnus alburnus*) at 1950 mg ai/L, which results in chlormequat chloride being classified as practically nontoxic to estuarine/marine fish on an acute exposure basis. No chronic toxicity data for estuarine/marine fish are available for this assessment.

#### *d) Estuarine/Marine Invertebrates*

No acute or chronic guideline studies regarding the toxicity of chlormequat chloride to estuarine/marine invertebrates were available for this assessment. However, ECOTOX reports a study by Linden *et al.* (1979) which established an $LC_{50}$ for the copepod *Nitocra spinipes* as 80 mg ai/L, which indicates chlormequat is slightly toxic to estuarine/marine invertebrates on an acute exposure basis. No chronic toxicity data for estuarine/marine invertebrates are available for this assessment.

#### *e) Aquatic Plants*

Chlormequat is classified as moderately toxic to the aquatic vascular plant *Lemna gibba* based on reductions in all measured parameters, the most sensitive being frond number, with an $EC_{50}$ of 2.8 mg ai/L and a NOEC of 0.04 mg ai/L (MRID 467152-21). Chlormequat chloride is less toxic to nonvascular plants such as green algae *Scenedesmus subcapitatus* with a 96-hr $EC_{50}$ >899 mg ai/L and a NOAEC of 233 mg ai/L (MRID 467152-22;) and blue-green algae (cyanobacteria; *Anabaena flos-aquae*) with an $EC_{50}$ >207 mg ai/L and a NOAEC=207 mg ai/L (MRID 467152-23).

### 2. Terrestrial Effects

#### *a) Avian Acute Oral, Dietary and Chronic*

The available data indicate that chlormequat chloride is slightly toxic to avian species on an acute exposure basis. Two acute oral toxicity studies, with the Japanese quail (*Coturnix coturnix japonica*) indicated an $LD_{50}$ of 556 mg ai/kg bw (MRID 467152-10) and 1018 mg ai/A (MRID 467152-11;), respectively. In both studies, all mortalities occurred in the first day of the 14-day studies. Chlormequat chloride is slightly toxic (possibly) to practically nontoxic to Japanese quail ($LC_{50}$>3175 mg ai/kg diet; MRID 467152-12) and the mallard duck ($LC_{50}$>5438 mg ai/kg diet; MRID 467152-13) on a subacute dietary exposure basis.

A supplemental avian reproduction study with the Japanese quail (MRID 467152-14) was submitted which had mean-measured concentrations of 158, 387 and 982 mg/kg diet. The study was conducted with a two week pre-treatment period followed by a 6-week exposure period, rather than the guideline 10-week pre-laying exposure followed by a 10-week egg-laying exposure period. The most sensitive endpoints were the adult parameters of food consumption and male body weight gain; both endpoints showed significant adverse effects at all treatment levels. As a result, the required NOAEC could not be statistically determined (<158 mg ai/kg diet) from this study. The most sensitive reproductive parameter was a significant reduction in hatchlings per eggs set and number of cracked eggs in the highest test concentration. Additionally, the study authors reported that absolute testes weight was significantly reduced (by 16%) in the 982 mg/kg group and that there was a significant increase in egg shell thinning and decreased egg strength at the highest test concentration. These reductions may reflect effects on endocrine-mediated processes.

#### *b) Mammalian Acute and Chronic*

Mammalian toxicity studies are normally reviewed by the Health Effects Division in support of the human health risk assessments conducted by that division. However, they are also used to characterize the toxicity to mammalian wildlife by EFED. The mammalian toxicity data (Norway rat study; MRID 417216-04) indicate that chlormequat chloride is moderately toxic to mammals on an acute oral exposure basis, with males ($LD_{50}$=487 mg ai/kg bw) being slightly more sensitive than females ($LD_{50}$=560 mg ai/kg bw). In a two-generation study with Norway rats, there were parental effects evident by decreased body weight at 255 mg ai/kg bw (males again slightly more sensitive than females), with a NOAEL of 86.4 mg ai/kg bw (MRID 467152-06). Offspring effects (NOAEL=86.4 mg ai/kg bw) were reduced mean litter size, body weight and delayed development

#### *c) Non-target Insects*

Chlormequat chloride is classified as practically nontoxic to honey bees (*Apis mellifera*) on both an acute contact and acute oral basis ($LD_{50}$>100 µg ai/bee; MRID 467152-24). No sublethal effects were reported in the study.

#### *d) Terrestrial Plants*

A non-guideline seedling emergence test (MRID 467152-19) was submitted for chlormequat chloride, with only six plants (4 dicot, 2 monocot) tested, rather than the 10 species preferred in guideline studies. Species tested were oat (*Avena sativa)*, onion (*Allium cepa*), carrot (*Daucus carota*), oilseed rape (*Brassica napus*), soybean (*Glycine max*) and sugar beet (*Beta vulgaris*).

There were five treatment levels and a control, with eight replicates per treatment, five seeds per replicate. There was no effect at the highest treatment level (1.9 lbs ai/A) for five of the six species. The percent emergence of the dicotyledonous plant oilseed rape was significantly reduced by 38% at the highest level tested, resulting in an $EC_{25}$ of >0.9 ai/A and a NOEC of 0.9 lb ai/A.

A non-guideline vegetative vigor study (MRID 467152-20) was submitted for chlormequat chloride, only six plants (4 dicot, 2 monocot) were tested, rather than the 10 species preferred in guideline studies. Species tested were oat, onion, carrot, pea (*Pisum sativum*), sunflower (*Helianthus annuus*) and cabbage (*Brassica oleracea*). The study design varied with species, but the treatment levels were 0.21, 0.42, 0.84, 1.7 and 3.4 lb ai/A for all species. The most sensitive species was sunflower, with a calculated $EC_{25}$ of 1.5 lb ai/A. A NOEC was not determined due to significant reductions in fresh weight (biomass) at all treatment levels (>25% at the lowest treatment). Carrot biomass was also effected, with an $EC_{25}$ of 2.0 lbs ai/A and a NOEC of 0.21 lbs ai/A. Although the $EC_{25}$ for pea was >3.4 lbs ai/A, there was a 20% biomass reduction at 3.4 lbs ai/A, making the NOEC 1.7 lbs ai/A. The other three species tested were unaffected at all treatment levels.

**Table 9.** Terrestrial plant toxicity endpoints used in RQ calculations

| Study Type | $EC_{25}$ | | NOAEC | |
|---|---|---|---|---|
| | **Mono** | **Dicot** | **Mono** | **Dicot** |
| Seedling Emergence | >1.9 | >0.9 | 1.9 | 0.9 |
| Vegetative Vigor | >3.4 | 1.5 | 3.4 | <0.21 |

### 3. ECOTOX

The Agency's ECOTOX database (www.epa.gov/ecotox) was reviewed for toxicological endpoints. There were several reported terrestrial studies; none were of greater sensitivity than those used in this assessment. The estuarine/marine fish and invertebrate endpoints reported above were selected from the ECOTOX report; no other reported aquatic endpoints were more sensitive than those used in this assessment.

## III. RISK CHARACTERIZATION

The risk quotient (RQ) approach is used in this assessment, comparing the ratio of exposure concentrations to effects endpoints with predetermined levels of concern (LOCs). Laboratory environmental fate, laboratory ecological effects, and use data that provide the basis for these risk quotients have been discussed previously in the assessment. Although risk is often defined as the likelihood and magnitude of adverse ecological effects, the risk quotient-based approach does not provide a quantitative estimate of likelihood and/or magnitude of an adverse effect. Estimated environmental concentrations (EECs) are divided by acute and chronic toxicity values to calculate RQs. If the RQs exceed the LOCs, the Agency presumes potential for risk to the taxa. These LOCs (**Table 10**) are the Agency's interpretive policy and are used to determine the need to consider regulatory action by indicating whether a pesticide, used as directed on the label, has the potential to cause adverse effects on non-target organisms.

**Table 10.** Levels of concern (LOCs) for various taxa.

| Risk Presumption | RQ | LOC |
|---|---|---|
| **Birds** | | |
| Acute Risk | $EEC/LC_{50}$ or $LD_{50}$/sqft or $LD_{50}$/day | 0.5 |
| Acute Restricted Use | $EEC/LC_{50}$ or $LD_{50}$/sqft or $LD_{50}$/day (or $LD_{50}$ < 50 mg/kg) | 0.2 |
| Acute Endangered Species | $EEC/LC_{50}$ or $LD_{50}$/sqft or $LD_{50}$/day | 0.1 |
| Chronic Risk | EEC/NOAEC | 1 |
| **Wild Mammals** | | |
| Acute Risk | $EEC/LC_{50}$ or $LD_{50}$/sqft or $LD_{50}$/day | 0.5 |
| Acute Restricted Use | $EEC/LC_{50}$ or $LD_{50}$/sqft or $LD_{50}$/day (or $LD_{50}$ < 50 mg/kg) | 0.2 |
| Acute Endangered Species | $EEC/LC_{50}$ or $LD_{50}$/sqft or $LD_{50}$/day | 0.1 |
| Chronic Risk | EEC/NOAEC | 1 |
| **Aquatic Animals** | | |
| Acute Risk | $EEC/LC_{50}$ or $EC_{50}$ | 0.5 |
| Acute Restricted Use | $EEC/LC_{50}$ or $EC_{50}$ | 0.1 |
| Acute Endangered Species | $EEC/LC_{50}$ or $EC_{50}$ | 0.05 |
| Chronic Risk | EEC/NOAEC | 1 |
| **Terrestrial and Semi-Aquatic Plants** | | |
| Acute Risk | $EEC/EC_{25}$ | 1 |
| Acute Endangered Species | EEC/NOAEC or $EC_{05}$ | 1 |
| **Aquatic Plants** | | |
| Acute Risk | $EEC/EC_{50}$ | 1 |
| Acute Endangered Species | EEC/NOAEC or $EC_{05}$ | 1 |

### A. Risk Estimation

RQ values for the proposed use of chlormequat chloride on bedding and containerized nursery plants indicate potential risk to aquatic and terrestrial animals and plants. The acute and chronic toxicity endpoints used in this risk assessment are summarized **Table 11**.

**Table 11.** The most sensitive endpoints used in the chlormequat chloride risk assessment.

| Environment | Taxa | Type of Risk | Type of Endpoint | Endpoint | Units | MRID |
|---|---|---|---|---|---|---|
| Aquatic Freshwater | Fish | Acute | $LC_{50}$ | >1400 | mg ai/L | 467152-17 |
| | | Chronic | NOAEC | No data | - | - |
| | Invertebrates | Acute | $EC_{50}$ | 16.9 | mg ai/L | 001387-19 |

| Environment | Taxa | Type of Risk | Type of Endpoint | Endpoint | Units | MRID |
|---|---|---|---|---|---|---|
| | | Chronic | NOAEC | 5 | mg ai/L | 467152-16 |
| | Plants | Acute | $EC_{50}$ | 2.8 | mg ai/L | 467152-21 |
| | | Listed | NOAEC | 0.04 | mg ai/L | 467152-21 |
| Terrestrial | Avian | Acute | $LD_{50}$ | 556 | mg ai/kg-bw | 467152-10 |
| | | Chronic | NOAEC | <158 | mg ai/kg-diet | 467152-14 |
| | Mammalian | Acute | $LD_{50}$ | 487 | mg ai/kg-bw | 417216-04 |
| | | Chronic | NOAEC | 86.4 | mg ai/kg-bw | 467152-06 |
| | Plants | Acute | $EC_{25}$ | >0.9 | lb ai/A | 467152-19 |
| | | Listed | NOAEC | 0.9 | lb ai/A | 467152-20 |

### 1. Aquatic Species

#### *a) Freshwater Fish*

Because chlormequat chloride is classified as practically nontoxic to freshwater fish, *i.e.* the $LC_{50}$ is greater than 100 mg/L, the potential for acute risk to freshwater is presumed to be low. If 100 mg/L was the toxicity endpoint, RQs would be <0.01. There are no guideline chronic toxicity data available with which to evaluate potential chronic risk to freshwater fish. Chronic risk is presumed in the absence of data.

#### *b) Freshwater Invertebrates*

No acute or chronic risk LOCs are exceeded freshwater invertebrates (**Table 12**).

**Table 12.** Risk Quotients for freshwater invertebrates

| Scenario | | Peak EEC mg/L | Toxicity Endpoint mg/L | RQ |
|---|---|---|---|---|
| FL Turf | Acute | 0.153 | 16.9 | <0.01 |
| PA Turf | | 0.143 | 16.9 | <0.01 |
| | | | | |
| FL Turf | Chronic | 0.110 | 5 | 0.02 |
| PA Turf | | 0.093 | 5 | 0.02 |

#### *c) Estuarine/Marine Fish*

Chlormequat chloride is classified as practically nontoxic on an acute exposure basis to estuarine/marine fish, *i.e.* the $LC_{50}$ is greater than 100 mg/L, and the potential for risk to estuarine fish is presumed to be low. There are no chronic toxicity data available with which to evaluate potential chronic risk to estuarine/marine fish.

#### *d) Estuarine/Marine Invertebrates*

No acute risk LOCs are exceeded for estuarine/marine invertebrates based on the estuarine/marine invertebrate endpoint found in ECOTOX (**Table 13**). There are no chronic toxicity data available with which to evaluate potential chronic risk to estuarine/marine invertebrates.

**Table 13.** Risk Quotients for estuarine/marine invertebrates.

| Scenario | | Peak EEC mg/L | Toxicity Endpoint mg/L | RQ |
|---|---|---|---|---|
| FL Turf | Acute | 0.153 | 80 | <0.01 |
| PA Turf | | 0.143 | 80 | <0.01 |
| | | | | |
| FL Turf | Chronic | 0.110 | - | - |
| PA Turf | | 0.093 | - | - |

### *e) Aquatic Plants*

The acute risk LOC for non-listed vascular plant species is not exceeded for aquatic plant species (**Table 14**). The acute risk LOC for listed species is exceeded by more than a factor of three. RQs for aquatic nonvascular plants are <0.01.

**Table 14.** Risk Quotients for the most sensitive aquatic plants.

| Scenario | | Peak EEC mg/L | Toxicity Endpoint mg/L | RQ |
|---|---|---|---|---|
| FL Turf | Unlisted | 0.153 | 2.8 | 0.05 |
| PA Turf | | 0.143 | 2.8 | 0.05 |
| | | | | |
| FL Turf | Listed | 0.110 | 0.04 | 3.6[a] |
| PA Turf | | 0.093 | 0.04 | 3.8[a] |

exceeds acute risk LOC (RQ≥1)

## 2. Terrestrial

For terrestrial risk estimation, RQs are based on one growing cycle at the maximum label rate applied three times at five day intervals. Three growing cycles per year are allowed by the label; therefore exposure could possibly be higher. While the target plants would be different for each growing cycle, non-target species such as weeds could be subject to multiple growing cycles.

### *a) Avian Acute*

When both dose-based and dietary-based toxicity estimates are available for birds, acute risk quotients are calculated using both a dose-based and dietary-based approach. The dose-based RQs are calculated using a body weight adjusted and consumption-weighted equivalent dose. The adjustments account for the fact that smaller-sized animals have to consume more food in terms of their body weight than larger animals and that differential amounts of food have to be consumed depending on the water content and nutritive value of the food. By expressing the Kenaga nomogram estimated residues in terms of daily equivalent dose, estimated environmental concentrations can then be compared to the dose-based $LD_{50}$. However, in the case of chlormequat chloride, RQs can only be calculated from the $LD_{50}$ since subacute dietary toxicity testing failed to establish $LC_{50}$ values. Although at the highest dose tested in the Japanese quail dietary study chlormequat chloride would be classified as slightly toxic on a subacute dietary exposure basis to birds, *i.e.* the $LC_{50}$ is >3175 mg/L, it is not known how much greater the $LC_{50}$ would be, thus RQs based on dietary exposure are not presented.

Chlormequat chloride is classified as slightly toxic on an acute oral exposure basis. Dose-based RQs calculated using the acute oral $LD_{50}$ are presented in **Table 15**. Dose-based RQs range from 6.9 for small birds (20g) foraging on short grass to 0.06 large (1000g) birds foraging on fruit/pods/large insects. The acute avian LOC (RQ≥0.5) is exceeded for all size classes foraging on short grass, tall grass and broadleaf plants/small insects. The acute risk to listed species LOC (RQ≥0.1) is exceeded for small- and medium-size birds foraging on fruit/pods/large insects.

**Table 15.** Upper-bound dose-based avian acute risk quotient (RQ) values ($LD_{50}$ = 556 mg/kg-bw).

| Forage items | Size class | | |
|---|---|---|---|
| | **20g** | **100g** | **1000g** |
| Short grass | **6.9**[a] | **3.1** | **0.98** |
| Tall grass | **3.2** | **1.4** | **0.45** |
| Broadleaf/small insects | **3.9** | **1.7** | **0.55** |
| Fruits/pods/seeds/large insects | *0.43*[b] | *0.19* | 0.06 |

[a]Bold indicates exceeds acute risk to non-listed species LOC (RQ≥0.5)
[b]Italics indicates exceeds acute risk to endangered species LOC (RQ≥0.1)

### *b) Avian Chronic*

Because a NOAEC was below the lowest dose tested in the Japanese quail avian reproduction study, definitive chronic RQs cannot be calculated due to lack of data. However, calculating with the lowest dose tested provides an indication of the minimum extent to which LOCs are exceeded. RQ values calculated using the LOAEC from the Japanese quail study (**Table 16**) exceed the chronic risk LOC (RQ≥1.0) for all forage groups. The chronic LOC is exceeded by a factor of greater than 15X for birds foraging on short grass. Since the actual NOAEC is likely to be lower, avian chronic RQs will be higher than those presented here.

**Table 16.** Chronic dietary-based RQs calculated from the Japanese quail reproduction study. These RQs are lower than are indicated by the study (LOAEC=158).

| **Forage item** | **RQ** |
|---|---|
| Short Grass | >15* |
| Tall Grass | >7* |
| Broadleaf plants/sm insects | >9* |
| Fruits/pods/seeds/lg insects | >1* |

*Exceeds chronic risk LOC (RQ≥1.0)

### *c) Mammalian Acute*

Mammalian acute RQs (**Table 17**) range from 0.01 for large (1000g) granivorous mammals to 2.2 for small (15g) mammals foraging on short grass, a 4-fold exceedance of the acute risk LOC (RQ≥0.5). There are exceedances of the acute risk LOC for all size classes foraging on short grass and broadleaf plant/small insects and for small- and medium-size mammals foraging on tall grass. The listed species LOC is exceeded for all-sized mammals foraging on all food categories except seeds and for large mammals foraging of fruits/pods/lg insects

**Table 17.** Upper-bound dose-based mammalian acute risk quotient (RQ) values for the use chlormequat chloride ($LD_{50}$=487 mg/kg-bw).

| **Forage items** | **Size class** | | |
|---|---|---|---|
| | **15g** | **35g** | **1000g** |
| Short grass | **2.2**[a] | **1.8** | **0.99** |
| Tall grass | **0.99** | **0.84** | *0.45*[b] |
| Broadleaf/small insects | **1.2** | **1.0** | **0.56** |
| Fruits/pods/large insects | *0.13* | *0.12* | 0.06 |
| Seeds | 0.03 | 0.03 | 0.01 |

[a]Bold indicates exceeds acute risk to non-listed species LOC (RQ≥0.5)
[b]Italics indicates exceeds acute risk to endangered species LOC (RQ≥0.1)

### *d) Mammalian Chronic*

When assessing potential chronic risk to mammals, in accordance with the overview document, the dietary-based NOAEC is converted to a dose-based NOAEL using the standard USFDA laboratory rat conversion, which can be scaled to different mammalian size classes. The dose-based RQs are calculated using a body weight adjusted and consumption-weighted equivalent dose. The adjustments account for the fact that smaller-sized animals have to consume more food in terms of their body weight than larger animals and that differential amounts of food have to be consumed depending on the water content and nutritive value of the food. By expressing the Kenaga nomogram estimated residues in terms of daily equivalent dose, estimated environmental concentrations can then be compared to the dose-based NOAEC. Both sets of RQs are presented in **Table 18**.

Dose-based RQs exceed the chronic risk LOC (1.0) for all size classes of mammals foraging on short grass, tall grass and broadleaf plants/small insects, by factors ranging from 3X to 12X . The only dietary-based RQ value that exceeds the chronic risk LOC is for mammals foraging on short grass; however, if dietary-based RQ values are adjusted to reflect that different-sized animals consume differing amounts of food, the dietary-based RQ values would likely be similar to the dose-based values.

**Table 18.** Comparison of dose-based and dietary-based upper-bound mammalian chronic risk quotient (RQ) values for the use chlormequat chloride (NOAEC=86.4).

| **Forage items** | **Dose-based** | | | **Dietary-based** |
|---|---|---|---|---|
| | Size class | | | |
| | **15g** | **35g** | **1000g** | |
| Short grass | **12**[a] | **10** | **5.6** | **1.4** |
| Tall grass | **5.6** | **4.8** | **2.6** | 0.65 |
| Broadleaf/small insects | **6.9** | **5.9** | **3.1** | 0.79 |
| Fruits/pods/large insects | 0.76 | 0.65 | 0.35 | 0.09 |
| Seeds | 0.17 | 0.14 | 0.08 | xx |

[a]Bold indicates exceeds chronic risk LOC (RQ≥1.0)

### *e) Non-target Plants*

For a single application of chlormequat chloride (3.7 lbs ai/A) the terrestrial plant LOC (1.0) is exceeded for dicotyledonous plants in wetlands adjacent to chlormequat use sites. The RQ (**Table 19**) for endangered monocotyledonous wetland plants for drift plus runoff (loading) is 1.0 (at the highest dose tested); because there were no effects on monocots at the highest dose tested, an $EC_{25}$ was not established, thus the RQ for non-listed plants is less than 1.0. For dicots, the listed species LOC is exceeded with an RQ of 2.1 and the non-listed LOC is exceeded with an RQ between 1.0 and 2.1. There are no exceedances for adjacent upland species or as a result of drift alone.

**Table 19.** Risk quotients for terrestrial plants. Monocots: seedling emergence $EC_{25}$>1.9 lbs ai/A, NOEC=1.9 lbs ai/A; vegetative vigor $EC_{25}$>3.4 lbs ai/A, NOEC=3.4 lbs ai/A. Dicots: seedling emergence $EC_{25}$> 0.9 lbs ai/A, NOEC=0.9 lbs ai/A; vegetative vigor $EC_{25}$=1.5 lbs ai/A, NOEC<0.21 lbs ai/A.

| | Application Method | Adjacent Upland | | Adjacent Wetland | | Drift Only | |
|---|---|---|---|---|---|---|---|
| | | Monocot | Dicot | Monocot | Dicot | Monocot | Dicot |
| Nonlisted | Ground Spray | <0.12 | <0.25 | <1.0 | **<2.1**[a] | <0.02 | 0.04 |
| Listed | Ground Spray | 0.12 | 0.25 | **1.0**[a] | **2.1**[a] | 0.02 | 0.04 |

[a]exceeds LOC for non-listed species
[b]$EC_{25}$ was determined to be between 0.9 and 1.9 lbs ai/A.
[c]meets or exceeds the LOC for listed species

## B. Risk Description

Based on this screening-level deterministic risk assessment, EFED cannot refute the risk hypothesis that the labeled outdoor uses of chlormequat chloride may pose risk of adverse effects to non-target species. Chlormequat chloride is expected to be moderately mobile to mobile (FAO classification scheme) in the environment. Major routes of dissipation in the environment include microbial degradation in soils and aquatic systems. There is uncertainty regarding chlormequat chloride's persistence in the environment. In aerobic soil metabolism studies, chlormequat chloride degraded with half-lives ranging from 4-6 weeks. But there were significant unidentified residues in these studies. In aquatic environments, chlormequat chloride was short-lived, degrading with half-lives of ~ 1 week. However, significant nonextractable residues were detected in these studies and it is uncertain whether or not they consist of parent chlormequat chloride and/or residues of risk concern.

Although potential risk to aquatic animals appears to be low, available data indicate that the outdoor use of chlormequat chloride has the potential to adversely affect listed aquatic plants and non-target terrestrial animal and plant species. Due to important data gaps regarding Agency guideline studies, there is appreciable uncertainty regarding some risk conclusions. While this assessment uses conservative assumptions, greater refinement and additional data would be required to preclude potential risk given the exceedances noted in the previous section of the document. For terrestrial species, there is potential acute risk to birds for most size class/forage item categories, as well as the terrestrial-phase amphibians and reptiles for which birds are considered surrogates. The chronic risk LOC for birds is exceeded across all forage items; however, RQs for chronic effects will be higher because a NOAEC has not been determined. Potential acute risk is also indicated to mammals in most of the size class/forage categories, and potential chronic risk to mammals is indicated for all-size classes in three of the five forage categories. Consistent with chlormequat being a PGR, potential risk to non-target aquatic vascular plants and to terrestrial plants in wetlands adjacent to use sites is indicated.

### 1. Aquatic

No aquatic animal RQ exceeded any LOC; however, chronic data are lacking for freshwater fish and potential risk cannot be precluded in the absence of data. However, based on the use of acute-to-chronic ratios for freshwater invertebrates (acute and chronic) and freshwater fish (acute), and using the lowest available $LC_{50}$ (>100 mg/L), the chronic RQ would be <0.5, less than half the chronic LOC. The acute to chronic ratio for fish would have to be more than double that for the daphnids tested before the LOC would be exceeded. Additionally, based on the aerobic aquatic metabolism half-lives, chlormequat chloride is not expected to persist in most waterbodies.

Based on submitted data, aquatic vascular plant species are potentially affected by chlormequat chloride. Although the unlisted species LOC is not exceeded, the listed species LOC is exceeded by a factor of more than three for aquatic vascular plants. Non-vascular plants are considerably (several orders of magnitude) less sensitive to chlormequat chloride than vascular plants.

Consistent with a screening-level approach, the aquatic exposure estimates used in this assessment are designed to be conservative. Major assumptions that contribute to the protective nature of the aquatic exposure estimates include the applicability of the standard models and surrogate PRZM scenarios to the nursery/shade house use, the application intervals modeled, and the area treated. The PRZM/EXAMS models and scenarios used in this assessment were developed to simulate pesticide applications in open agricultural fields and not specifically for containerized ornamentals and bedding plants in nurseries/shade houses. The impact of rainfall and corresponding pesticide transport is likely dampened due to the use of containers and/or shade covers relative to open agricultural fields, which leads to a protective assessment. The application interval was assumed to be 5 days (which is the minimum permitted by the label) for all 9 applications. Since there is a maximum of 3 applications per crop cycle, it is likely that the interval between applications of subsequent crop cycles will be greater than 5 days, and thus the 5-day interval is likely a protective assumption. This will likely result in an overestimation of chronic exposure since a longer interval between applications would allow for greater degradation in the water body prior to subsequent applications. Also, the standard ecological aquatic modeling scenario consists of application to an entire 10-ha field simultaneously. The Cycocel® label, however, states that applications by mechanical (tractor) multi-nozzle sprayers may not exceed one acre of plants per day, per mixer/loader/applicator. The assumption that the entire 10-ha field of bedding plants is treated simultaneously with chlormequat chloride is likely a protective assumption.

### 2. Terrestrial

Dietary-based and dose-based avian RQ values are calculated using the sub-acute dietary $LC_{50}$ and the acute oral $LD_{50}$. The dose-based calculation takes into account that different-sized animals have to consume different amounts of food and the differing nutritional value of feed items. The $LD_{50}$ may give a better indication of inherent toxicity than the $LC_{50}$ in cases where food avoidance may be an issue in the test animals. The greater energy demands in wild birds could make similar avoidance in natural settings unlikely. Because a subacute dietary $LC_{50}$ for chlormequat chloride was not defined, and the $LC_{50}$ exceeded the highest dietary test concentration (3175 ppm), no definitive dietary-based RQs were calculated. If the highest dose tested were used to calculate RQs, the acute risk LOC would be exceeded for short grass and the restricted use and listed species LOCs would be exceeded for the tall grass and broadleaf plants/small insects forage categories. Due to the mass of chemical applied, even at the high-end regulatory limit for testing, 5000 ppm, above which chemicals are classified as practically nontoxic, the listed species LOC would be exceeded in three of the four forage categories. Because of the magnitude of the EECs, *i.e.* greater than 1/10th the highest dose tested, risk to endangered species on a dietary basis cannot be precluded.

Dose-based RQs result in exceedances of the acute risk LOC for all size classes of birds foraging on short grass, tall grass and broadleaf plants/small insects and small (20g) birds foraging on fruit/pods/seeds/large insects. The acute risk LOC for restricted use and listed species is also exceeded for medium-sized birds foraging on fruit/pods/seeds/large insects. RQs are calculated using upper-bound Kenaga values. If mean Kenaga values (expected to be exceeded about 50% of the time) were used to calculate the RQs, acute risk LOC would still be exceeded for small- and medium-sized birds foraging on short grass, tall grass and broadleaf plants/large insects and large birds foraging on short grass. The listed species LOC would be exceeded for large birds foraging on tall grass and broadleaf plants/large insects and for small- and medium-sized birds foraging on fruits/pods/seeds/large insects.

Because a NOAEC was not determined in the avian reproduction study, definitive chronic RQ values could not be calculated. However, the lowest dose tested was used to give an indication of potential chronic risk. The chronic risk LOC is exceeded for birds across all forage items at the maximum application rate for one growing cycle. The chronic RQ exceeded the LOC by >15-fold for birds foraging on short grass. The most sensitive endpoints were reduced feed consumption and decreased male body weight gain. While there is generally a high-degree of variability in feed consumption, the reduced feed consumption in the non-guideline study may imply the birds were not acclimated properly. Males in all three treatment groups lost weight relative to their starting weight, up to an average of 4.5g in the highest treatment level. The control males gained an average of 2.1g. But the ecological significance of this endpoint is not clear. A loss of 4.5g represents a 6% reduction in weight, based on an average size Japanese quail. For male birds that provide parental care of the young, given the increased energy demands on the wild birds (relative to study conditions), this reduced weight may lead to reduced survivorship or impaired development of offspring. Additionally, if a wild species was more sensitive than the Japanese quail, the effect could be amplified.

There were effects seen at the highest dose tested that have could be indicative of effects on endocrine-mediated processes (*e.g.*, eggshell thinning). Hypothetically ignoring effects at the lowest dose, using the NOAEC for these other effects (387 mg ai/kg bw), the chronic RQs would exceed the LOC in three of the four forage categories by 3- to 6-fold.

Chronic values (calculated with the lowest dose tested) are based on upper-bound Kenaga values. The non-definitive RQs based on mean Kenaga values also exceed the chronic risk LOC for birds across the same forage categories. EECs exceed the lowest dose tested for more than 100 days for all three forage categories, based on the upper-bound residues, and for more than 50 days based on the mean residues, indicating that residues above the chronic toxicity threshold could be available to foraging wildlife for an extended period. The chronic risk LOC based on mean residues is expected to be exceeded approximately half of the time.

Terrestrial animal RQs are calculated using a default foliar half life of 35 days. If data were generated that demonstrated, hypothetically, three-day half life was appropriate, the maximum RQ would be reduced by roughly 50%. A reduction in the application rate would also reduce RQs. However, because a NOAEC is not established, it is not known how far these parameters would have to be changed to get all RQs below the LOC. Even with a less conservative foliar dissipation rate of 3 days rather than the default 35-day half-life, chronic RQs would still exceed the LOC by a factor of 8x.

Because the Japanese quail reproduction study did not establish a NOAEC, the utility of the study was greatly reduced for this risk assessment. Additionally, the study deviates appreciably from EPA guidelines. The Agency typically prefers birds have a 10-week pre-laying exposure period followed by a 10-week exposure period during egg laying. The supplemental reproduction study submitted to the Agency was designed as an eight-week laying study, with a two-week pre-treatment period, followed by a six week treatment period. It is not clear how the results of this study would relate to an Agency guideline study.

Avian exposure modeling considered only one growing cycle. Since three growing cycles are allowed per year, the mass of chlormequat chloride available may be underestimated. However, since target plants are different for each application cycle, only non-target forage items (*e.g.* weeds) would potentially be subjected to applications over more than one growing cycle.

The acute risk LOC is exceeded for all size classes of mammals foraging on short grass and broadleaf plant/small insects, as well as small and medium size classes foraging on short grass and broadleaf plants/small insects. The acute risk to listed species LOC (RQ≥0.1) is exceeded for small and intermediate size classes foraging on fruits/pods/large insects and large mammals foraging on tall grass. RQs are calculated using upper bound (95%) Kenaga values. RQs calculated with mean Kenaga values still exceed the acute risk LOC for small and medium size classes foraging on short grass and the listed species LOC for all size classes foraging on short grass and small and medium size classes foraging on tall grass and fruit/pods/large insects; however, mean exposure values are expected to be higher about half of the time.

If the rate per application (for three applications, five days apart) was below 0.25 lbs ai/A only small and medium-sized mammals would exceed the listed species LOC at the upper-bound residues. Using a minimum application interval of 21-day or using a hypothetical three day half life results in lower RQs, but does not appreciably change the risk picture. However, the calculated RQs are for only one growing cycle, and therefore do not represent the total mass of chlormequat chloride potentially available for exposure. Since target plants are different for each application cycle, only non-target forage items (*e.g.* weeds) would potentially be subjected to applications over more than one growing cycle.

Two methods (dietary-based and dose-based) are used to estimate chronic risk to mammals and can result in considerably different RQ estimates. The dose-based ($LD_{50}$) calculation takes into account that different-sized animals have to consume different amounts of food and that the food itself has differing nutritional value. The acute oral $LD_{50}$ is believed to provide a better indication of inherent toxicity than the $LC_{50}$ in cases where food avoidance may be an issue in the test animals. If the dietary-based RQ values are adjusted to account for these factors, it is possible that these RQs would be roughly similar to the dose-based RQ values. Dose-based chronic RQs using the upper-bound residues exceed the chronic risk LOC for all size classes foraging on short grass, tall grass and broadleaf plant/small insect by factors of up to 12-fold. Dietary-based chronic risk quotients exceed the LOC using upper-bound residue estimates for mammals foraging on short grass and broadleaf plants/small insects. Using the mean residues, dose-based RQs (1.0-4.3) exceed the LOC for all size classes foraging on short grass, tall grass and broadleaf plants/small insects, except large mammals on tall grass (RQ=0.8). Dietary-based RQs do not exceed the LOC based on mean residues; however, the mean residues are expected to be exceeded about half of the time.

Given that chlormequat chloride is used as a PGR, effects on plants are to be expected. A single application of chlormequat chloride results in an exceedance of the acute risk to unlisted species LOC for dicots and exceedance of the listed species LOC for both monocots and dicots in wetlands adjacent to use sites. It is not clear to what degree wetlands would be adjacent to the use sites, but it cannot be ruled out based on this screening level assessment. It is also not known what effect cumulative applications of chlormequat chloride might have on sensitive plants. Because one of the effects seen in the study was a reduction in number of seeds emerged, affected wetlands could be subject to reduced numbers of sensitive individuals through seed mortality, or a delay the emergence of sensitive plants. Delayed emergence may adversely affect a plant's ability to reproduce or affect the availability of a plant as food source for higher trophic levels at a sensitive time.

Additionally, the vegetative vigor study did not establish a NOAEC, based on >25% effects at the lowest dose tested. However, based on the drift RQ, the NOAEC would need to be approximately 5X lower than the lowest rate tested to result in an exceedance for drift alone. The available data, and the product label, suggest there are differences among species in sensitivity to chlormequat chloride, and only six species were tested for each study, rather than the 10 per study preferred. Because the non-listed plant LOC is exceeded for dicots, potential indirect effects on listed animals cannot be precluded based on this screening-level risk assessment.

#### *Endocrine Disruption Potential*

In a non-guideline avian reproduction study, chronic exposure to chlormequat chloride resulted in increased numbers of cracked eggs in birds and a significant decrease in testes weight, increased eggshell thinning and reduced eggshell strength at the highest dose tested. Additionally, delayed development is reported in mammalian chronic studies. While these effects are often associated with effects on endocrine-mediated pathways, it is unclear from the submitted study whether chlormequat chloride has the capacity to act on endocrine-mediated processes.

The EPA is required under the FFDCA, as amended by FQPA, to develop a screening program to determine whether certain substances (including all pesticide active and other ingredients) "*may have an effect in humans that is similar to an effect produced by a naturally occurring estrogen, or other such endocrine effects as the Administrator may designate*." Following the recommendations of its Endocrine Disruptor Screening and Testing Advisory Committee (EDSTAC), EPA determined that there was scientific basis for including, as part of the program, the androgen and thyroid hormone systems, in addition to the estrogen hormone system. EPA also adopted EDSTAC's recommendation that the Program include evaluations of potential effects in wildlife. For pesticide chemicals, EPA will use FIFRA and, to the extent that effects in wildlife may help determine whether a substance may have an effect in humans, FFDCA authority to require the wildlife evaluations. As the science develops and resources allow, screening of additional hormone systems may be added to the Endocrine Disruptor Screening Program (EDSP). When the appropriate screening and/or testing protocols being considered under the Agency's EDSP have been developed, chlormequat chloride may be subjected to additional screening and/or testing to better characterize effects related to endocrine disruption.

### C. Uncertainties and Data Gaps

The environmental fate dataset for chlormequat chloride is incomplete. There are no acceptable data for hydrolysis, photolysis, anaerobic soil metabolism and terrestrial field dissipation. It was assumed that chlormequat chloride is stable with respect to these degradation pathways. In the aerobic soil and aerobic aquatic metabolism studies all transformation products greater than 10% of the applied may not have been identified. A total residue approach, which assumed that all unidentified extractable residues are of similar toxicity to parent chlormequat chloride, was used for modeling.

The extent to which the species tested, which are generally chosen for traits that make them suitable for use in laboratory testing, represent the sensitivity spectrum of non-target organisms is not clearly understood. It is possible that the laboratory tests represent a relatively insensitive portion of the non-target organisms that could be potentially exposed. If that were the case, the potential risk to animals would be underestimated.

The environmental effects database contains areas of uncertainty. In the avian reproduction studies with the Japanese quail, deviations from Agency guidelines range from fairly minor, such as the use of a test species other than those preferred by the Agency, to an appreciable difference in study design. Agency guideline avian reproduction studies, conducted with the mallard duck and/or northern bobwhite quail, are conducted for 20-22 weeks, with a 10-week pre-laying exposure followed by a 10-week egg laying exposure period. The submitted study was conducted with a two week pre-treatment period followed by a 6-week exposure period, all with laying birds. It is uncertain how the results of this study would relate to a guideline study. The submitted study did not establish a NOAEC, an important assessment endpoint, as statistically significant effects (feed consumption, adult male weight gain) were seen at the lowest dose tested.
Additionally, there are no data regarding chronic effects to fish and a NOEC was not defined in the vegetative vigor study. Given the propensity of chlormequat to persist under some environmental conditions, there is a potential for chronic exposure. The lack of chronic toxicity data is a major impediment to estimating potential risk.

The T-REX model uses conservative screening-level assumptions, such as the use of Hoerger-Kenaga upper-bound residues and that 100% of the animals' diet consists of contaminated food. In this case, chlormequat chloride will be used in nurseries and shadehouses and applied primarily to relatively high-value plants. It seems logical that operators will employ various methods to limit browse on the target plants. However, weeds, seeds and insects could be contaminated via direct deposition and spray drift and make up an appreciable portion of an animal's diet. It is not possible in this screening-level assessment to determine the likelihood of sufficient exposure to pose risk.

It is unlikely that the base assumption in TerrPlant for channelized runoff to wetlands will be met in the case of chlormequat chloride. The model assumes 10 acres draining to one acre, but the label limits application to one acre per day. Although it is possible for 10 contiguous acres to be treated, or even for the same acre to be treated 10 times over 10 days, this temporal element is not accounted for by TerrPlant. Further, application of chlormequat chloride is limited to containerized ornamentals and bedding plants, providing for at least a minimal disconnect from the greater watershed. This represents a source of uncertainty in the assessment.

## IV. CONCLUSION

This screening-level risk assessment for the proposed outdoor use of chlormequat chloride indicates potential risk to aquatic and terrestrial plants, birds, and mammals. It is not clear what potential effects may occur in reptiles or terrestrial-phase amphibians, although there are indications of risk to their surrogate taxon, birds. Based on potential risk to sensitive plant species, there is a potential for indirect effects to most terrestrial animals given chlormequat chloride's potential effect on primary productivity and wetland habitat. Indirect effects to species with obligate relationships to aquatic vascular plants cannot be ruled out based on this assessment.

## V. THREATENED AND ENDANGERED SPECIES

Levels of concern for threatened and endangered species are exceeded for several types of wildlife, including birds, mammals and both aquatic and terrestrial plants. Because potential risk is indicated in their surrogates, there is potential risk to listed amphibians and reptiles. Exceedance of LOCs for plants indicate concern for indirect effects on listed terrestrial animal species reliant on susceptible plant communities, or those solely dependent on a sensitive plant for some portion of their life cycle (obligate relationships). Due to lack of data, chronic risk to freshwater fish is presumed.

The Overview of Ecological Risk Assessment Process in the Office of Pesticide Programs, U.S. Environmental Protection Agency (USEPA 2004, the 'Overview Document') discusses methods for providing the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS), collectively 'the Services', with additional information regarding the listed animal species acute levels of concern (LOCs). A tool has been developed by EFED in consultation with the Services to evaluate the chance of an individual organism being affected given the toxicity of the chemical to the organism and the dose-response curve (see **Appendix IV** for more detail). For the present time, the Excel spreadsheet tool IECV1.1 will allow for such calculations by entering in the mean slope estimate and the 95 percent confidence bounds of that estimate as the slope parameter for the spreadsheet. It is important to note that the model output can go as low as $10^{-16}$ in estimating the event probability. This cut-off is a limit in the Excel spreadsheet environment and should not be interpreted as an agreed upon lower bound threshold for concern for individual effects in any given listed species. The toxicity studies used in this risk assessment do not report dose-response curves, and due to resource limitations, it was not possible to determine if the data are available to calculate the curves. In cases where dose-response curves are unavailable, event probabilities are calculated for the listed species LOC based on a default slope assumption of 4.5 as per original Agency assumptions of typical dose-response slope cited in Urban and Cook (1986).

For birds and mammals, the listed species LOC is 0.1. The chance of one individual being affected at an RQ equal to the LOC is 1 in 294,000. For birds, the highest acute RQ in this assessment is 6.9, for small-sized birds foraging on short grass. If listed birds are as sensitive to chlormequat chloride as the endpoint used in the model indicates, and exposed to the concentration modeled, the chance of an individual being affected is approximately 1 in 1. Large-sized birds foraging on fruits/pods/large insects (RQ = 0.55) results in the potential for 1 in 8 individuals to be affected. The highest acute mammalian RQ in this assessment is 2.2, for small-sized mammals foraging on short grass. If listed mammals are as sensitive to chlormequat as the endpoint used in the model indicates, and exposed to the concentration modeled, the chance of an individual being affected is approximately 1 in 1. For medium-sized mammals foraging on fruits/pods/large insects (RQ = 0.12; lowest mammal RQ exceeding the LOC), the chance of an individual effect is about 1 in 58,000.

Because the screening-level risk assessment indicates that the outdoor chlormequat chloride uses exceed the endangered species LOC for birds (terrestrial-phase amphibians, reptiles), mammals, and plants, a 'may affect' designation can not be precluded based on this assessment. Due to lack of data, chronic risk to freshwater fish is presumed. Additionally, the acute risk LOC for terrestrial plants is exceeded. The Agency considers this to be indicative of a potential for adverse effects to those listed species that rely either on a specific plant species (plant species obligate) or multiple plant species (plant dependant) for some important aspect of their life cycle (indirect effects). Indirect effects may include general habitat modification, host plant loss, and food supply disruption. Further analysis regarding the overlap of individual species with each use site is required prior to determining the likelihood of potential impact to listed species. Such a refinement is outlined in the following sections.

### A. Action Area

For listed species assessment purposes, the action area is considered to be the area affected directly or indirectly by the Federal action and not merely the immediate area involved in the action. At the initial screening-level, the risk assessment considers broadly described taxonomic groups and so conservatively assumes that listed species within those broad groups are co-located with the pesticide treatment area. This means that terrestrial plants and wildlife are assumed to be located on or adjacent to the treated site and aquatic organisms are assumed to be located in a surface water body adjacent to the treated site. The assessment also assumes that the listed species are located within an assumed area, which has the relatively highest potential exposure to the pesticide, and that exposures are likely to decrease with distance from the treatment area.

If the assumptions associated with the screening-level action area result in RQs that are below the listed species LOCs, a "no effect" determination conclusion is made with respect to listed species in that taxa, and no further refinement of the action area is necessary. Furthermore, RQs below the listed species LOCs for a given taxonomic group indicate no concern for indirect effects upon listed species that depend upon the taxonomic group covered by the RQ as a resource. However, in situations where the screening assumptions lead to RQs in excess of the listed species LOCs for a given taxonomic group, a "may affect" designation cannot be precluded and may be associated with direct effects on listed species belonging to that taxonomic group or may extend to indirect effects upon listed species that depend upon that taxonomic group as a resource. In such cases, additional information on the biology of listed species, the locations of these species, and the locations of use sites need to be considered along with available information on the fate and transport properties of the pesticide to determine the extent to which screening assumptions regarding an action area apply to a particular listed organism. These subsequent refinement steps could delineate how this information would impact the action area for a particular listed organism and may potentially include areas of exposure that are downwind and downstream of the pesticide use site.

### B. Taxonomic Groups Potentially at Risk

The RQs calculated based on the ratio of EECs to toxicity endpoints, in this case the $LD_{50}$ and NOAEC from animal toxicity studies and NOEC from plant toxicity studies, indicate potential risk to listed birds (terrestrial-phase amphibians, reptiles), mammals, and plants (aquatic vascular and terrestrial; **Table 20**). Due to lack of data, chronic risk to fish is presumed. **Appendix VI** provides a tabulation of species for each taxon that may be affected by this action.

Should estimated exposure levels occur in proximity to listed resources, the available screening-level information suggests a potential concern for direct effects on some listed species associated with the proposed new uses of chlormequat chloride. This Level I screening assessment is based on the initial assumption that listed species within the taxonomic groups of concern are actually present in areas for which the estimated exposure levels used for RQ calculation can be expected to occur. A specific determination of “may affect” for any RQ in excess of listed species LOCs cannot be made until a determination of the co-occurrence of the listed species with the action area has been determined. This was not done for this assessment.

**Table 20**. Listed species risks associated with potential direct or indirect effects due to the proposed applications of chlormequat chloride in containerized ornamental production.

| Listed Taxon | Direct Effects Acute | Direct Effects Chronic | Indirect Effects |
|---|---|---|---|
| Terrestrial and semi-aquatic plants - monocots | Yes | - | Yes[1] |
| Terrestrial and semi-aquatic plants - dicots | Yes | - | Yes[1] |
| Insects | No | - | Yes[1] |
| Birds | Yes | Yes | Yes[1] |
| Terrestrial phase amphibians | Yes | Yes | Yes[1] |
| Reptiles | Yes | Yes | Yes[1] |
| Mammals | Yes | Yes | Yes[1] |
| Aquatic plants | Yes | - | Yes[1] |
| Freshwater fish | No | No data[2] | Yes[1] |
| Aquatic phase amphibians | No | No data | Yes[1] |
| Freshwater invertebrates | No | No | Yes[1] |
| Mollusks | No data | No data | Yes[1] |
| Marine/estuarine fish | No | No data | Yes[1] |
| Marine/estuarine crustaceans | No | No data | Yes[1] |

[1]Nonlisted LOC exceeded for terrestrial and semi-aquatic plants (monocots and dicots), therefore potential for adverse effects to those species that rely either on a specific plant species or multiple plant species. Plant indirect effects may include general habitat modification, host plant loss, and food supply disruption.
[2]Lack of data does not preclude potential risk.

### C. Indirect Effects Analysis

Because terrestrial plant RQs are above non-endangered species LOCs, the Agency considers this to be indicative of a potential for adverse effects to those listed species that are plant species obligates or plant dependant for some important aspect of their life cycle. The extent to which the new uses of chlormequat chloride will indirectly affect listed animal species will require identification of listed species that co-occur in areas of chlormequat chloride use and an evaluation of critical habit as described below. Because of the potential extent of the proposed uses of chlormequat chloride, EFED cannot preclude the possibility of a ‘may affect’ designation for listed species based on this assessment.

## D. Critical Habitat

The screening-level risk assessment has identified potential concerns for direct and indirect effects on listed species associated with action areas where chlormequat chloride is used. In light of the potential for effects on listed species, the next step for EPA and the Services 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 the potential impact of the use of chlormequat chloride on listed species and whether 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 are potentially impacted directly by the use of the pesticide. EPA and the Services will work together to conduct the necessary analysis.

This screening-level risk assessment provides a table of potential biological entities that, if they are constituent elements of one or more critical habitats, would be of potential concern (**Appendix VI**). These correspond to the taxa identified above as being of potential concern for indirect effects and include freshwater fish (aquatic-phase amphibians) (presumption of chronic risk), birds (terrestrial-phase amphibians, reptiles), and mammals, as well as terrestrial and aquatic plants. These tables should serve as an initial step in problem formulation for further assessment of critical habitat impacts outlined above.

## E. Co-occurrence Analysis

The goal of the analysis for co-location is to determine whether sites of pesticide use are geographically associated with known locations of listed species. At the screening level, this analysis is accomplished using the Agency's LOCATES (v. 2.10.3) database. The database uses location information for listed species at the county level and compares it to agricultural census data for crop production at the same county level of resolution. The database contains Federally-listed species that are located within states known to produce the crop upon which the pesticide will be used. Because the Level-I screening assessment considers **both** direct and indirect effects across generic taxonomic groupings, it is not possible to exclude any taxonomic group from a LOCATES database query for a screening-level risk assessment. The utility of the database is limited in the case of chlormequat chloride by the lack of resolution in the data regarding containerized nurseries and bedding plant production sites.

Because the outdoor uses of chlormequat chloride are new, the extent of its potential use has not yet been determined. As noted previously, at the screening level, it is not possible to evaluate all the potential direct and indirect effects that could impact endangered animals. Therefore, a 'may effect' designation cannot be precluded for listed animals based on this assessment.

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## VII. APPENDIX I. ENVIRONMENTAL FATE AND TRANSPORT DATA

### Abiotic Degradation

*Hydrolysis*

There are no acceptable data to fulfill this guideline requirement.

*Aqueous Photolysis*

There are no acceptable data to fulfill this guideline requirement.

*Soil Photolysis*

There are no acceptable data to fulfill this guideline requirement.

### Metabolism

*Aerobic Soil Metabolism*

In an aerobic soil metabolism study classified as **supplemental** (MRID 46751225), chlormequat chloride decreased from 91-103% at day 0 to 47-60% at day 28, 22-37% at day 56, and was 11-17% at day 112 in two loamy sand soils and two silt loam soils. Soils were was sequentially extracted four times with methanol:water (1:1, v:v), then four times with acidified water (pH 2). Nonextractable residues increased from 0.9-6.0% at day 0 to 19.0-27.8% at 112 days. Chlormequat chloride degraded with log-linear half-lives of 34-43 d. There were no identified major degradates; however up to 10.7% and 43.7% of the applied radioactivity in the soil extracts of two soils was unaccounted for and no attempt was made to identify the transformation product(s). Consequently, all transformation products detected at >10% of the applied may not have been identified. Using a total residue approach that assumes all uncharacterized extractable residues are of equal toxicity to chlormequat chloride results in half-lives of 32 – 132 d.

*Anaerobic Soil Metabolism*

There are no acceptable data to fulfill this guideline requirement.

*Aerobic Aquatic Metabolism*

In an aerobic aquatic metabolism study classified as **supplemental** (MRID 46715227), chlormequat chloride decreased in the total systems from 105-108% at day 0 to 37-92% at day 7, 1.4-20% at day 14, 1.7-6.3% at day 30 and was 0.1-0.6% at study termination in a river water-sandy loam and pond water-silt loam system. Sediment were sequentially extracted 1-3 times with methanol:acidified (pH 2) water (1:1, v:v), followed by 1-5 times with acidic (pH 2) water. There were no identified major degradates; however there was an unidentified TLC fraction at a maximum of 11.1 and 13.4% of the applied radioactivity in the sediment and total system of the river water-sandy loam system. Nonextractable residues increased from 1.0-2.6% at time 0 to 49.0-59.2% at 30 days and were 27.7-31.3% at 105 study termination. Chlormequat chloride degraded with total system half-lives of 4.9-8.7d.

*Anaerobic Aquatic Metabolism*

Not required

**Mobility**

*Batch Equilibrium*

In a batch equilibrium study classified as **acceptable** (MRID 46715228), following 16 hours of equilibration, 11.6-65.3%, 38.9-78.0%, 13.8-40.2%, and 16.2-72.7% of the applied [$^{14}$C]chlormequat chloride was adsorbed to a Speyer 2.2 loamy sand, Sisseln sandy loam, Les Evouettes silt loam, and Wilson sand soils, respectively. Following the second desorption step, the percent of [$^{14}$C]chlormequat chloride desorbed from the test soils, as percent of the radioactivity adsorbed, was 11.7-47.2% for the Speyer 2.2 loamy sand, 14.7-58.2% for the Sisseln I sandy loam, 22.0-63.6% for the Les Evouettes silt loam, and 13.4-43.6% for the Wilson sand soils. Freundlich adsorption and desorption coefficients are listed in the table below.

| Soil | Adsorption | | | | Desorption | | | |
|---|---|---|---|---|---|---|---|---|
| | $K_F$ | 1/n | $r^2$ | $K_{Foc}$ | $K_F$ | 1/n | $r^2$ | $K_{Foc}$ |
| Speyer 2.2 Loamy sand | 1.25 | 0.5109 | 0.9899 | 54.6 | 1.93 | 0.4695 | 0.9841 | 84.3 |
| Sisseln I Sandy loam | 4.57 | 0.6905 | 0.9984 | 291 | 5.29 | 0.6187 | 0.9982 | 337 |
| Les Evouettes Silt loam | 1.13 | 0.7015 | 0.9913 | 81.2 | 1.54 | 0.5909 | 0.9783 | 110 |
| Wilson Sand | 1.73 | 0.5433 | 0.9939 | 92.7 | 2.99 | 0.5346 | 0.9944 | 160 |

In a batch equilibrium study classified as **acceptable** (MRID 46715229), 5 or 16 hours of equilibration, 22.4-49.0%, 59.9-76.9%, and 58.1-63.5% of the applied [$^{14}$C]chlormequat chloride was adsorbed to the Breda sandy loam, Westmaas loam, and Itingen silt loam soils.. Following the second desorption step, the percent of [$^{14}$C]chlormequat chloride desorbed from the test soils, as percent of the radioactivity adsorbed, was 40.6-68.8% for the Breda sandy loam, 21.9-34.6% for the Westmaas loam, and 20.7-55.0% for the Itingen silt loam soils. Freundlich adsorption and desorption coefficients are listed in the table below.

| Soil | Adsorption | | | | Desorption | | | |
|---|---|---|---|---|---|---|---|---|
| | $K_F$ | 1/N | $r^2$ | $K_{Foc}$ | $K_F$ | 1/N | $r^2$ | $K_{Foc}$ |
| Breda Sandy loam | 2.14 | 0.7680 | 0.9998 | 89.4 | 3.18 | 0.7629 | 0.9996 | 133 |
| Westmaas Loam | 9.12 | 0.8486 | 0.9999 | 912 | 12.5 | 0.8590 | 0.9996 | 1249 |
| Itingen Silt loam | 8.08 | 0.9553 | 1.0000 | 385 | 10.8 | 0.8618 | 0.9997 | 514 |

*Column Leaching*

In an aged column leaching study classified as **supplemental** (MRID 46715230), following 15 days of aging, the mass balance was 98 -105% of the applied radioactivity. Extractable and unextractable residues accounted for 46-49 % and 18-23% of the applied, respectively. Cumulative [$^{14}$C]$CO_2$ comprised 33-34% of the applied, collected on days 7 and 15 of aging. A mass balance following the 2-day leaching period was not determined. The pooled leachates contained 0.29-0.49% of the applied radioactivity. Data characterizing the radioactivity in the soil columns were not provided.

In an aged column leaching study classified as **supplemental** (MRID 124061), following 30 days of aging, 69% of the initial radioactivity was recovered, of which 43% was recovered from the soil inside the nylon mesh bag and 26% was recovered from the untreated soil outside of the nylon mesh bag. Following 45 days of leaching with distilled water, an average of 79% of the applied was recovered in the 0-3 inch segment, 2% in the 3-6 inch segment, 1% in the 6-9 inch segment, and <0.1% in the 9-12 inch segment. Radioactivity in the leachate volumes totaled 2.5% of the applied. In the leachates, an average of <0.02% of the applied was recovered on days 0-3, 2.0% on day 4, 0.4% on day 5, 0.1% on day 6, <0.02% on days 8-35 days, and 0.02% on days 36-45. A maximum of 2.5% of the applied was recovered in the leachates on days 4-6. The soil was too coarsely sieved (12.7 mm), so that gravel might still have been present. In addition, the temperature of the soil column during leaching was not reported, and it was not stated whether leaching was conducted in the dark. Also, distilled water was used which could lead to dispersion of clays that could affect soil structure.

In an unaged column leaching study classified as **supplemental** (MRID 124062), following leaching with 20 inches of distilled water, at a rate not exceeding 1 inch/hour, through a 15 cm column, 75-103% of the applied was recovered in the 0-3 inch segment, 1.6-14% in the 3-6 inch segment, 0.5-2.6% in the 6-9 inch segment, and <0.1-1.0% in the 9-12 inch segment for the sand soil. Radioactivity in the leachate samples was <0.1% of the applied. The test soils were too coarsely sieved (12.7 mm) prior to use in the study, so that gravel might still have been present. In addition, the temperature of the soil column during leaching was not reported, and it was not stated whether leaching was conducted in the dark. Also, distilled water was used which could lead to dispersion of clays that could affect soil structure.

**Terrestrial Field Dissipation**

There are no acceptable data to fulfill this guideline requirement.

**Bioaccumulation**

Not required.

# VIII. APPENDIX II. PRZM/EXAMS OUTPUT FILES

## FL turf

stored as FLturf TR_RED.out
Chemical: chlormequat chloride
PRZM environment: FLturfC.txt modified Monday, 16 June 2003 at 12:48:06
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 15:33:30
Metfile: w12834.dvf modified Wedday, 3 July 2002 at 08:04:28
Water segment concentrations (ppb)

| Year | Peak | 96 hr | 21 Day | 60 Day | 90 Day | Yearly |
|---|---|---|---|---|---|---|
| 1961 | 53.26 | 47.55 | 31.56 | 16.87 | 14.31 | 4.268 |
| 1962 | 96.08 | 86.64 | 56.71 | 31.53 | 22.88 | 6.633 |
| 1963 | 68.32 | 61.26 | 50.6 | 36.67 | 27.78 | 7.914 |
| 1964 | 98.01 | 88.49 | 70.06 | 37.34 | 35.78 | 10.2 |
| 1965 | 153 | 136 | 102 | 54.05 | 38.18 | 10.79 |
| 1966 | 98.58 | 87.91 | 65.06 | 51.35 | 39.55 | 10.96 |
| 1967 | 81.87 | 73.5 | 49.17 | 26.33 | 19.74 | 5.828 |
| 1968 | 184 | 165 | 111 | 59.08 | 41.8 | 11.4 |
| 1969 | 63.35 | 56.93 | 50.42 | 32.5 | 23.46 | 6.644 |
| 1970 | 15.45 | 14.1 | 9.588 | 6.682 | 5.579 | 1.64 |
| 1971 | 84.94 | 75.54 | 47.7 | 32.64 | 26.74 | 7.588 |
| 1972 | 93.18 | 82.98 | 53.04 | 34.56 | 26.31 | 7.469 |
| 1973 | 9.025 | 8.125 | 7.009 | 5.355 | 4.02 | 1.465 |
| 1974 | 41.41 | 36.77 | 23.51 | 16.67 | 13.13 | 3.782 |
| 1975 | 19.95 | 17.66 | 11.74 | 8.305 | 7.126 | 2.086 |
| 1976 | 78.69 | 71.13 | 62.76 | 44.1 | 31.91 | 8.564 |
| 1977 | 61.67 | 56.67 | 37.62 | 18.64 | 14.48 | 4.836 |
| 1978 | 136 | 119 | 77.82 | 38.25 | 31 | 8.648 |
| 1979 | 122 | 111 | 75.93 | 39.09 | 33.61 | 9.689 |
| 1980 | 27.55 | 25.61 | 20.69 | 14.31 | 11.61 | 3.407 |
| 1981 | 33.94 | 30.62 | 19.29 | 11.34 | 10.08 | 3.6 |
| 1982 | 72.13 | 63.89 | 40.99 | 32.14 | 23.75 | 6.709 |
| 1983 | 153 | 140 | 116 | 60.28 | 42.66 | 11.76 |
| 1984 | 309 | 281 | 189 | 94.81 | 66.46 | 17.82 |
| 1985 | 37.9 | 33.24 | 20.43 | 12.77 | 10.3 | 3.147 |
| 1986 | 44.13 | 40.14 | 26.05 | 13.82 | 10.73 | 3.472 |
| 1987 | 15.82 | 13.96 | 10.82 | 7.674 | 6.934 | 2.102 |
| 1988 | 33.74 | 29.83 | 18.81 | 11.19 | 8.961 | 2.623 |
| 1989 | 30.26 | 27.57 | 21.14 | 12.25 | 8.819 | 2.416 |
| 1990 | 7.688 | 6.856 | 6.366 | 4.846 | 3.999 | 1.312 |

Sorted results

| Prob. | Peak | 96 hr | 21 Day | 60 Day | 90 Day | Yearly |
|---|---|---|---|---|---|---|
| 0.032258064516129 | 309 | 281 | 189 | 94.81 | 66.46 | 17.82 |
| 0.0645161290322581 | 184 | 165 | 116 | 60.28 | 42.66 | 11.76 |
| 0.0967741935483871 | 153 | 140 | 111 | 59.08 | 41.8 | 11.4 |
| 0.129032258064516 | 153 | 136 | 102 | 54.05 | 39.55 | 10.96 |
| 0.161290322580645 | 136 | 119 | 77.82 | 51.35 | 38.18 | 10.79 |
| 0.193548387096774 | 122 | 111 | 75.93 | 44.1 | 35.78 | 10.2 |
| 0.225806451612903 | 98.58 | 88.49 | 70.06 | 39.09 | 33.61 | 9.689 |
| 0.258064516129032 | 98.01 | 87.91 | 65.06 | 38.25 | 31.91 | 8.648 |
| 0.290322580645161 | 96.08 | 86.64 | 62.76 | 37.34 | 31 | 8.564 |
| 0.32258064516129 | 93.18 | 82.98 | 56.71 | 36.67 | 27.78 | 7.914 |
| 0.354838709677419 | 84.94 | 75.54 | 53.04 | 34.56 | 26.74 | 7.588 |
| 0.387096774193548 | 81.87 | 73.5 | 50.6 | 32.64 | 26.31 | 7.469 |
| 0.419354838709677 | 78.69 | 71.13 | 50.42 | 32.5 | 23.75 | 6.709 |
| 0.451612903225806 | 72.13 | 63.89 | 49.17 | 32.14 | 23.46 | 6.644 |
| 0.483870967741936 | 68.32 | 61.26 | 47.7 | 31.53 | 22.88 | 6.633 |
| 0.516129032258065 | 63.35 | 56.93 | 40.99 | 26.33 | 19.74 | 5.828 |
| 0.548387096774194 | 61.67 | 56.67 | 37.62 | 18.64 | 14.48 | 4.836 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.580645161290323 | 53.26 | 47.55 | 31.56 | 16.87 | 14.31 | 4.268 |
| 0.612903225806452 | 44.13 | 40.14 | 26.05 | 16.67 | 13.13 | 3.782 |
| 0.645161290322581 | 41.41 | 36.77 | 23.51 | 14.31 | 11.61 | 3.6 |
| 0.67741935483871 37.9 | 33.24 | 21.14 | 13.82 | 10.73 | 3.472 | |
| 0.709677419354839 | 33.94 | 30.62 | 20.69 | 12.77 | 10.3 | 3.407 |
| 0.741935483870968 | 33.74 | 29.83 | 20.43 | 12.25 | 10.08 | 3.147 |
| 0.774193548387097 | 30.26 | 27.57 | 19.29 | 11.34 | 8.961 | 2.623 |
| 0.806451612903226 | 27.55 | 25.61 | 18.81 | 11.19 | 8.819 | 2.416 |
| 0.838709677419355 | 19.95 | 17.66 | 11.74 | 8.305 | 7.126 | 2.102 |
| 0.870967741935484 | 15.82 | 14.1 | 10.82 | 7.674 | 6.934 | 2.086 |
| 0.903225806451613 | 15.45 | 13.96 | 9.588 | 6.682 | 5.579 | 1.64 |
| 0.935483870967742 | 9.025 | 8.125 | 7.009 | 5.355 | 4.02 | 1.465 |
| 0.967741935483871 | 7.688 | 6.856 | 6.366 | 4.846 | 3.999 | 1.312 |

0.1 153 139.6 110.1 58.577 41.575 11.356
Average of yearly averages: 6.2924

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: FLturf TR_RED
Metfile: w12834.dvf
PRZM scenario: FLturfC.txt
EXAMS environment file: pond298.exv
Chemical Name: chlormequat chloride

| Description | Variable Name | Value | Units | Comments |
|---|---|---|---|---|
| Molecular weight | mwt | 158.1 | g/mol | |
| Henry's Law Const. | henry | 1.6e-15 | atm-m^3/mol | |
| Vapor Pressure | vapr | 7.5e-8 | torr | |
| Solubility | sol | 10e6 | mg/L | |
| Kd | Kd | | mg/L | |
| Koc | Koc | 272 | mg/L | |
| Photolysis half-life | kdp | 0 | days | Half-life |
| Aerobic Aquatic Metabolism | kbacw | 12.6 | days | Halfife |
| Anaerobic Aquatic Metabolism | kbacs | 0 | days | Halfife |
| Aerobic Soil Metabolism | asm | 100 | days | Halfife |
| Hydrolysis: | pH 7 | 0 | days | Half-life |
| Method: CAM | 2 | integer | See PRZM manual | |
| Incorporation Depth: | DEPI | | cm | |
| Application Rate: | TAPP | 4.15 | kg/ha | |
| Application Efficiency: | APPEFF | .99 | fraction | |
| Spray Drift | DRFT | .01 | fraction of application rate applied to pond | |
| Application Date | Date | 15-4 | dd/mm or dd/mmm or dd-mm or dd-mmm | |
| Interval 1 | interval | 5 | days | Set to 0 or delete line for single app. |
| Interval 2 | interval | 5 | days | Set to 0 or delete line for single app. |
| Interval 3 | interval | 5 | days | Set to 0 or delete line for single app. |
| Interval 4 | interval | 5 | days | Set to 0 or delete line for single app. |
| Interval 5 | interval | 5 | days | Set to 0 or delete line for single app. |
| Interval 6 | interval | 5 | days | Set to 0 or delete line for single app. |
| Interval 7 | interval | 5 | days | Set to 0 or delete line for single app. |
| Interval 8 | interval | 5 | days | Set to 0 or delete line for single app. |
| Record 17: | FILTRA | | | |
| | IPSCND | 1 | | |
| | UPTKF | | | |
| Record 18: | PLVKRT | | | |
| | PLDKRT | | | |
| | FEXTRC | 0.5 | | |
| Flag for Index Res. Run | IR | Pond | | |
| Flag for runoff calc. | RUNOFF | none | none, monthly or total(average of entire run) | |

## PA turf

stored as PAturfTR_RED.out
Chemical: chlormequat chloride
PRZM environment: PAturfC.txt modified Satday, 12 October 2002 at 15:27:02
EXAMS environment: pond298.exv modified Thuday, 29 August 2002 at 15:33:30
Metfile: w14737.dvf modified Wedday, 3 July 2002 at 08:06:12
Water segment concentrations (ppb)

| Year | Peak | 96 hr | 21 Day | 60 Day | 90 Day | Yearly |
|---|---|---|---|---|---|---|
| 1961 | 62.26 | 56.13 | 41.81 | 22.7 | 16.27 | 5.878 |
| 1962 | 68.36 | 62.26 | 43.4 | 24.06 | 18.81 | 6.969 |
| 1963 | 11.47 | 10.81 | 9.817 | 7.707 | 6.072 | 3.266 |
| 1964 | 20.89 | 19.68 | 17.55 | 13.6 | 11.17 | 3.579 |
| 1965 | 10.33 | 9.601 | 8.811 | 6.919 | 5.428 | 1.983 |
| 1966 | 11.6 | 10.95 | 9.901 | 7.616 | 5.912 | 2.653 |
| 1967 | 130 | 118 | 84.63 | 47.68 | 40.89 | 13.03 |
| 1968 | 109 | 102 | 75.52 | 46.27 | 38.37 | 11.72 |
| 1969 | 22.57 | 20.51 | 14.71 | 8.259 | 7.348 | 3.782 |
| 1970 | 10.99 | 10.3 | 9.386 | 7.378 | 5.893 | 2.466 |
| 1971 | 32.25 | 29.87 | 26.02 | 18.17 | 13.92 | 4.581 |
| 1972 | 157 | 146 | 108 | 72.84 | 52.78 | 15.6 |
| 1973 | 73.16 | 69.02 | 49.05 | 37.63 | 28.79 | 9.521 |
| 1974 | 51.33 | 48.64 | 40.42 | 28.38 | 21.6 | 7.116 |
| 1975 | 26.1 | 23.9 | 17.72 | 11.97 | 10.08 | 3.431 |
| 1976 | 18.71 | 17.31 | 12.1 | 7.344 | 5.88 | 3.273 |
| 1977 | 15.75 | 14.45 | 10.37 | 8.809 | 7.427 | 2.659 |
| 1978 | 53.68 | 51.87 | 42.58 | 24.72 | 18.75 | 5.809 |
| 1979 | 82.3 | 78.14 | 59.75 | 33.93 | 25.89 | 8.128 |
| 1980 | 14.42 | 13.42 | 12.65 | 9.357 | 7.295 | 2.485 |
| 1981 | 51.56 | 48.12 | 41.39 | 25.2 | 18.76 | 5.456 |
| 1982 | 96.31 | 90.07 | 71.71 | 48.36 | 35.65 | 10.85 |
| 1983 | 17.17 | 15.69 | 13.04 | 11.5 | 10.64 | 3.653 |
| 1984 | 146 | 137 | 94.63 | 56.14 | 42.91 | 12.22 |
| 1985 | 47.76 | 45.32 | 36.63 | 26.46 | 20.45 | 6.596 |
| 1986 | 38.97 | 36.61 | 27.68 | 20.8 | 16.84 | 5.219 |
| 1987 | 23.25 | 21.11 | 14.37 | 9.757 | 9.001 | 3.539 |
| 1988 | 148 | 140 | 107 | 59 | 43.12 | 12.46 |
| 1989 | 64.75 | 60.7 | 53.95 | 38.65 | 28.79 | 8.719 |
| 1990 | 123 | 115 | 81.47 | 45.44 | 35.14 | 10.74 |

Sorted results

| Prob. | Peak | 96 hr | 21 Day | 60 Day | 90 Day | Yearly | | |
|---|---|---|---|---|---|---|---|---|
| 0.032258064516129 | | | 157 | 146 | 108 | 72.84 | 52.78 | 15.6 |
| 0.0645161290322581 | | | 148 | 140 | 107 | 59 | 43.12 | 13.03 |
| 0.0967741935483871 | | | 146 | 137 | 94.63 | 56.14 | 42.91 | 12.46 |
| 0.129032258064516 | | | 130 | 118 | 84.63 | 48.36 | 40.89 | 12.22 |
| 0.161290322580645 | | | 123 | 115 | 81.47 | 47.68 | 38.37 | 11.72 |
| 0.193548387096774 | | | 109 | 102 | 75.52 | 46.27 | 35.65 | 10.85 |
| 0.225806451612903 | | | 96.31 | 90.07 | 71.71 | 45.44 | 35.14 | 10.74 |
| 0.258064516129032 | | | 82.3 | 78.14 | 59.75 | 38.65 | 28.79 | 9.521 |
| 0.290322580645161 | | | 73.16 | 69.02 | 53.95 | 37.63 | 28.79 | 8.719 |
| 0.32258064516129 | | 68.36 | 62.26 | 49.05 | 33.93 | 25.89 | 8.128 | |
| 0.354838709677419 | | | 64.75 | 60.7 | 43.4 | 28.38 | 21.6 | 7.116 |
| 0.387096774193548 | | | 62.26 | 56.13 | 42.58 | 26.46 | 20.45 | 6.969 |
| 0.419354838709677 | | | 53.68 | 51.87 | 41.81 | 25.2 | 18.81 | 6.596 |
| 0.451612903225806 | | | 51.56 | 48.64 | 41.39 | 24.72 | 18.76 | 5.878 |
| 0.483870967741936 | | | 51.33 | 48.12 | 40.42 | 24.06 | 18.75 | 5.809 |
| 0.516129032258065 | | | 47.76 | 45.32 | 36.63 | 22.7 | 16.84 | 5.456 |
| 0.548387096774194 | | | 38.97 | 36.61 | 27.68 | 20.8 | 16.27 | 5.219 |
| 0.580645161290323 | | | 32.25 | 29.87 | 26.02 | 18.17 | 13.92 | 4.581 |
| 0.612903225806452 | | | 26.1 | 23.9 | 17.72 | 13.6 | 11.17 | 3.782 |
| 0.645161290322581 | | | 23.25 | 21.11 | 17.55 | 11.97 | 10.64 | 3.653 |
| 0.67741935483871 | | 22.57 | 20.51 | 14.71 | 11.5 | 10.08 | 3.579 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.709677419354839 | | 20.89 | 19.68 | 14.37 | 9.757 | 9.001 | 3.539 |
| 0.741935483870968 | | 18.71 | 17.31 | 13.04 | 9.357 | 7.427 | 3.431 |
| 0.774193548387097 | | 17.17 | 15.69 | 12.65 | 8.809 | 7.348 | 3.273 |
| 0.806451612903226 | | 15.75 | 14.45 | 12.1 | 8.259 | 7.295 | 3.266 |
| 0.838709677419355 | | 14.42 | 13.42 | 10.37 | 7.707 | 6.072 | 2.659 |
| 0.870967741935484 | | 11.6 | 10.95 | 9.901 | 7.616 | 5.912 | 2.653 |
| 0.903225806451613 | | 11.47 | 10.81 | 9.817 | 7.378 | 5.893 | 2.485 |
| 0.935483870967742 | | 10.99 | 10.3 | 9.386 | 7.344 | 5.88 | 2.466 |
| 0.967741935483871 | | 10.33 | 9.601 | 8.811 | 6.919 | 5.428 | 1.983 |
| | | | | | | | |
| 0.1 | 144.4 | 135.1 | 93.63 | 55.362 | 42.708 | 12.436 | |
| | | | | | Average of yearly averages: | | 6.57936666666666 |

Inputs generated by pe4.pl - 8-August-2003

Data used for this run:
Output File: PAturfTR_RED
Metfile: w14737.dvf
PRZM scenario: PAturfC.txt
EXAMS environment file: pond298.exv
Chemical Name: chlormequat chloride

| Description | Variable Name | Value | Units | Comments | |
|---|---|---|---|---|---|
| Molecular weight | mwt | 158.1 | g/mol | | |
| Henry's Law Const. | henry | 1.6e-15 | atm-m^3/mol | | |
| Vapor Pressure | vapr | 7.5e-8 | torr | | |
| Solubility | sol | 10e6 | mg/L | | |
| Kd | Kd | | mg/L | | |
| Koc | Koc | 272 | mg/L | | |
| Photolysis half-life | kdp | 0 | days | Half-life | |
| Aerobic Aquatic Metabolism | kbacw | 12.6 | days | Halfife | |
| Anaerobic Aquatic Metabolism | | kbacs | 0 | days | Halfife |
| Aerobic Soil Metabolism | asm | 100 | days | Halfife | |
| Hydrolysis: | pH 7 | 0 | days | Half-life | |
| Method: CAM | 2 | integer | See PRZM manual | | |
| Incorporation Depth: | DEPI | | cm | | |
| Application Rate: TAPP | 4.15 | kg/ha | | | |
| Application Efficiency: | APPEFF | .99 | fraction | | |
| Spray Drift | DRFT | .01 | fraction of application rate applied to pond | | |
| Application Date | Date | 15-4 | dd/mm or dd/mmm or dd-mm or dd-mmm | | |
| Interval 1 | interval | 5 | days | Set to 0 or delete line for single app. | |
| Interval 2 | interval | 5 | days | Set to 0 or delete line for single app. | |
| Interval 3 | interval | 5 | days | Set to 0 or delete line for single app. | |
| Interval 4 | interval | 5 | days | Set to 0 or delete line for single app. | |
| Interval 5 | interval | 5 | days | Set to 0 or delete line for single app. | |
| Interval 6 | interval | 5 | days | Set to 0 or delete line for single app. | |
| Interval 7 | interval | 5 | days | Set to 0 or delete line for single app. | |
| Interval 8 | interval | 5 | days | Set to 0 or delete line for single app. | |
| Record 17: | FILTRA | | | | |
| | IPSCND 1 | | | | |
| | UPTKF | | | | |
| Record 18: | PLVKRT | | | | |
| | PLDKRT | | | | |
| | FEXTRC 0.5 | | | | |
| Flag for Index Res. Run | IR | Pond | | | |
| Flag for runoff calc. | RUNOFF | none | none, monthly or total(average of entire run) | | |

# IX. APPENDIX III.  TREX MODEL INFORMATION

*Points to Consider in Development of Risk Description for Birds and Mammals*

**Acute and Reproduction Dietary Discussions**

The risk assessment includes numerous calculations of dietary exposure for multiple weight classes of animals.   However, there are energetic considerations that suggest that some weight class/food item combinations are not likely to naturally occur.  For example, there are not likely to be many 15 g mammals or 20 g birds that exclusively feed on vegetation.  The risk assessor is urged to consult such texts as the Wildlife Exposure Factors Handbook (USEPA 1993), which provides more comprehensive approaches to consider energy requirements and energy availability to estimate dietary exposure.  In addition, age of individuals may also play an important role in the types and relative amounts of food items selected.  This should also be taken into account when describing dietary risks.

**Acute Toxicity RQ Approaches**

Dose-based and dietary-based acute RQs should be provided to risk managers whenever effects data allow.  There are limitations to each approach.  The dose-based approach considers that the uptake and absorption kinetics of a gavage toxicity study to approximate exposure associated with uptake from a dietary matrix.  Toxic response is a function of duration and intensity of exposure.  For many compounds a gavage dose represents a very short-term high intensity exposure, where dietary exposure may be of a more prolonged nature.  The dietary-based approach assumes that animals in the field are consuming food at a rate similar to that of confined laboratory animals.  Energy content in food items differs between the field and the laboratory as does the energy requirements of wild and captive animals.  The Wildlife Exposure Factors Handbook can provide insights into energy requirements of animals in the wild as well as energy content of their diets

**Reproduction RQ Approach**

The typical 21-week avian reproduction study does not address the exposure duration needed to elicit the observed responses.  The study protocol was designed to establish a steady-state tissue concentration for bioaccumulative compounds. For other pesticides it is entirely possible that steady-state tissue concentrations are achieved earlier than the 21-week exposure period.  Moreover, pesticides may exert effects at critical periods of the reproduction cycle and so long term exposure may not be necessary to elicit the effect observed in the 21-week protocol.  The EFED risk assessment uses the single-day maximum estimated EEC as a conservative approach.  The degree to which this exposure is conservative cannot be determined by the existing reproduction study.  However, risk assessment discussions should be accompanied by the graphics from T-REX model regarding the number of days dietary exposure is above the NOAEC.  The greater number of days EECs exceed the NOAEC, the greater the confidence in predictions of reproductive risk concerns.

## X. APPENDIX IV. TERRPLANT MODEL

Exposure to Terrestrial Plants including Wetlands (August 8, 2001; version 1.0)

Terrestrial plants inhabiting dry and semi-aquatic (wetland) areas may be exposed to pesticides from runoff and/or spray drift. Semi-aquatic areas are low-lying wet areas that may dry up at times throughout the year.

EFED's runoff scenario is (1) based on a pesticide's water solubility and the amount ot pesticide present on the soil surface and its top one inch, (2) characterized as "sheet runoff" (one treated acre to an adjacent acre) for dry areas, (3) characterized as "channel runoff" (10 acres to a distant low-lying acre) for semi-aquatic or wetland areas, and (4) based on percent runoff values of 0.01, 0.02, and 0.05 for water solubilities of <10, 10-100, and >100 ppm, respectively.

EFED's Spray Drift scenario is assumed as (1) 1% for ground application, and (2) 5% for aerial, airblast, forced air, and spray chemigation applications. The spray drift ratio used here is in agreement with the policy procedures at the time the worksheet was designed.

Currently, 1) this worksheet is designed to derive the plant exposure concentrations from a single, maximum application rate only. 2) For pesticide applications with incorporation of depth of less than 1 inch, the total loading EECs derived for the incorporation method will be same as the unincorporated method.

To calculate RQ values for Non-Endangered Terrestrial Plants:

Terrestrial Plants Inhabiting Areas Adjacent to Treatment Site:

Emergence RQ = Total Loading to Adjacent Area or EEC/Seedling Emergence EC25
Drift RQ = Drift EEC/Vegetative Vigor EC25

Terrestrial Plants Inhabiting Semi-aquatic Areas Adjacent to Treatment Site:

Emergence RQ = Total Loading to Semi-aquatic Area or EEC/Seedling Emergence EC25
Drift RQ = Drift EEC/Vegetative Vigor EC25

To calculate RQ values for Endangered Terrestrial Plants:

Endangered Terrestrial Plants Inhabiting Areas Adjacent to Treatment Site:

Emergence RQ = Total Loading to Adjacent Area or EEC/Seedling Emergence EC05
Drift RQ = Drift EEC/Vegetative Vigor EC05 or NOAEC

Endangered Terrestrial Plants Inhabiting Semiaquatic Areas Near Treatment Site:

Emergence RQ = Total Loading to Semiaquatic Area or EEC/Seedling Emergence EC05

Drift RQ = Drift EEC/Vegetative Vigor EC05 or NOAEC

Formulas used to calculate EEC values (8/08/01; version 1.0)

To calculate EECs for terrestrial plants inhabiting in areas adjacent to treatment sites

Un-incorporated Ground Application (Non-granular):

Sheet Runoff = Application Rate (lb ai/A) x Runoff Value
Drift = Application Rate (lb ai/A) x 0.01
Total Loading = EEC = Sheet Runoff + Drift

Incorporated Ground Application with Drift (Non-granular):

Sheet Runoff = [Application Rate (lb ai/A)/Incorporation Depth (inch)] x Runoff Value

Drift = Application Rate (lb ai/A) x 0.01
Total Loading = EEC = Sheet Runoff + Drift

Un-incorporated Ground Application (Granular):

Sheet Runoff = EEC = Application Rate (lb ai/A) x Runoff Value

Incorporated Ground Application without Drift (Granular):

Sheet Runoff = EEC = [Application Rate (lb ai/A)/Incorportion Depth (inch)]

x Runoff Value

Aerial/Airblast/Spray Chemigation Applications:

Sheet Runoff = Application Rate (lb ai/A) x Runoff Value x Application Efficiency of 0.6

Drift = Application Rate (lb ai/A) x 0.05
Total Loading = EEC = Sheet Runoff + Drift

Runoff Value = 0.01, 0.02, or 0.05 when the solubility of the chemical is <10 ppm, 10-100 ppm, or>100 ppm, respectively

Incorporation Depth: Use the minimum incorporation depth reported on the label.

## XI. APPENDIX V. INDIVIDUAL EFFECT CHANCE MODEL

### Use of the Probit Dose Response Relationship to Provide Information on the Endangered Species Levels of Concern

### Introduction

The document entitled Overview of Ecological Risk Assessment Process in the Office of Pesticide Programs, U.S. Environmental Protection Agency (USEPA 2004, the Overview Document) discusses methods for providing the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) with additional information regarding the listed animal species acute levels of concern (LOCs). This document provides (1) the background information on how agreements were reached between the services and USEPA for methods to provide additional LOC information, and (2) a discussion of issues concerning those methods and their resolution. Risk Assessors within the Environmental Fate and Effects Division (EFED) should use the Overview Document as well as the following information as guidance for using the probit dose response relationship as a tool for providing additional information on the listed species LOCs

Effective immediately, all screening-level risk assessments (REDS, Section 3's, Section 18's, etc.) using risk quotient (RQ) methods will incorporate this analysis, regardless of whether listed species LOCs are exceeded or not.

### Background on Discussion of LOCs with USFWS and NMFS

Over the course of negotiations with the USFWS and NMFS, one topic of discussion centered on the risk quotient values established as screening thresholds for consideration of direct toxic effects on listed species (i.e., the acute listed species LOCs of 0.1 and 0.05 used for terrestrial and aquatic animals, respectively). The Agency provided the Services with the mathematical interpretations of these LOC values, which was documented in the background information supplied to the Services and is included in the Overview Document CD distributed to all employees in EFED. In short, the interpretation of the LOCs was discussed in terms of best estimates of the chance of an individual event (mortality or immobilization) should exposure at the estimated environmental concentration actually occur for a species with sensitivity to the pesticide on par with the toxicity endpoint selected for RQ calculation.

The mathematics were based on a long-held <u>assumption</u> of a probit dose-response relationship for acute toxicity endpoints. The listed species LOCs or the fraction (0.05 or 0.1) of the dose estimated to produce 50% mortality were used to interpolate from a probit dose response curve to estimate the associated ECx, LDx, or LCx. These values were then used to estimate the chance of an individual event.

Two issues were identified over the course of discussions with the Services in regard to the Agency's presentations of the math and the interpretation of the LOCs. First was the issue that the chance of individual event was highly dependant upon the assumed shape and slope of the dose-response relationship. Second was that the Services were unwilling to present a <u>generic</u> threshold of the chance of an individual event, below which the Services would not have a concern for listed species impacts  The services indicated that the baseline conditions of a species and it's biology would dictate species-specific concerns for  tolerated effects.   Further discussion on the confidence of extreme value extrapolations for probit dose response did not achieve an agreement between all parties on what the lower limit of cutoff in reporting extreme events should be for interpretation of listed species acute LOCs.  Even consideration of using the most intolerant listed species within taxonomic groups as a screening basis for other more tolerant listed species was not accepted as a viable strategy for establishing generic effects thresholds for listed species.

Consequently, it was accepted by all parties that the Agency would provide in its risk assessments an interpretation of the listed species LOCs in terms of the chance of an individual effect should organisms be exposed to a media concentration or dose corresponding to 1/10 or 1/20 of the $LC_{50}$, $LD_{50}$, or $EC_{50}$ used as the acute toxicity measurement endpoint for a particular animal taxonomic group.  To accomplish this interpretation, the Agency would use (1) the slope of the dose response relationship available from the toxicity study used to establish the acute toxicity measurement endpoints for each animal taxonomic group;  (2) an assumption of a probit dose response relationship; (3) a mean estimate of slope consistent with current Agency statistical procedures; and (4) a lower limit to the estimate of individual effect chance based on what could be calculated by Excel spreadsheet "Normdist" function.

**Issues with the LOC Interpretation Method and Their Resolution**

Discussion within the Agency has identified three issues with regard to the calculation of the chance of individual event corresponding to the listed species acute LOCs.  The largest issue is the extrapolation to extremely low probability events, referring to the very large confidence intervals surrounding such estimates.  A secondary issue, but still very important, is the extent to which probit dose response slopes can be calculated for existing studies (i.e., the fitting of a probit dose response relationship to available data). The third issue is how to proceed when information is unavailable to estimate a slope. The following guidance information will address these issues:

<u>Extrapolation to Extremely Low Probability Events</u>

The nature of this issue centers on the fact that slope estimates are accompanied by a corresponding variance in the slope term.  This variance in the slope term and to some extent the variance in the median lethal dose estimate, can result in wide variations of effects probabilities at the upper and lower tails of the dose range.  While the Agency has agreed to present the effects probability associated with the LOCs based on the mean estimate of slope, it is evident that expression of this single estimate of the corresponding effects probability would suggest that the Agency has inordinately high confidence in this estimate, when in fact there is likely considerable variability in the estimate.  Consequently, for the short term, it is recommended that both the estimate of effects probability be calculated for the mean slope estimate and listed species LOC <u>and</u> available information on the 95% confidence interval of the slope estimate be used to calculate an upper and lower estimate of the effects probability.  It is important to note that interpretation of these results is not required under agreement with the Services.  The Services have requested that the results be made available in the screening assessment reports.  It is recommended that reporting minimally include the following discussion:

> " Based on an assumption of a probit dose response relationship with a mean estimated slope of **(enter slope here)**, the corresponding estimated chance of individual mortality associated with the listed species LOC of (0.1 or 0.05) the acute toxic endpoint for **(enter appropriate animal taxonomic group)** is **(enter value)**. It is recognized that extrapolation of very low probability events is associated with considerable uncertainty in the resulting estimates. To explore possible bounds to such estimates, the upper and lower values for the mean slope estimate **(enter the 95 percent confidence interval for the slope)** were used to calculate upper and lower estimates of the effects probability associated with the listed species LOC. These values are **(enter the upper and lower estimates)**."

For the present time, the Excel spreadsheet tool IECV1.1 will allow for such calculations by entering in the mean slope estimate and the 95 percent confidence bounds of that estimate as the slope parameter for the spreadsheet. It is important to note that the model output can go as low as 10 E-16 in estimating the event probability. This cut-off is a limit in the Excel spreadsheet environment and is not to be interpreted as an agreed upon lower bound threshold for concern for individual effects in any given listed species.

*EFED will continue to work on establishing subsequent approaches to account for both the variance in the slope and the median lethal dose estimate when establishing this upper and lower estimates of effects estimates associated with the listed species LOCs.*

<u>Probit Slopes for Existing Studies</u>

Slope information may or may not be estimated for a given study upon which RQs were calculated. When the available data evaluation records (DERs) or study reports provide the slope information (i.e., mean slope estimate, p-value of estimate, and 95% confidence interval of the estimate) , it should be used as reported once these reported values have been carefully reviewed to ensure their accuracy. However, there are likely to be situations where slope information is not provided in the DERs. For such situations, the raw data from the study must be entered into and analyzed by the EFED current statistical package for acute effects studies. See the EFED Statistical Workgroup for assistance with accessing these software. Probit slope information will be used from these analyses. However, there are two distinctions that must be made in the reporting of these results for listed species evaluation. First, studies with good probit fit characteristics can be used as reported accompanied with a statement that the probit dose response relationship was statistically appropriate for the data set. Alternatively, if the assumption of a probit dose response was shown to be statistically unsupported, the slope estimates are still used in the listed species LOC interpretation (remember we have in our policy assumed probit dose response when LOCs were established), but the statistical rejection criteria must be presented along with a statement :

> "Although the Agency has assumed a probit dose response relationship in establishing the listed species LOCs, the available data for the toxicity study generating RQs for this taxonomic group do not statistically support a probit dose response relationship **(enter the p-value from the statistical package)** and so the confidence in estimated event probabilities based on this dose response relationship and the listed species LOC is low."

*EFED will continue to work on the development of statistical tools to explore alternative dose response relationships in situations where the assumption of probit dose response relationship is not upheld by available data.*

<u>How to Proceed When Information is Unavailable to Estimate a Slope</u>

State in the assessment that information is unavailable to estimate a slope from the available toxicity study and the reason why re-analysis of raw data is not possible. Then state that a event probability was calculated for the listed species LOC based on a default slope assumption of 4.5 as per original Agency assumptions of typical slope cited in Urban and Cook (1986).

**References**

United States Environmental Protection Agency (USEPA). 2004. Overview of Ecological Risk Assessment Process in the Office of Pesticide Programs, U.S. Environmental Protection Agency. Office of Prevention, Pesticides and Toxic Substances, Office of Pesticide Programs, Washington, DC.

Urban D.J. and N.J. Cook. 1986. Hazard Evaluation Division Standard Evaluation Procedure Ecological Risk Assessment. EPA 540/9-85-001. U.S. Environmental Protection Agency, Office of Pesticide Programs, Washington, DC.

## XII. APPENDIX VI. ENDANGERED SPECIES COUNT FROM THE LOCATES DATABASE BY LISTED TAXON FOR EACH CROP

# *Species Counts by State for Indicated Crops*

No species were excluded.

Minimum of 1 Acre.
All Medium Types Reported

*floriculture crops - bedding/garden plants, cut flowers& florist greens, foliage and potted flowering plants- total, nursery and greenhouse crops -*
AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

### *Alabama*

The taxa Amphibian has 2 species co-occurring with indicated crops.

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Bivalve has 28 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 9 species co-occurring with indicated crops.

The taxa Ferns has 2 species co-occurring with indicated crops.

The taxa Fish has 15 species co-occurring with indicated crops.

The taxa Gastropod has 10 species co-occurring with indicated crops.

The taxa Mammal has 4 species co-occurring with indicated crops.

The taxa Monocot has 3 species co-occurring with indicated crops.

The taxa Reptile has 5 species co-occurring with indicated crops.

### *Arizona*

The taxa Amphibian has 2 species co-occurring with indicated crops.

The taxa Bird has 8 species co-occurring with indicated crops.

The taxa Dicot has 14 species co-occurring with indicated crops.

The taxa Fish has 17 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Mammal has 8 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 2 species co-occurring with indicated crops.

### *Arkansas*

The taxa Bird has 3 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Bivalve has 5 species co-occurring with indicated crops.

The taxa Crustacean has 2 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

## *California*

The taxa Amphibian has 6 species co-occurring with indicated crops.

The taxa Bird has 16 species co-occurring with indicated crops.

The taxa Conf/cycds has 2 species co-occurring with indicated crops.

The taxa Crustacean has 9 species co-occurring with indicated crops.

The taxa Dicot has 161 species co-occurring with indicated crops.

The taxa Fish has 29 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 22 species co-occurring with indicated crops.

The taxa Mammal has 20 species co-occurring with indicated crops.

The taxa Marine mml has 2 species co-occurring with indicated crops.

The taxa Monocot has 18 species co-occurring with indicated crops.

The taxa Reptile has 8 species co-occurring with indicated crops.

## *Colorado*

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Dicot has 6 species co-occurring with indicated crops.

The taxa Fish has 6 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

## *Connecticut*

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 1 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

## *Delaware*

The taxa Bird has 2 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

## *Florida*

The taxa Amphibian has 1 species co-occurring with indicated crops.

The taxa Bird has 10 species co-occurring with indicated crops.

The taxa Bivalve has 7 species co-occurring with indicated crops.

The taxa Conf/cycds has 1 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 49 species co-occurring with indicated crops.

The taxa Fish has 4 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Lichen has 1 species co-occurring with indicated crops.

The taxa Mammal has 13 species co-occurring with indicated crops.

The taxa Marine mml has 1 species co-occurring with indicated crops.

The taxa Monocot has 3 species co-occurring with indicated crops.

The taxa Reptile has 10 species co-occurring with indicated crops.

## *Georgia*

The taxa Amphibian has 1 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Bird has 5 species co-occurring with indicated crops.

The taxa Bivalve has 16 species co-occurring with indicated crops.

The taxa Conf/cycds has 1 species co-occurring with indicated crops.

The taxa Dicot has 9 species co-occurring with indicated crops.

The taxa Ferns has 2 species co-occurring with indicated crops.

The taxa Fish has 8 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

The taxa Marine mml has 1 species co-occurring with indicated crops.

The taxa Monocot has 6 species co-occurring with indicated crops.

The taxa Reptile has 2 species co-occurring with indicated crops.

### *Hawaii*

The taxa Arachnid has 1 species co-occurring with indicated crops.

The taxa Bird has 32 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 233 species co-occurring with indicated crops.

The taxa Ferns has 12 species co-occurring with indicated crops.

The taxa Gastropod has 39 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Marine mml has 1 species co-occurring with indicated crops.

The taxa Monocot has 22 species co-occurring with indicated crops.

The taxa Reptile has 2 species co-occurring with indicated crops.

### *Idaho*

The taxa Bird has 1 species co-occurring with indicated crops.

The taxa Dicot has 3 species co-occurring with indicated crops.

The taxa Fish has 8 species co-occurring with indicated crops.

The taxa Gastropod has 2 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

### *Illinois*

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 7 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 7 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

## *Indiana*

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 11 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

## *Iowa*

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Dicot has 3 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Fish has 2 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

## *Kansas*

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Fish has 4 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

### *Kentucky*

The taxa Bird has 7 species co-occurring with indicated crops.

The taxa Bivalve has 22 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 9 species co-occurring with indicated crops.

The taxa Fish has 3 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

### *Louisiana*

The taxa Bird has 5 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Fish has 2 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Marine mml has 1 species co-occurring with indicated crops.

The taxa Reptile has 7 species co-occurring with indicated crops.

### *Maine*

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Fish has 2 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

### *Maryland*

The taxa Bird has 2 species co-occurring with indicated crops.

The taxa Bivalve has 1 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Fish has 2 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

### *Massachusetts*

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Insect has 3 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 2 species co-occurring with indicated crops.

### *Michigan*

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Insect has 4 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

The taxa Monocot has 3 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

### *Minnesota*

The taxa Bird has 2 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Dicot has 2 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Monocot has 2 species co-occurring with indicated crops.

### *Mississippi*

The taxa Amphibian has 1 species co-occurring with indicated crops.

The taxa Bird has 6 species co-occurring with indicated crops.

The taxa Bivalve has 7 species co-occurring with indicated crops.

The taxa Dicot has 2 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Fish has 3 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Reptile has 7 species co-occurring with indicated crops.

### *Missouri*

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 6 species co-occurring with indicated crops.

The taxa Dicot has 6 species co-occurring with indicated crops.

The taxa Fish has 5 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

### *Montana*

The taxa Bird has 2 species co-occurring with indicated crops.

The taxa Dicot has 2 species co-occurring with indicated crops.

The taxa Fish has 4 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

### *Nebraska*

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Fish has 2 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

### *Nevada*

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Dicot has 7 species co-occurring with indicated crops.

The taxa Fish has 15 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

### *New Hampshire*

The taxa Bird has 1 species co-occurring with indicated crops.

The taxa Bivalve has 1 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

### *New Jersey*

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Dicot has 2 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 3 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

### *New Mexico*

The taxa Amphibian has 1 species co-occurring with indicated crops.

The taxa Bird has 7 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 10 species co-occurring with indicated crops.

The taxa Fish has 9 species co-occurring with indicated crops.

The taxa Gastropod has 2 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Mammal has 5 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

### *New York*

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 1 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

### *North Carolina*

The taxa Arachnid has 1 species co-occurring with indicated crops.

The taxa Bird has 5 species co-occurring with indicated crops.

The taxa Bivalve has 8 species co-occurring with indicated crops.

The taxa Dicot has 20 species co-occurring with indicated crops.

The taxa Fish has 4 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Lichen has 1 species co-occurring with indicated crops.

The taxa Mammal has 4 species co-occurring with indicated crops.

The taxa Marine mml has 1 species co-occurring with indicated crops.

The taxa Monocot has 5 species co-occurring with indicated crops.

The taxa Reptile has 5 species co-occurring with indicated crops.

### *North Dakota*

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

### *Ohio*

The taxa Bird has 2 species co-occurring with indicated crops.

The taxa Bivalve has 6 species co-occurring with indicated crops.

The taxa Dicot has 3 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Insect has 4 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 2 species co-occurring with indicated crops.

### *Oklahoma*

The taxa Bird has 6 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Fish has 4 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

### *Oregon*

The taxa Bird has 5 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 11 species co-occurring with indicated crops.

The taxa Fish has 22 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

### *Pennsylvania*

The taxa Bird has 2 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Reptile has 1 species co-occurring with indicated crops.

### *Rhode Island*

The taxa Bird has 1 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

### *South Carolina*

The taxa Amphibian has 1 species co-occurring with indicated crops.

The taxa Bird has 5 species co-occurring with indicated crops.

The taxa Bivalve has 1 species co-occurring with indicated crops.

The taxa Dicot has 12 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Lichen has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Marine mml has 6 species co-occurring with indicated crops.

The taxa Monocot has 6 species co-occurring with indicated crops.

The taxa Reptile has 5 species co-occurring with indicated crops.

### *South Dakota*

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Fish has 2 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

### *Tennessee*

The taxa Arachnid has 1 species co-occurring with indicated crops.

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Bivalve has 38 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 16 species co-occurring with indicated crops.

The taxa Ferns has 1 species co-occurring with indicated crops.

The taxa Fish has 16 species co-occurring with indicated crops.

The taxa Gastropod has 2 species co-occurring with indicated crops.

The taxa Lichen has 1 species co-occurring with indicated crops.

The taxa Mammal has 3 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

### *Texas*

The taxa Amphibian has 4 species co-occurring with indicated crops.

The taxa Arachnid has 10 species co-occurring with indicated crops.

The taxa Bird has 13 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 20 species co-occurring with indicated crops.

The taxa Fish has 4 species co-occurring with indicated crops.

The taxa Insect has 8 species co-occurring with indicated crops.

The taxa Mammal has 5 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

The taxa Reptile has 6 species co-occurring with indicated crops.

### *Utah*

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Dicot has 19 species co-occurring with indicated crops.

The taxa Fish has 8 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

### *Vermont*

The taxa Bird has 1 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Bivalve has 1 species co-occurring with indicated crops.

The taxa Dicot has 1 species co-occurring with indicated crops.

The taxa Mammal has 1 species co-occurring with indicated crops.

The taxa Monocot has 1 species co-occurring with indicated crops.

### *Virginia*

The taxa Amphibian has 1 species co-occurring with indicated crops.

The taxa Bird has 3 species co-occurring with indicated crops.

The taxa Bivalve has 13 species co-occurring with indicated crops.

The taxa Crustacean has 1 species co-occurring with indicated crops.

The taxa Dicot has 12 species co-occurring with indicated crops.

The taxa Fish has 5 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Insect has 3 species co-occurring with indicated crops.

The taxa Mammal has 5 species co-occurring with indicated crops.

The taxa Monocot has 4 species co-occurring with indicated crops.

The taxa Reptile has 1 species co-occurring with indicated crops.

### *Washington*

The taxa Bird has 5 species co-occurring with indicated crops.

The taxa Dicot has 7 species co-occurring with indicated crops.

The taxa Fish has 18 species co-occurring with indicated crops.

The taxa Insect has 1 species co-occurring with indicated crops.

The taxa Mammal has 4 species co-occurring with indicated crops.

### *West Virginia*

The taxa Amphibian has 1 species co-occurring with indicated crops.

The taxa Bird has 1 species co-occurring with indicated crops.

The taxa Bivalve has 5 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Gastropod has 1 species co-occurring with indicated crops.

The taxa Mammal has 4 species co-occurring with indicated crops.

AL, AK, AZ, AR, CA, CO, CT, DE, DC, FL, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MA, MI, MN, MS, MO, MT, NE, NV, NH, NJ, NM, NY, NC, ND, OH, OK, OR, PA, PR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV, WI, WY

The taxa Monocot has 1 species co-occurring with indicated crops.

### *Wisconsin*

The taxa Bird has 4 species co-occurring with indicated crops.

The taxa Bivalve has 2 species co-occurring with indicated crops.

The taxa Dicot has 4 species co-occurring with indicated crops.

The taxa Insect has 2 species co-occurring with indicated crops.

The taxa Mammal has 2 species co-occurring with indicated crops.

The taxa Monocot has 2 species co-occurring with indicated crops.

### *Wyoming*

The taxa Bird has 1 species co-occurring with indicated crops.

The taxa Dicot has 2 species co-occurring with indicated crops.

The taxa Fish has 1 species co-occurring with indicated crops.

The taxa Mammal has 4 species co-occurring with indicated crops.

**No species were excluded.**

**Dispersed species included in report.**