Bureau of Land Management

Reno, Nevada

Tebuthiuron
Ecological Risk Assessment

Final Report

November 2005

Bureau of Land Management Contract No. NAD010156
ENSR Document Number 09090-020-650

EXECUTIVE SUMMARY

The Bureau of Land Management (BLM), United States Department of the Interior (USDI), is proposing a program to treat vegetation on up to six million acres of public lands annually in 17 western states in the continental United States (U.S.) and Alaska. As part of this program, the BLM is proposing the use of ten herbicide active ingredients (a.i.) to control invasive plants and noxious weeds on approximately one million of the 6 million acres proposed for treatment. The BLM and its contractor, ENSR, are preparing a Vegetation Treatments Programmatic Environmental Impact Statement (EIS) to evaluate this and other proposed vegetation treatment methods and alternatives on lands managed by the BLM in the western continental U.S. and Alaska. In support of the EIS, this Ecological Risk Assessment (ERA) evaluates the potential risks to the environment that would result from the use of the herbicide tebuthiuron, including risks to rare, threatened, and endangered (RTE) plant and animal species.

One of the BLM's highest priorities is to promote ecosystem health, and one of the greatest obstacles to achieving this goal is the rapid expansion of invasive plants (including noxious weeds and other plants not native to the region) across public lands. These invasive plants can dominate and often cause permanent damage to natural plant communities. If not eradicated or controlled, invasive plants will jeopardize the health of public lands and the activities that occur on them. Herbicides are one method employed by the BLM to control these plants.

Herbicide Description

Tebuthiuron is a nonselective systemic herbicide for use against broad-leaf and woody weeds, grasses, and bushes. This chemical disrupts photosynthesis by blocking electron transport and the transfer of light energy. Tebuthiuron is available in pellet and wettable powder formulations. Tebuthiuron is used by the BLM in their Rangeland, Public-Domain Forest Land, Energy and Mineral Sites, Rights-of-Way, and Recreation programs. Application is carried out through both aerial and ground dispersal. Aerial dispersal (pellet formulation) is performed using planes or helicopters. Ground dispersal is via foot or horseback with backpack sprayers and all terrain vehicles or trucks equipped with spot or boom/broadcast sprayers. The BLM typically applies tebuthiuron at 0.5 pounds (lbs) a.i. per acre (a.i./ac), with a maximum application rate of 4.0 lbs a.i./ac.

Ecological Risk Assessment Guidelines

The main objectives of this ERA were to evaluate the potential ecological risks from tebuthiuron to the health and welfare of plants and animals and their habitats and to provide risk managers with a range of generic risk estimates that vary as a function of site conditions. The categories and guidelines listed below were designed to help the BLM determine which of the proposed alternatives evaluated in the EIS should be used on BLM-managed lands.

- Exposure pathway evaluation – The effects of tebuthiuron on several ecological receptor groups (i.e., terrestrial animals, non-target terrestrial and aquatic plants, fish, and aquatic invertebrates) via particular exposure pathways were evaluated. The resulting exposure scenarios included the following:
  - direct contact with the herbicide or a contaminated waterbody;
  - indirect contact with contaminated foliage;
  - ingestion of contaminated food items;
  - off-site drift of spray to terrestrial areas and waterbodies;
  - surface runoff from the application area to off-site soils or waterbodies;
  - wind erosion resulting in deposition of contaminated dust; and
  - accidental spills to waterbodies.

- Definition of data evaluated in the ERA – Herbicide concentrations used in the ERA were based on typical and maximum application rates provided by the BLM. These application rates were used to predict herbicide concentrations in various environmental media (e.g., soils, water). Some of these calculations required computer models:

  - AgDRIFT® was used to estimate off-site herbicide transport due to spray drift.

  Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) was used to estimate off-site transport of herbicide in surface runoff and root-zone groundwater.

  - CALPUFF was used to predict the transport and deposition of herbicides sorbed to wind-blown dust.

- Identification of risk characterization endpoints – Endpoints used in the ERA included acute mortality; adverse direct effects on growth, reproduction, or other ecologically important sublethal processes; and adverse indirect effects on the survival, growth, or reproduction of salmonid fish. Each of these endpoints was associated with measures of effect such as the no observed adverse effect level (NOAEL) and the median lethal effect dose and median lethal concentration (LD_{50} and LC_{50}).

- Development of a conceptual model – The purpose of the conceptual model is to display working hypotheses about how tebuthiuron might pose hazards to ecosystems and ecological receptors. This is shown via a diagram of the possible exposure pathways and the receptors evaluated for each pathway.

In the analysis phase of the ERA, estimated exposure concentrations (EECs) were identified for the various receptor groups in each of the applicable exposure scenarios via exposure modeling. Risk quotients (RQs) were then calculated by dividing the EECs by herbicide- and receptor-specific or exposure media-specific Toxicity Reference Values (TRVs) selected from the available literature. These RQs were compared to Levels of Concern (LOCs) established by the United States Environmental Protection Agency (USEPA) Office of Pesticide Programs (OPP) for specific risk presumption categories (i.e., acute high risk, acute high risk potentially mitigated through restricted use, acute high risk to endangered species, and chronic high risk).

Uncertainty

Uncertainty is introduced into the herbicide ERA through the selection of surrogates to represent a broad range of species on BLM-managed lands, the use of mixtures of tebuthiuron with other potentially toxic ingredients (i.e., inert ingredients and adjuvants), and the estimation of effects via exposure concentration models. The uncertainty inherent in screening level ERAs is especially problematic for the evaluation of risks to RTE species, which are afforded higher levels of protection through government regulations and policies. To attempt to minimize the chances of underestimating risk to RTE and other species, the lowest toxicity levels found in the literature were selected as TRVs; uncertainty factors were incorporated into these TRVs; allometric scaling was used to develop dose values; model assumptions were designed to conservatively estimate herbicide exposure; and indirect as well as direct effects on species of concern were evaluated.

Herbicide Effects

Literature Review

According to the Ecological Incident Information System (EIIS) database run by the USEPA OPP, tebuthiuron has been associated with three reported "ecological incidents" involving damage or mortality to non-target flora. It was listed as probable (2 incidents) or highly probable (1 incident) that registered use of tebuthiuron was responsible.

A review of the available ecotoxicological literature was conducted in order to evaluate the potential for tebuthiuron to negatively directly or indirectly affect non-target taxa. This review was also used to identify or derive TRVs for use

in the ERA. The sources identified in this review indicate that tebuthiuron has moderate toxicity to most terrestrial species. In mammals, tebuthiuron is considered to have low acute dermal toxicity, but adverse effects can occur when organisms are exposed for greater periods of time or from exposure to tebuthiuron via diet or oral gavage. Tebuthiuron is essentially non-toxic to birds and is slightly toxic to honeybees (*Apis* spp.). Tests conducted on crop plant species found that seed emergence was the most sensitive indicator of toxicity with adverse effects noted at concentrations as low as 0.03 lbs a.i./ac. Tebuthiuron has low toxicity to cold- and warmwater fish and amphibians, slight toxicity to aquatic invertebrates, and high toxicity to aquatic plants. Amphibians were more tolerant of tebuthiuron than fish. While tebuthiuron was not highly toxic to aquatic plants under acute exposure conditions, chronic exposure resulted in toxicity at relatively low concentrations. Tebuthiuron is not expected to bioconcentrate in aquatic organisms.

Ecological Risk Assessment Results

Based on the ERA conducted for tebuthiuron, there is the potential for risk to ecological receptors from exposure to herbicides under specific conditions on BLM-managed lands. The following bullets summarize the risk assessment findings for tebuthiuron under each evaluated exposure scenario:

- Direct Spray – Risks were predicted for pollinating insects resulting from direct spray and indirect contact with contaminated foliage. No risks were predicted for other terrestrial wildlife at the typical application rate. Risks were predicted for avian and mammalian herbivores resulting from ingestion of food items contaminated by direct spray at the maximum application rate. Risk to terrestrial and aquatic non-target plants is likely when plants or waterbodies are accidentally sprayed. No risks were predicted for fish; chronic risks were predicted for aquatic invertebrates in the pond and the stream.

- Off-Site Drift – Risk to non-target terrestrial plants (typical and RTE) may occur when herbicides are applied from the ground and buffer zones are 100 feet (ft) or less. No risks were predicted for fish, aquatic invertebrates, aquatic plants, or piscivorous birds.

- Surface Runoff – No risks to typical non-target terrestrial plants were predicted in any scenario. Risks to RTE terrestrial plant species were predicted in 4 scenarios at the typical application rate and 8 scenarios at the maximum application rate (in watersheds with clay and silt soils and more than 50 inches of precipitation per year). Acute risk to non-target aquatic plants in the pond was predicted in 9 scenarios (mostly in watersheds with sandy soils) at the typical application rate and most scenarios (37/42) at the maximum application rate. Chronic risks to aquatic plants in the pond were predicted in nearly the same set of scenarios (more risk to plants in watersheds with clay and loam soils at lower precipitation levels). Acute risks to aquatic plants were predicted in 10 scenarios in the stream at the maximum application rate (mostly in watersheds with sand and clay soils and 50 or more inches of precipitation annually). No acute risks to aquatic plants were predicted at the typical rate, and no chronic risks to aquatic plants were predicted in the stream. No risks to aquatic invertebrates were predicted in the stream; chronic risks to aquatic invertebrates were predicted in the pond for most scenarios at the maximum application rate and for one scenario at the typical application rate (watershed with sandy soils and 10 inches of annual precipitation). No risks were predicted for fish or piscivorous birds in any modeled scenarios.

- Wind Erosion and Transport Off-Site – No risks were predicted for non-target terrestrial plants (only taxon modeled) under any of the evaluated conditions.

- Accidental Spill to Pond – Risk to fish, aquatic invertebrates, and non-target aquatic plants may occur when herbicides are spilled directly into the pond.

In addition, species that depend on non-target plant species for habitat, cover, and/or food may be indirectly impacted by a possible reduction in terrestrial or aquatic vegetation. For example, accidental direct spray, off-site drift, and

surface runoff may negatively impact terrestrial and aquatic plants, reducing the cover available to RTE salmonids within the stream.

Based on the results of the ERA, it is unlikely that RTE species would be harmed by appropriate use (see following section) of the herbicide tebuthiuron on BLM-managed lands. Although non-target terrestrial and aquatic plants have the potential to be adversely affected by application of tebuthiuron for the control of invasive plants, adherence to certain application guidelines (e.g., defined application rates, equipment, herbicide mixture, and downwind distance to sensitive habitat) would minimize the potential effects on non-target plants and associated indirect effects on species that depend on those plants for food, habitat, and cover.

Recommendations

The following recommendations are designed to reduce potential unintended impacts to the environment from the application of tebuthiuron:

- Although the BLM does not currently use adjuvants or tank mixes with tebuthiuron products, if this changes in the future, care must be taken when selecting adjuvants and tank mixtures since these have the potential to increase the level of toxicity above that predicted for the a.i. alone. This is especially important for application scenarios that already predict potential risk from the a.i. itself.

- Review, understand, and conform to "Environmental Hazards" section on herbicide label. This section warns of known pesticide risks to wildlife receptors or to the environment and provides practical ways to avoid harm to organisms or the environment.

- Avoid accidental direct spray and spill conditions to reduce the greatest potential impacts.

- Use the typical application rate rather than the maximum application rate, to reduce risk for off-site drift and surface runoff exposures to non-target RTE and aquatic plants.

- In watersheds with downgradient ponds or streams, limit the use of tebuthiuron to those watersheds that do not have predicted risks to aquatic plants resulting from surface runoff (e.g., at the typical application rate, most watersheds without sandy soils).

- If RTE terrestrial plants are present, do not apply tebuthiuron in watersheds with clay or silt soils and 50 or more inches of precipitation per year.

- Establish the following buffer zones to reduce off-site drift impacts to terrestrial plants:

    - Ground application by low boom (spray boom height set at 20 inches above the ground) – 100 ft from typical and RTE non-target terrestrial plants at the maximum application rate (buffer of less than [<] 25 ft at the typical application rate).
    - Ground application by high boom (spray boom height set at 50 inches above the ground) – 100 ft from typical non-target terrestrial plants at the maximum application rate; 100 ft from RTE terrestrial plants at the typical application rate; and more than 100 ft (no risk was predicted at 900 ft) from RTE terrestrial plants at the maximum application rate.

- Consider the proximity of potential application areas to salmonid habitat and the possible effects of herbicides on riparian vegetation. Maintain appropriate buffer zones around salmonid-bearing streams (see above buffer recommendations).

The results from this ERA assist the evaluation of proposed alternatives in the EIS and contribute to the development of a Biological Assessment (BA), specifically addressing the potential impacts to proposed and listed RTE species on western BLM-managed lands. Also, this ERA will inform BLM field offices on the proper application of tebuthiuron to ensure that impacts to plants and animals and their habitat are minimized to the extent practical.

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LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS

ac	-	acres
a.i.	-	active ingredient
ARS	-	Agricultural Research Service
BA	-	Biological Assessment
BCF	-	Bioconcentration Factor
BLM	-	Bureau of Land Management
BO	-	Biological Opinion
BW	-	Body Weight
°C	-	degrees Celsius
CBI	-	Confidential Business Information
cm	-	centimeter
cms	-	cubic meters per second
CWE	-	Cumulative Watershed Effect
DPR	-	Department of Pesticide Registration
EC_{25}	-	Concentration causing 25% inhibition of a process (Effect Concentration)
EC_{50}	-	Concentration causing 50% inhibition of a process (Median Effective Concentration)
EEC	-	Estimated Exposure Concentration
EIS	-	Environmental Impact Statement
EIIS	-	Ecological Incident Information System
EFED	-	Environmental Fate and Effects Division
ERA	-	Ecological Risk Assessment
ESA	-	Endangered Species Act
FIFRA	-	Federal Insecticide, Fungicide, and Rodenticide Act
FOIA	-	Freedom of Information Act
ft	-	feet
g	-	grams
gal	-	gallon
GLEAMS	-	Groundwater Loading Effects of Agricultural Management Systems
HHRA	-	Human Health Risk Assessment
HSDB	-	Hazardous Substances Data Bank
in	-	inch
IPM	-	Integrated Pest Management
IRIS	-	Integrated Risk Information System
IUPAC	-	International Union of Pure and Applied Chemistry
Kd		partition coefficient
kg	-	kilogram
K_{oc}	-	organic carbon-water partition coefficient
K_{ow}	-	octanol-water partition coefficient
L	-	Liters
lb(s)	-	pound(s)
LC_{50}	-	Concentration causing 50% mortality (Median Lethal Concentration)
LD_{50}	-	Dose causing 50% mortality (Median Lethal Dose)
LOAEL	-	Lowest Observed Adverse Effect Level
LOC(s)	-	Level(s) of Concern
Log	-	Common logarithm (base 10)
m	-	meters
mg	-	milligrams
mg/kg	-	milligrams per kilogram

LIST OF ACRONYMS, ABBREVIATIONS, AND SYMBOLS (continued)

mg/L	-	milligrams per Liter
mmHg	-	millimeters of mercury
MSDS	-	Material Safety Data Sheet
MW	-	Molecular Weight
NASQAN	-	National Stream Quality Accounting Network
NMFS	-	National Marine Fisheries Service
NOAA	-	National Oceanic and Atmospheric Administration
NOAEL	-	No Observed Adverse Effect Level
OPP	-	Office of Pesticide Programs
ORNL	-	Oak Ridge National Laboratory
ppm	-	parts per million
RQ	-	Risk Quotient
RTE	-	Rare, Threatened, and Endangered
RTEC	-	Registry of Toxic Effects of Chemical Substances
SDTF	-	Spray Drift Task Force
TOXNET	-	National Library of Medicines Toxicology Data Network
TP	-	Transformation Product
TRV	-	Toxicity Reference Value
US	-	United States
USDA	-	United States Department of Agriculture
USDI	-	United States Department of the Interior
USEPA	-	United States Environmental Protection Agency
USFWS	-	United States Fish and Wildlife Service
USLE	-	Universal Soil Loss Equation
µg	-	microgram
>	-	greater than
<	-	less than
=	-	equal to

1.0 INTRODUCTION

The Bureau of Land Management (BLM), United States Department of the Interior (USDI), is proposing a program to treat vegetation on up to six million acres of public lands annually in 17 western states in the continental United States (U.S.) and Alaska. The primary objectives of the proposed program include fuels management, weed control, and fish and wildlife habitat restoration. Vegetation would be managed using five primary vegetation treatment methods - mechanical, manual, biological, chemical, and prescribed fire.

The BLM and its contractor, ENSR, are preparing a *Vegetation Treatments Programmatic Environmental Impact Statement* (EIS) to evaluate proposed vegetation treatment methods and alternatives on lands managed by the BLM in the western continental U.S. and Alaska (ENSR 2004a). As part of the EIS, several ERAs and a Human Health Risk Assessment (HHRA; ENSR 2004b) were conducted on several herbicides used, or proposed for use, by the BLM. These risk assessments evaluate potential risks to the environment and human health from exposure to these herbicides both during and after treatment of public lands. For the ERA, the herbicide a.i. evaluated were tebuthiuron, diuron, bromacil, chlorsulfuron, sulfometuron-methyl, diflufenzopyr, Overdrive® (a mix of dicamba and diflufenzopyr), imazapic, diquat, and fluridone. The HHRA evaluated the risks to humans from only six a.i. (sulfometuron-methyl, imazapic, diflufenzopyr, dicamba, diquat, and fluridone) because the other a.i. were already quantitatively evaluated in previous EISs (e.g., USDI BLM 1991). [Note that in the HHRA, Overdrive® was evaluated as its two separate components, dicamba and diflufenzopyr, as these two a.i. have different toxicological endpoints, indicating that their effects on human health are not additive.] The purpose of this document is to summarize results of the ERA for the herbicide tebuthiuron.

Updated risk assessment methods were developed for both the HHRA and ERA and are described in a separate document, *Vegetation Treatments Programmatic EIS Ecological Risk Assessment Methodology* (hereafter referred to as the "Methods Document;" ENSR 2004c). The methods document provides, in detail, specific information and assumptions used in three models utilized for this ERA (exposure point modeling using GLEAMS, AgDRIFT®, and CALPUFF).

1.1 Objectives of the Ecological Risk Assessment

The purpose of the ERA is to evaluate the ecological risks of nine herbicides on the health and welfare of plants and animals and their habitats, including threatened and endangered species. This analysis will be used by the BLM, in conjunction with analyses of other treatment effects on plants and animals, and effects of treatments on other resources, to determine which of the proposed treatment alternatives evaluated in the EIS should be used by the BLM. The BLM Field Offices will also utilize this ERA for guidance on the proper application of herbicides to ensure that impacts to plants and animals are minimized to the extent practical when treating vegetation. The U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries), in their preparation of a Biological Opinion (BO), will also use the information provided by the ERA to assess the potential impact of vegetation treatment actions on fish and wildlife and their critical habitats.

This ERA, which provides specific information regarding the use of the terrestrial herbicide tebuthiuron, contains the following sections:

Section 1: Introduction

Section 2: BLM Herbicide Program Description – This section contains information regarding herbicide formulation, mode of action, and specific BLM herbicide use, which includes application rates and methods of dispersal. This section also contains a summary of incident reports documented with the United States Environmental Protection Agency (USEPA).

Section 3: Herbicide Toxicology, Physical-Chemical Properties, and Environmental Fate – This section contains a summary of scientific literature pertaining to the toxicology and environmental fate of tebuthiuron in terrestrial and aquatic environments, and discusses how its physical-chemical properties are used in the risk assessment.

Section 4: Ecological Risk Assessment – This section describes the exposure pathways and scenarios and the assessment endpoints, including potential measured effects. It provides quantitative estimates of risks for several risk pathways and receptors.

Section 5: Sensitivity Analysis – This section describes the sensitivity of each of three models used for the ERA to specific input parameters. The importance of these conditions to exposure concentration estimates is discussed.

Section 6: Rare, Threatened, and Endangered Species (RTE) – This section identifies RTE species potentially directly and/or indirectly affected by the herbicide program. It also describes how the ERA can be used to evaluate potential risks to RTE species.

Section 7: Uncertainty in the Ecological Risk Assessment – This section describes data gaps and assumptions made during the risk assessment process and how uncertainty should be considered in interpreting results.

Section 8: Summary – This section provides a synopsis of the ecological receptor groups, application rates, and modes of exposure. This section also provides a summary of the factors that most influence exposure concentrations with general recommendations for risk reduction.

2.0 BLM HERBICIDE PROGRAM DESCRIPTION

2.1 Problem Description

One of the BLM's highest priorities is to promote ecosystem health, and one of the greatest obstacles to achieving this goal is the rapid expansion of weeds across public lands. These invasive plants can dominate and often cause permanent damage to natural plant communities. If not eradicated or controlled, noxious weeds will jeopardize the health of public lands and the myriad of activities that occur on them. The BLM's ability to respond effectively to the challenge of noxious weeds depends on the adequacy of the agency's resources.

Millions of acres of once healthy, productive rangelands, forestlands and riparian areas have been overrun by noxious or invasive weeds. Noxious weeds are any plant designated by a federal, state, or county government as injurious to public health, agriculture, recreation, wildlife, or property (Sheley et al. 1999). Invasive plants include not only noxious weeds, but also other plants that are not native to the region. The BLM considers plants invasive if they have been introduced into an environment where they did not evolve. Invasive plants usually have no natural enemies to limit their reproduction and spread (Westbrooks 1998). They invade recreation areas, BLM-managed public lands, National Parks, State Parks, roadsides, streambanks, federal, state, and private lands. Invasive weeds can:

- destroy wildlife habitat, reduce opportunities for hunting, fishing, camping and other recreational activities;
- displace RTE species and other species critical to ecosystem functioning (e..g, riparian plants);
- reduce plant and animal diversity;
- invade following wildland and prescribed fire (potentially into previously unaffected areas), limiting regeneration and establishment of native species and rapidly increasing acreage of infested land;
- increase fuel loads and decrease the length of fire cycles and/or increase the intensity of fires;
- disrupt waterfowl and neo-tropical migratory bird flight patterns and nesting habitats; and
- cost millions of dollars in treatment and loss of productivity to private land owners.

The BLM uses an Integrated Pest Management (IPM) approach to manage invasive plants. Management techniques may be biological, mechanical, chemical, or cultural. Many herbicides are currently used by the BLM under their chemical control program. This report considers the impact to ecological receptors (animals and plants) from the use of the herbicide tebuthiuron for the management of vegetation on BLM lands.

2.2 Herbicide Description

The herbicide-specific use-criteria discussed in this document were obtained from the product label as registered with the USEPA as it applies to BLM use. Tebuthiuron application rates and methods discussed in this section are based on past and predicted BLM herbicide use and are in accordance with herbicide labels approved by the USEPA. The BLM should be aware of all state-specific label requirements and restrictions. In addition, new USEPA approved herbicide labels may be issued after publication of this report, and BLM land managers should be aware of all newly approved federal, state, and local restrictions on herbicide use when planning vegetation management programs.

Tebuthiuron, depending upon the rate of application, can be either a selective or nonselective, systemic herbicide that is absorbed by plant roots from the soil and moved in the plant through the water conducting system (xylem). Activity

is reported on grassy, broadleaf, and woody species. This chemical disrupts photosynthesis by blocking electron transport and the transfer of light energy. Tebuthiuron is formulated as a wettable powder, dry flowable, and granule/pellet.

Tebuthiuron is used by the BLM for vegetation control in their Rangeland, Public-Domain Forest Land, Energy and Mineral Sites, Rights-of-Way, and Recreation programs. It is rarely, if ever, used near estuarine or marine habitats. The majority of the land treated by BLM with herbicides is inland. Application is carried out in these programs through both aerial and ground methods. Aerial applications (pellet formulation only) are performed using planes or helicopters. Ground application of wettable powder, dry flowable, and pelletted formulations are executed on foot or horseback with backpack sprayers and all terrain vehicles or trucks equipped with spot or boom/broadcast sprayers. The BLM typically applies tebuthiuron at 0.5 lbs a.i./ac, with a maximum application rate of 4.0 lbs a.i./ac. Details regarding expected tebuthiuron usage by BLM are provided in Table 2-1 at the end of this section.

2.3 Herbicide Incident Reports

An "ecological incident" occurs when non-target flora or fauna is killed or damaged due to application of a pesticide. When ecological incidents are reported to a state agency or other proper authority, they are investigated and an ecological incident report is generated. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) requires product registrants to report adverse effects of their product to the USEPA.

The USEPA OPP manages a database, the EIIS, which contains much of the information in the ecological incident reports. As part of this risk assessment, the USEPA was requested to provide all available incident reports in the EIIS that listed tebuthiuron as a potential source of the observed ecological damage.

The USEPA EIIS contained three incident reports involving tebuthiuron. One incident report indicated that it was "highly probable" that the use of tebuthiuron resulted in the observed effects. Tebuthiuron was applied on a Right-of-Way along power lines in Florida, which allegedly resulted in the mortality of trees and algae in a nearby pond. This incident was classified as accidental misuse of the herbicide. Tebuthiuron was listed as the "probable" cause in the remaining two incidents. One of these incidents listed damage to several trees 200 ft from application area caused by runoff from the accidental use of this herbicide. The second incident involved the registered use of tebuthiuron along with five additional pesticides, and 400 acres of cotton plants were allegedly damaged from runoff of the pesticide mixture from the application site.

TABLE 2-1
BLM Tebuthiuron Use Statistics

Program	Scenario	Vehicle	Method	Used?	Application Rate	
					Typical (lbs a.i./ac)	Maximum (lbs a.i./ac)
Rangeland	Aerial	Plane	Fixed Wing	Yes	0.5	4.0
		Helicopter	Rotary	Yes	0.5	4.0
	Ground	Human	Backpack	Yes	0.5	4.0
			Horseback	Yes	0.5	4.0
		ATV	Spot	Yes	0.5	4.0
			Boom/Broadcast	Yes	0.5	4.0
		Truck	Spot	Yes	0.5	4.0
			Boom/Broadcast	Yes	0.5	4.0
Public-Domain Forest Land	Aerial	Plane	Fixed Wing	Yes	0.5	4.0
		Helicopter	Rotary	Yes	0.5	4.0
	Ground	Human	Backpack	Yes	0.5	4.0
			Horseback	Yes	0.5	4.0
		ATV	Spot	Yes	0.5	4.0
			Boom/Broadcast	Yes	0.5	4.0
		Truck	Spot	Yes	0.5	4.0
			Boom/Broadcast	Yes	0.5	4.0
Energy and Mineral Sites	Aerial	Plane	Fixed Wing	Yes	0.5	4.0
		Helicopter	Rotary	Yes	0.5	4.0
	Ground	Human	Backpack	Yes	4.0	4.0
			Horseback	Yes	4.0	4.0
		ATV	Spot	Yes	4.0	4.0
			Boom/Broadcast	Yes	4.0	4.0
		Truck	Spot	Yes	4.0	4.0
			Boom/Broadcast	Yes	4.0	4.0
Rights-of-way	Aerial	Plane	Fixed Wing	Yes	0.5	4.0
		Helicopter	Rotary	Yes	0.5	4.0
	Ground	Human	Backpack	Yes	0.5	4.0
			Horseback	Yes	0.5	4.0
		ATV	Spot	Yes	0.5	4.0
			Boom/Broadcast	Yes	0.5	4.0
		Truck	Spot	Yes	0.5	4.0
			Boom/Broadcast	Yes	0.5	4.0
Recreation	Aerial	Plane	Fixed Wing	Yes	0.5	4.0
		Helicopter	Rotary	Yes	0.5	4.0
	Ground	Human	Backpack	Yes	4.0	4.0
			Horseback	Yes	4.0	4.0
		ATV	Spot	Yes	4.0	4.0
			Boom/Broadcast	Yes	4.0	4.0
		Truck	Spot	Yes	4.0	4.0
			Boom/Broadcast	Yes	4.0	4.0
Aquatic				No		

3.0 HERBICIDE TOXICOLOGY, PHYSICAL-CHEMICAL PROPERTIES, AND ENVIRONMENTAL FATE

This section summarizes available herbicide toxicology information, describes how this information was obtained, and provides a basis for the LOC values selected for this risk assessment. Tebuthiuron's physical-chemical properties and environmental fate are also discussed.

3.1 Herbicide Toxicology

A review of the available ecotoxicological literature was conducted in order to evaluate the potential for tebuthiuron to negatively effect the environment and to derive TRVs for use in the ERA (provided in italics in sections 3.1.2 and 3.1.3). The process for the literature review and the TRV derivation is provided in the Methods Document (ENSR 2004c). This review generally included a review of published manuscripts and registration documents, information obtained through a Freedom of Information Act (FOIA) request to EPA, electronic databases (e.g., EPA pesticide ecotoxicology database, EPA's on-line ECOTOX database), and other internet sources. This review included both freshwater and marine/estuarine data, although the focus of the review was on the freshwater habitats more likely to occur on BLM lands.

Endpoints for aquatic receptors and terrestrial plants were reported based on exposure concentrations (milligrams per Liter [mg/L] and lbs/ac, respectively). Dose-based endpoints (e.g., LD_{50}s) were used for birds and mammals. When possible, dose-based endpoints were obtained directly from the literature. When dosages were not reported, dietary concentration data were converted to dose-based values (e.g., LC_{50} to LD_{50}) following the methodology recommended in USEPA risk assessment guidelines (Sample et al. 1996). Acute TRVs were derived first to provide an upper boundary for the remaining TRVs; chronic TRVs were always equivalent to, or less than, the acute TRV. The chronic TRV was established as the highest NOAEL value that was less than both the chronic lowest observed adverse effect level (LOAEL) and the acute TRV. When acute or chronic toxicity data was unavailable, TRVs were extrapolated from other relevant data using an uncertainty factor of 3, as described in the Methods Document (ENSR 2004c).

This section reviews the available information identified for tebuthiuron and presents the TRVs selected for this risk assessment (Table 3-1). Appendix A presents a summary of the tebuthiuron data identified during the literature review. . Toxicity data are presented in the units used in the reviewed study. In most cases this applies to the a.i. itself (e.g., tebuthiuron); however, some data correspond to a specific product or applied mixture (e.g., Spike) containing the a.i. under consideration, and potentially other ingredients (e.g., other a.i. or inert ingredients). This topic, and others related to the availability of toxicity data, is discussed in Section 7.1 of the Uncertainty section. The review of the toxicity data did not focus on the potential toxic effects of inert ingredients (inerts), adjuvants, surfactants, and degradates. Section 7.3 of the Uncertainty section discusses the potential impacts of these constituents in a qualitative manner.

3.1.1 Overview

According to USEPA ecotoxicity classifications presented in registration materials[1], tebuthiuron has moderate toxicity to most terrestrial species. In mammals, tebuthiuron is considered to have low acute dermal toxicity, but adverse effects can occur when organisms are exposed for greater periods of time. Adverse effects were demonstrated

[1] Available at http://www.epa.gov/oppefed1/ecorisk_ders/toera_analysis_eco.htm#Ecotox

in mammals from exposure to tebuthiuron via diet or oral gavage. Tebuthiuron is essentially non-toxic to birds and slightly toxic to honeybees. Tests conducted on crop plant species found that seed emergence was the most sensitive indicator of toxicity with adverse effects noted at concentrations as low as 0.03 lbs a.i./ac (6 percent of the typical application rate).

Tebuthiuron is classified as having low toxicity to cold- and warmwater fish and amphibians, slight toxicity to aquatic invertebrates, and high toxicity to aquatic plants. Amphibians were more tolerant of tebuthiuron than fish. While tebuthiuron was not highly toxic to aquatic plants under acute exposure conditions, chronic exposure resulted in toxicity at relatively low concentrations. Tebuthiuron is not expected to bioconcentrate in aquatic organisms.

3.1.2 Toxicity to Terrestrial Organisms

3.1.2.1 Mammals

According to USEPA ecotoxicity classifications, tebuthiuron is considered to have moderate toxicity to mammals. Various mammalian toxicological studies have been conducted. In acute oral exposure studies, exposure to tebuthiuron at dose levels as low as 58 mg a.i./kilogram (kg) body weight (BW) caused adverse effects in small mammals (PIP 1993). No adverse effects were observed at 25 mg a.i./kg BW (PIP 1993). Acute dermal exposure studies found no adverse effects to rabbits (*Leporidae* spp.) exposed to 5,000 mg a.i./kg BW (USEPA 1994a, MRID 40583902). In 21-day subchronic studies, no adverse effects were observed in rabbits exposed to the lowest concentration tested (1,000 mg a.i./kg BW; USEPA 1994a, MRID 00149733).

In dietary studies, rats (*Rattus norvegicus* spp.) fed 200 parts per million (ppm; 14 mg a.i./kg BW-day) of tebuthiuron in their diets for two generations exhibited adverse effects (decreased BW), while no adverse effects were observed in rats fed 100 ppm (7 mg a.i./kg BW-day) (USEPA 1994a, MRID 00090108).

Based on these findings, the oral LD_{50} (the dose that caused 50 percent mortality of the test organisms; 58 mg a.i./kg BW) and chronic dietary NOAEL (7 mg a.i./kg BW-day) were selected as the dietary small mammal TRVs. The dermal small mammal TRV was established at >5,000 mg a.i./kg BW.

In acute toxicity tests for large mammal species, the dose that caused the death of 50 percent of the dogs exposed (the LD_{50}) to tebuthiuron was greater than (>) 500 mg a.i./kg BW (USEPA 1994a, MRID 00226375). In a 90-day feeding trial, adverse effects were observed in beagle dogs (*Canis familiaris*) fed 1,000 ppm (equivalent to 25 mg a.i./kg BW-day) (USEPA 1994a, MRID 00020663). In the same study, no adverse effects were observed in dogs fed 500 ppm (equivalent to 12.5 mg a.i./kg BW-day).

The large mammal dietary LD_{50} was established at >500 mg a.i./kg BW-day, and the NOAEL TRV was established at 12.5 mg a.i./kg BW-day.

3.1.2.2 Birds

In the studies evaluated, no adverse effects were reported in birds exposed to tebuthiuron. In acute oral exposure tests, the LD_{50} for mallards (*Anas platyrhynchos*) and bobwhite quail (*Colinus virginianus*) dosed with tebuthiuron (96.4% a.i.) was > 2,500 mg/kg BW in water (USEPA 2003, MRID 00041680 and MRID 00041681). In acute dietary exposures, the LD_{50} for mallards was greater than the highest concentration tested, 5,093 ppm in diet (equivalent to 509 mg a.i./kg BW-day) (USEPA 2003, MRID 40601002). In similar tests, the LD_{50} value for bobwhite quail fed diets containing tebuthiuron was > 5,113 ppm (equivalent to 3,088 mg a.i./kg BW-day) (USEPA 2003, MRID 40601001). In these dietary tests, the test organism was presented with the dosed food for 5 days, with 3 days of additional observations after the dosed food was removed. The endpoint reported for this assay is generally an LC_{50} representing mg a.i./kg food. This concentration-based value was converted to a dose-based value following the methodology presented in the Methods Document (ENSR 2004c). Then the dose-based value was multiplied by the number of days of exposure (generally 5) to result in an LD_{50} value representing the full herbicide exposure over the course of the test. This resulted in LD_{50} values of >15,440 mg a.i./kg BW and >2,545 mg a.i./kg BW for the bobwhite quail and mallard, respectively.

A 30 day dietary study reported no effects to hens exposed to 1,000 mg a.i./kg BW-day (equivalent to a dietary concentration of 10,000 ppm) (PIP 1993). Twenty-two week chronic reproductive studies reported no effects to mallards and bobwhite quail fed diets of 100 ppm (equivalent to 10 mg a.i./kg BW-day and 60 mg a.i./kg BW-day, respectively) (USEPA 2003, MRID 00093690 and MRID 00104243).

The small bird dietary LD_{50} was established at >15,440 mg a.i./kg BW, based on the bobwhite quail. A small bird dietary NOAEL value was calculated by dividing the daily dose LD_{50} (3,088 mg a.i./kg BW-day) by an uncertainty factor of 3. The resulting small bird dietary NOAEL was 1,029 mg a.i./kg BW-day. This value was used rather than > 60 mg a.i./kg BW-day because no adverse effects were reported in the acute study, suggesting that this higher NOAEL calculated from an experimentally-based LD_{50} (equivalent to an 8-day no effects concentration) would more realistically represent the risk of chronic tebuthiuron toxicity. The uncertainty factor was selected based on a review of the application of uncertainty factors (Chapman et al. 1998) and the use of uncertainty factors for this assessment is described in the Methods Document (ENSR 2004c).. It may be noted that the use of this NOAEL TRV to evaluate chronic scenarios is conservative since it is based on a short term, not a chronic, study.

The large bird dietary LD_{50} was established at >2,545 mg a.i./kg BW-day, based on the mallard duck. The large bird NOAEL was established at 1,000 mg a.i./kg BW-day based on hens.

3.1.2.3 Terrestrial Invertebrates

A standard acute contact toxicity bioassay in honeybees is required for the USEPA pesticide registration process. In this study, tebuthiuron was directly applied to the bee's thorax and mortality was assessed during a 48-hr period. Data from the USEPA (2003, MRID 40840401) indicate the LD_{50} for the honeybee is > 100 micrograms (µg a.i.)/bee. However, a tebuthiuron fact sheet published by the U.S. Department of Energy (USDOE 2000) reports a LD_{50} of 30 µg a.i./bee. This value could not be confirmed by other information sources.

The honeybee dermal LD_{50} TRV was set at 30 µg a.i./bee. Based on a honeybee weight of 0.093 g, this TRV was expressed as 323 mg a.i./kg BW.

3.1.2.4 Terrestrial Plants

Toxicity tests were conducted on numerous crop plant species (plants tested were vegetable crop species and not western rangeland or forest species). Endpoints in the terrestrial plant toxicity tests were generally related to seed germination, seed emergence, and sub-lethal (i.e. growth) impacts observed during vegetative vigor assays. Germination was not significantly affected by tebuthiuron concentrations of 6 lb a.i./ac (USEPA 2003, MRID 41066902). Seed emergence and vegetative vigor also were examined, with seed emergence being the most sensitive indicator of toxicity. Seed emergence studies were conducted by applying the herbicide to soil containing newly sown seed. The concentration that affected 25 percent of the tested plants (the effect concentration [EC_{25}]) ranged as low as 0.03 lb a.i./ac (USEPA 2003, MRID 41066901).

The lowest and highest germination-based NOAELs were selected to evaluate risk in surface runoff scenarios of the risk assessment. Emergence endpoints were used when germination data was unavailable. These TRVs were >6 and 0.01 lbs a.i./ac (extrapolated from the EC_{25}), based on germination and emergence data, respectively. Two additional endpoints were used to evaluate other plant scenarios. These included the seed emergence EC_{25} of 0.03 lb. a.i./ac and a NOAEL of 0.01 lb a.i./ac (extrapolated from the EC_{25} by dividing by an uncertainty factor of 3).

3.1.3 Toxicity to Aquatic Organisms

3.1.3.1 Fish

The effects of tebuthiuron were examined in both cold- and warmwater fish species. In acute toxicity tests, the 96-hour LC_{50} values (i.e., the concentration that causes 50% mortality) were 115 and 112 mg/L using 97% and 100% tebuthiuron products for cold- and warmwater fish, respectively (Caux et al. 1997). Chronic exposure of rainbow trout (*Oncorhynchus mykiss*) fry showed adverse effects (as reduced growth after 45 days of exposure) at tebuthiuron

concentrations of 52 mg/L, while the no effect concentration was 26 mg/L using a 98% tebuthiuron product (USEPA 2003, MRID 00090083). In warmwater fish, chronic toxicity (as reduced length after 33 days of exposure) was observed at 18 mg a.i./L, while no effects occurred at 9.3 mg a.i./L (USEPA 2003, MRID 00090084). Consequently, tebuthiuron is considered to have low toxicity to fish.

The lower of the cold- and warmwater fish endpoints were selected as the TRVs for fish. Therefore the warmwater 96-hour LC_{50} of 112 mg/L was selected as the acute TRV and the warmwater fish NOAEL of 9.3 mg a.i./L was used as the TRV for chronic effects.

Based on tebuthiuron's octanol-water coefficient (K_{ow} = 1.78) and regression equations for bioconcentration potential, tebuthiuron is not expected to bioconcentrate in aquatic organisms (HSDB 2003).

3.1.3.2 Amphibians

Two acute toxicity tests were conducted on bullfrogs (*Rana catesbeiana*; Caux et al. 1997). After 96-hours of exposure, the LC_{50} concentration was determined to be < 398 mg/L, but > 306 mg/L using products containing > 97% tebuthiuron.

The LC_{50} (398 mg/L) was selected as an amphibian acute TRV. Since there was no suitable NOAEL reported in the literature, the NOAEL was extrapolated from the LC_{50} using an uncertainty factor of 3. The resulting NOAEL TRV was 133 mg/L.

3.1.3.3 Aquatic Invertebrates

According to the USEPA ecotoxicity classifications, tebuthiuron is moderately toxicity to aquatic invertebrates. In 48-hour aquatic toxicity tests, acute toxicity was observed in aquatic invertebrates exposed to concentrations (99.2% a.i.) of 297 mg/L of tebuthiuron (USEPA 2003, MRID 00041694). In chronic tests with chironomids, adverse effects in biomass were observed in the lowest concentration tested, 0.2 mg/L (Temple et al. 1991). No adverse effects on biomass were observed in snails (*Helisoma* and *Physa* spp.) exposed to 0.1 mg/L (Caux et al. 1997) using products containing >97% tebuthiuron.

The LC_{50} (297 mg./L) was selected as the invertebrate acute TRV. The snail NOAEL (0.1 mg/L) was selected as the invertebrate chronic TRV.

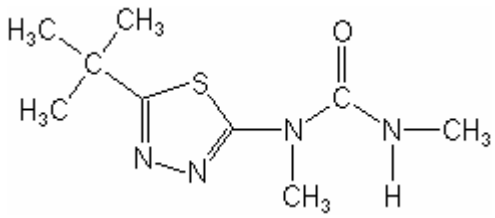
3.1.4 Aquatic Plants

Standard toxicity tests were conducted on aquatic plants, including aquatic macrophytes, algae, and diatoms. In acute toxicity tests, the median effective concentration (EC_{50}; adverse effects to 50 percent of the organisms tested) was reported to be as low as 0.05 mg/L (USEPA 2003, Study ID NAOTEB07) at a purity of 98% tebuthiuron. No observable adverse effect levels ranged from 0.013 mg/L, using 98% tebuthiuron, for green algae (Caux et al. 1997) to 0.18, at 97.4% tebuthiuron, for various alga species (Price et al. 1989).

The EC_{50} (0.05 mg/L) was selected as the aquatic plant acute TRV, and the NOAEL (0.013 mg /L) was selected as the aquatic plant chronic TRV.

3.2 Herbicide Physical-Chemical Properties

The chemical formula for tebuthiuron is 1-(5-tert-butyl-1,3,4-thiadiazol-2-yl)-1,3-dimethylurea. At low pH values, some of the tebuthiuron molecules will be protonated to form positive ions (pKa = 1.2) (HSDB, 2003). The chemical structure of tebuthiuron is shown below:



Tebuthiuron Chemical Structure

The physical-chemical properties and degradation rates critical to tebuthiuron's environmental fate are listed in Table 3-2 which presents the range of values encountered in the literature for these parameters. To complete Table 3-2, available USEPA literature on tebuthiuron was obtained either from the Internet or through a FOIA request. Herbicide information that had not been cleared of Confidential Business Information (CBI) was not provided by USEPA as part of the FOIA documents. Additional sources, both on-line and in print, were consulted for information about the herbicide:

- The British Crop Protection Council and The Royal Society of Chemistry. 1994. The Pesticide Manual Incorporating the Agrochemicals Handbook. Tenth Edition. Surrey and Cambridge, United Kingdom.
- Compendium of Pesticide Common Names. 2003. A website listing all ISO-approved names of chemical pesticides. Available at: http://www.hclrss.demon.co.uk.
- California Department of Pesticide Registration (DPR.). 2003. USEPA/OPP Pesticide Related Database. Updated weekly. Available at: http://www.cdpr.ca.gov/docs/epa/epamenu.htm.
- Hazardous Substances Data Bank (HSDB). 2003. A toxicology data file on the National Library of Medicines Toxicology Data Network (TOXNET). Available at: http://toxnet.nlm.nih.gov.
- Hornsby, A., R. Wauchope, and A. Herner. 1996. Pesticide Properties in the Environment. P. Howard (ed.). Springer-Verlag, New York.
- Mackay, D., S. Wan-Ying, and M. Kuo-ching. 1997. Handbook of Environmental Fate and Exposure Data for Organic Chemicals. Volume III. Pesticides Lewis Publishers, Chelsea, Minnesota.
- Montgomery, J.H. (ed.). 1997. Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals. Volume V. Pesticide Chemicals. Lewis Publishers, Boca Raton, Florida.
- Tomlin, C (ed.). 1994. The Agrochemicals Desk Reference 2nd Edition. Lewis Publishers, Boca Raton, Florida.

Information was also obtained from the Agricultural Research Service (ARS) Pesticide Properties Database (ARS 1995).

Values selected for use in risk assessment calculations are shown in bold in Table 3-2. The organic carbon - water partition coefficient value, K_{oc}, used in risk assessment calculations represents the average of K_{oc} values found in USEPA (1994a) and in ARS (1995). The K_{oc} value (617) reported by Montgomery (1997) was not used in calculating an average K_{oc} because this value is much larger than the other reported values. The half-life in pond water was estimated using the physical-chemical properties listed in Table 3-2 and the information reviewed concerning the environmental fate of tebuthiuron in aquatic systems. Values for foliar half-life and foliar washoff fraction were obtained from a database included in the GLEAMS computer model (U.S. Department of Agriculture [USDA] 1999).

Residue rates were obtained from the Kenaga nomogram, as updated (Fletcher et al. 1994). Values selected for use in risk assessment calculations are shown in bold in Table 3-2, presented at the end of this section.

3.3 Herbicide Environmental Fate

Tebuthiuron is resistant to abiotic and biological degradation in the environment. It is persistent and mobile (USEPA 1994b). The K_{oc} measures the affinity of a chemical to organic carbon relative to water. The higher the K_{oc}, the less soluble in water and the higher affinity for organic carbon, an important constituent of soil particles. Therefore, the higher the K_{oc}, the less mobile the chemical. K_{oc} values reported for tebuthiuron ranged from 4 to 617 indicating that tebuthiuron under a variety of conditions could have very high to low mobility in soil. (Swann et al. 1986; Table 2-3). USEPA (1994b), however, states that tebuthiuron has a low absorbence to soils. Sorption of tebuthiuron increases with soil organic matter and clay content (HSDB 2003). Volatilization and photolysis from soil is negligible (Tomlin 1994). Biodegradation may slowly remove tebuthiuron from soils, but mobility may be the most important loss mechanism (HSDB 2003; USEPA 1994b). Field half-lives from 1 year to over 33 months have been reported (Table 3-2). Soil half-lives increase as organic matter content increases and as moisture content decreases (Tomlin 1994).

In aquatic systems, tebuthiuron is resistant to hydrolysis and photolysis; although, some photodegradation has been reported at pH 9 (HSDB 2003). Since tebuthiuron biodegrades in soils, biodegradation is also expected to slowly degrade the herbicide in aquatic systems (HSDB 2003). Based on the reported bioconcentration factors (BCFs), tebuthiuron has little tendency to bioaccumulate in aquatic organisms (HSDB 2003). Aquatic dissipation half-lives over 1 month under aerobic conditions and over 12 months under anaerobic conditions have been reported (USEPA 1994c).

TABLE 3-1
Selected Toxicity Reference Values for Tebuthiuron

Receptor	Selected TRV	Units	Duration	Endpoint	Species	Notes
RECEPTORS INCLUDED IN FOOD WEB MODEL						
Terrestrial Animals						
Honeybee	30	µg/bee	NR	LD_{50}		
Large bird	> 2545	mg a.i./kg bw	8 d	LD_{50}	mallard	
Large bird	1000	mg a.i./kg bw-day	30 d	NOAEL	chicken	
Piscivorous bird	1000	mg a.i./kg bw-day	30 d	NOAEL	chicken	
Small bird	> 15440	mg a.i./kg bw	8 d	LD_{50}	bobwhite quail	
Small bird	1029	mg a.i./kg bw-day	8 d	NOAEL	bobwhite quail	extrapolated from LD_{50}
Small mammal	7	mg a.i./kg bw-day	2 generations	NOAEL	rat	
Small mammal - dermal	> 5000	mg a.i./kg bw	NR	LD_{50}	rabbit	
Small mammal - ingestion	58	mg a.i./kg bw	acute	LD_{50}	mouse	water exposure; no diet available
Large mammal	> 500	mg a.i./kg bw	acute	LD_{50}	dog	
Large mammal	12.5	mg a.i./kg bw-day	90 d	NOAEL	dog	water exposure; no diet available
Terrestrial Plants						
Typical species-direct spray,drift,dust	0.03	lb a.i./ac	NR	EC_{25}	cabbage	based on seed emergence
RTE species-direct spray, drift,dust	0.01	lb a.i./ac	NR	NOAEL	cabbage	extrapolated from EC_{25}; based on seed emergence
Typical species – runoff	> 6	lb a.i./ac	5 d	NOAEL	10 species	based on seed germination
RTE species – runoff	0.01	lb a.i./ac	5d	NOAEL	cabbage	extrapolated from EC_{25}; based on seed emergence
Aquatic Species						
Aquatic invertebrates	297	mg/L	48 h	EC_{50}	water flea	99.2% a.i. product
Fish	112	mg/L	96 h	LC_{50}	bluegill sunfish	~ 100% a.i. product
Aquatic plants and algae	0.05	mg/L	14 d	EC_{50}	green algae	98% a.i. product
Aquatic invertebrates	0.1	mg/L	chronic	NOAEL	snail	Growth; > 97% a.i. product
Fish	9.3	mg a.i./L	chronic	NOAEL	fathead minnow	swimming speed
Aquatic plants and algae	0.013	mg/L	14 d	NOAEL	*Selenastrum*	98% a.i. product

TABLE 3-1 (Cont.)
Selected Toxicity Reference Values for Tebuthiuron

Receptor	Selected TRV	Units	Duration	Endpoint	Species	Notes
ADDITIONAL ENDPOINTS						
Amphibian	< 398	mg/L	96 h	LC_{50}	bullfrog	> 97% a.i. product
Amphibian	133	mg/L	96 h	NOAEL	bullfrog	extrapolated from LC_{50}
Warmwater fish	112	mg/L	96 h	LC_{50}	bluegill sunfish	~ 100% a.i. product
Warmwater fish	> 9.3	mg a.i./L	33 d	NOAEL	fathead minnow	growth;
Coldwater fish	115	mg/L	96 h	LC_{50}	rainbow trout	> 97% a.i. product
Coldwater fish	26	mg/L	45 d	NOAEL	rainbow trout	growth; 98% a.i. product

Notes:

Toxicity endpoints for terrestrial animals

LD_{50} - to address acute exposure
NOAEL – to address chronic exposure

Toxicity endpoints for terrestrial plants

EC_{25} – to address direct spray, drift, and dust impacts on typical species
EC_{05} or NOAEL - to address direct spray, drift, and dust impacts on threatened or endangered species
highest germination NOAEL - to address surface runoff impacts on typical species
lowest germination NOAEL - to address surface runoff impacts on threatened or endangered species

Toxicity endpoints for aquatic receptors

LC_{50} or EC_{50} - to address acute exposure (appropriate toxicity endpoint for non-target aquatic plants will be an EC50)
NOAEL – to address chronic exposure
Value for fish is the lower of the warmwater and coldwater values

Units represent those presented in the reviewed study
Piscivorous bird TRV - Large bird chronic TRV
Fish TRV - lower of coldwater and warm water fish TRVs
Durations:
h - hours
d - days
w - weeks
m - months
y - years
NR – Not reported

TABLE 3-2
Physical-Chemical Properties of Tebuthiuron

Parameter	Value
Herbicide family	thiadiazolyurea herbicide (Compendium of Pesticide Common Names 2003).
Mode of action	Photosynthetic electron transport inhibitor (Tomlin 1994).
Chemical Abstract Service number	34014-18-1 (USEPA 1994c).
Office of Pesticide Programs chemical code	105501 (USEPA 1994c).
Chemical name (International Union of Pure and Applied Chemistry [IUPAC])	1-(5-*tert*-butyl-1,3,4-thiadiazol-2-yl)-1,3-dimethylurea (Tomlin 1994).
Empirical formula	$C_9H_{16}N_4OS$ (USEPA 1994c).
Molecular weight (MW)	228.3 (USEPA 1994c).
Appearance, ambient conditions	Colorless to white crystalline solid (USEPA 1994c).
Acid / Base properties	1.2 (pKa) (HSDB 2003).
Vapor pressure (millimeters of mercury [mmHg] at 25ºC)	2×10^{-6} (USEPA 1994c; Hornsby et al. 1996; Tomlin 1994; Montgomery 1997).
Water solubility (mg/L at 25ºC)	2,500 (Tomlin 1994; USEPA 1994c; Hornsby et al. 1996); 2,300 to 2,500 (Montgomery 1997).
Log octanol-water partition coefficient (Log K_{ow}), unitless	1.79 (Tomlin 1994; USEPA 1994c; Montgomery 1997).
Henry's Law constant (atm-m^3/mole)	2.4×10^{-10} (Calculated from USEPA water solubility and vapor pressure).
Soil / Organic matter sorption coefficients (Kd / K_{oc})[(1)]	Kd / K_{oc}: 0.11 / 38 (sand, %OM 0.5), 0.62 / 77 (sandy loam, %OM 1.4), 0.82 / 79 (loam, %OM 1.8), 1.82 / 157 (clay loam, %OM 2.0), K_{OC}= 4 (USEPA 1994c; ARS 1995); 80 (Kd) (Hornsby et al. 1996); 2.79 (log(K_{oc})) (Montgomery 1997).
Bioconcentration factor (BCF)	A whole fish BCF of 2.63 was calculated from a 28-day flow-through study in which bluegill sunfish were exposed to 5.0 ppm tebuthiuron (USEPA 1994c).
Field dissipation half-life	1-2 years (CA and NE sites). A small scale retrospective study at a ranch near Sarita, TX showed that tebuthiuron can persist at relatively high levels in soil and soil water if restrictive layers block leaching to ground water. Tebuthiuron was found in ground water (15 ft depth to water) and was detectable in ground water four years after application. (USEPA 1994c); 12-15 months with persistence inversely proportional to soil moisture content. Amount of tebuthiuron recovered from field sites in north central AZ declined from 55% of that applied after 1 year to 5% after 8 years but increased for the remaining 2-3 years of the study. This increase may have been due to increased extraction of soil-bound residues. No metabolites were found, suggesting little or no degradation in soil (HSDB 2003). 12-15 months in areas receiving 40-60 inches annual rainfall (HSDB 2003); 15 months in areas of moderate to heavy rainfall and up to 45 months in low rainfall: >> 33 months in Loam (Fresno, CA); 12-15 months in clay soil (LA); 12-15 months in loam (Greenfield, IN) (Behl 1999); 360 days (Hornsby et al. 1996); 38% of 0.84 kg/Ha tebuthiuron applied to rangeland remained after 21 months (Montgomery 1997).
Soil dissipation half-life[(2)]	35.4 months in a sandy loam (24ºC, 75% field moisture capacity). > 1 month for tebuthiuron incubated initially under aerobic conditions for 30 days and then for 60 days under flooded conditions in a sandy loam. 4.7% tebuthiuron loss during study (USEPA 1994c). In vertisol: 139 days (saturation), 279 days (field capacity moisture content), 276 days (50% field capacity moisture content). In alfisol: 83 days (saturation), 91 days (field capacity moisture content), and 99 days (50% field capacity moisture content). Degradation kinetics consistent with a model in which tebuthiuron partitions into two soils pools, bound and labile (HSDB 2003). > 39 days (loam soil, 39 week study), > 48 weeks (loam soil, 23ºC) (HSDB 2003).

TABLE 3-2 (Cont.)
Physical-Chemical Properties of Tebuthiuron

Parameter	Value
Aquatic dissipation half-life	> 1 one month (aerobic pond water and sediment, 24ºC, 30 day test) 4.8% tebuthiuron loss during study. > 1 year (anaerobic pond water and sediment, 26ºC, 365 day test) 6.3% tebuthiuron loss during study (USEPA 1994c).
Hydrolysis half-life	Stable to hydrolysis at pH 3, 6, and 9 (64 day test) (HSDB 2003).
Photodegradation half-life in water	Did not photodegrade in sterile aqueous buffered solution (pH 5) irradiated for 33 days with a xenon light source (~25ºC). (USEPA 1994c); 87-89% tebuthiuron remaining after irradiation with artificial light for 23 days in deionized (pH 7.1) or natural (pH 8.1) water. 82% and 53% tebuthiuron in natural waters remaining after irradiation for 15 days with artificial light (HSDB 2003).
Photodegradation half-life in soil	39.7 days (USEPA 1994c).
Aquatic biodegradation half-life	Not available.
Soil biodegradation half-life	Not available.
Foliar half-life	30 days (USDA 1999).
Foliar wash-off fraction	0.90 (USDA 1999).
Half-life in pond(3)	1062 days (estimated from herbicide's environmental behavior and values in this table).
Residue Rate for grass (4)	**197 ppm** (maximum) and **36 ppm** (typical) per lb a.i./ac.
Residue Rate for vegetation (5)	**296 ppm** (maximum) and **35 ppm** (typical).
Residue Rate for insects (6)	**350 ppm** (maximum) and **45 ppm** (typical).
Residue Rate for berries (7)	**40.7 ppm** (maximum) and **5.4 ppm** (typical).

Notes:
Values presented in bold were used in risk assessment calculations.
(1) K_{oc} value used in risk assessment calculations is the average of K_{oc} values reported in USEPA 1994a with some data obtained from ARS 1995. The K_{oc} value used in risk assessment calculations was **71**.
(2) Some studies listed in this category may have been performed under field conditions, but insufficient information was provided in the source material to make this determination.
(3) Used in risk assessments to calculate aqueous herbicide concentration in pond water that receives herbicide laden runoff.
(4) Residue rates selected are the high and mean values for long grass (Fletcher et al. 1994).
(5) Residue rates selected are the high and mean values for leaves and leafy crops (Fletcher et al. 1994).
(6) Residue rates selected are the high and mean values for forage such as legumes (Fletcher et al. 1994).
(7) Residue rates selected are the high and mean values for fruit (includes both woody and herbaceous (Fletcher et al. 1994).

4.0 ECOLOGICAL RISK ASSESSMENT

This section presents a screening-level evaluation of the risks to ecological receptors from potential exposure to the herbicide tebuthiuron. The general approach and analytical methods for conducting the tebuthiuron ERA were based on USEPA's Guidelines for ERA (hereafter referred to as the "Guidelines;" USEPA 1998).

The ERA is a structured evaluation of all currently available scientific data (exposure chemistry, fate and transport, toxicity, etc.) that leads to quantitative estimates of risk from environmental stressors to non-human organisms and ecosystems. The current Guidelines for conducting ERAs include three primary phases: problem formulation, analysis, and risk characterization. These phases are discussed in detail in the Methods Document (ENSR 2004c) and briefly in the following sub-sections.

4.1 Problem Formulation

Problem formulation is the initial step of the standard ERA process and provides the basis for decisions regarding the scope and objectives of the evaluation. The problem formulation phase for tebuthiuron assessment included:

- definition of risk assessment objectives;
- ecological characterization;
- exposure pathway evaluation;
- definition of data evaluated in the ERA;
- identification of risk characterization endpoints; and
- development of the conceptual model.

4.1.1 Definition of Risk Assessment Objectives

The primary objective of this ERA was to evaluate the potential ecological risks from tebuthiuron to the health and welfare of plants and animals and their habitats. This analysis is part of the process used by the BLM to determine which of the proposed treatment alternatives evaluated in the EIS should be used on BLM-managed lands.

An additional goal of this process was to provide risk managers with a tool that develops a range of generic risk estimates that vary as a function of site conditions. This tool primarily consists of Excel spreadsheets (presented in the ERA Worksheets; Appendix B), which may be used to calculate exposure concentrations and evaluate potential risks in the risk assessment. A number of the variables included in the worksheets can be modified by BLM land managers for future evaluations.

4.1.2 Ecological Characterization

As described in Section 2.2, tebuthiuron is used by the BLM for vegetation management in Rangeland, Public-Domain Forest Land, Energy and Mineral Sites, Rights-of-Way, and Recreation programs. The proposed BLM program involves the general use and application of herbicides on public lands in 17 western states in the continental US, and Alaska. These applications have the potential to occur in a wide variety of ecological habitats that could

include: deserts, forests, and prairie land. It is not feasible to characterize all of the potential habitats within this report; however, this ERA was designed to address generic receptors, including RTE species (see Section 6.0) that could occur within a variety of habitats.

4.1.3 Exposure Pathway Evaluation

The following ecological receptor groups were evaluated:

- terrestrial animals;
- non-target terrestrial plants; and
- aquatic species (fish, invertebrates, and non-target aquatic plants).

These groups of receptor species were selected for evaluation because they: (1) are potentially exposed to herbicides within BLM management areas; (2) are likely to play key roles in site ecosystems; (3) have complex life cycles; (4) represent a range of trophic levels; and (5) are surrogates for other species likely to be found on BLM-managed lands.

The exposure scenarios considered in the ERA were primarily organized by potential exposure pathways. In general, the exposure scenarios describe how a particular receptor group may be exposed to the herbicide as a result of a particular exposure pathway. These exposure scenarios were developed to address potential acute and chronic impacts to receptors under a variety of exposure conditions that may occur within BLM-managed lands. Tebuthiuron is a terrestrial herbicide; therefore, as discussed in detail in the Methods Document (ENSR 2004c), the following exposure scenarios were considered:

- direct contact with the herbicide or a contaminated waterbody;
- indirect contact with contaminated foliage;
- ingestion of contaminated food items;
- off-site drift of spray to terrestrial areas and waterbodies;
- surface runoff from the application area to off-site soils or waterbodies;
- wind erosion resulting in deposition of contaminated dust; and
- accidental spills to waterbodies.

Two generic waterbodies were considered in this ERA: 1) a small pond (1/4 acre pond of 1 meter [m] depth, resulting in a volume of 1,011,715 L) and 2) a small stream representative of Pacific Northwest low-order streams that provide habitat for critical life-stages of anadromous salmonids. The stream size was established at 2 m wide and 0.2 m deep with a mean water velocity of approximately 0.3 meters per second, resulting in a base flow discharge of 0.12 cubic meters per second (cms).

4.1.4 Definition of Data Evaluated in the ERA

Herbicide concentrations used in the ERA were based on typical and maximum application rates provided by the BLM (Table 2-1). These application rates were used to predict herbicide concentrations in various environmental media (e.g., soils, water). Some of these calculations were fairly straightforward and required only simple algebraic calculations, but others required more complex computer models (e.g., transport from soils).

The AgDRIFT® computer model was used to estimate off-site herbicide transport due to spray drift. AgDRIFT® Version 2.0.05 (SDTF 2002) is a product of the Cooperative Research and Development Agreement between the USEPA's Office of Research and Development and the Spray Drift Task Force (SDTF, a coalition of pesticide registrants). The GLEAMS computer model was used to estimate off-site transport of herbicide in surface runoff and root-zone groundwater. GLEAMS is able to estimate a wide range of potential herbicide exposure concentrations as a function of site-specific parameters, such as soil characteristics and annual precipitation. The USEPA's guideline air quality California Puff (CALPUFF) air pollutant dispersion model was used to predict the transport and deposition of herbicides sorbed to wind-blown dust. CALPUFF "lite" version 5.7 was selected because of its ability to screen potential air quality impacts within and beyond 50 kilometers and its ability to simulate plume trajectory over several hours of transport based on limited meteorological data.

4.1.5 Identification of Risk Characterization Endpoints

Assessment endpoints and associated measures of effect were selected to evaluate whether populations of ecological receptors are potentially at risk from exposure to proposed BLM applications of tebuthiuron. The selection process is discussed in detail in Methods Document (ENSR 2004c), and the selected endpoints are presented below (impacts to RTE species are discussed in more detail in Section 6.0).

Assessment Endpoint 1: Acute mortality to mammals, birds, invertebrates, non-target plants

- **Measures of Effect** included median lethal effect concentrations (e.g., LD_{50} and LC_{50}) from acute toxicity tests on target organisms or suitable surrogates. To add conservatism to the RTE assessment, lowest available germination NOAELs were used to evaluate non-target RTE plants, and LOCs for RTE species were lower than for typical species.

Assessment Endpoint 2: Acute mortality to fish, aquatic invertebrates, and aquatic plants

- **Measures of Effect** included median lethal effect concentrations (e.g., LC_{50} and EC_{50}) from acute toxicity tests on target organisms or suitable surrogates (e.g., data from other coldwater fish to represent threatened and endangered salmonids). As with terrestrial species, lowest available germination NOAELs were used to evaluate non-target RTE plants, and LOCs for RTE species were lower than for typical species.

Assessment Endpoint 3: Adverse direct effects on growth, reproduction, or other ecologically important sublethal processes

- **Measures of Effect** included standard chronic toxicity test endpoints such as the NOAEL for both terrestrial and aquatic organisms. Depending on data available for a given herbicide, chronic endpoints reflect either individual impacts (e.g., growth, physiological impairment, behavior) or population-level impacts (e.g., reproduction; Barnthouse 1993). For salmonids, careful attention was paid to smoltification (i.e., development of tolerance to seawater and other indications of change of parr [freshwater stage salmonids] to adulthood), thermoregulation (i.e., ability to maintain body temperature), and migratory behavior, if such data were available.

Assessment Endpoint 4: Adverse indirect effects on the survival, growth, or reproduction of salmonid fish

- **Measures of Effect** for this assessment endpoint depended on the availability of appropriate scientific data. Unless literature studies were found that explicitly evaluated the indirect effects of tebuthiuron on salmonids and their habitat, only qualitative estimates of indirect effects were possible. Such qualitative estimates were limited

to a general evaluation of the potential risks to food (typically represented by acute and/or chronic toxicity to aquatic invertebrates) and cover (typically represented by potential for destruction of riparian vegetation). Similar approaches are already being applied by USEPA OPP for Endangered Species Effects Determinations and Consultations (http://www.epa.gov/oppfead1/endanger/effects).

4.1.6 Development of the Conceptual Model

The tebuthiuron conceptual model (Figure 4-1) is presented as a series of working hypotheses about how tebuthiuron might pose hazards to the ecosystem and ecological receptors. The conceptual model indicates the possible exposure pathways for the herbicide, as well as the receptors evaluated for each exposure pathway. Figure 4-2 presents the trophic levels and receptor groups evaluated in the ERA.

The conceptual model for herbicide application on BLM lands is designed to display potential herbicide exposure through several pathways, although all pathways may not exist for all locations. The exposure pathways and ecological receptor groups considered in the conceptual model are also described in Section 4.1.3.

The terrestrial herbicide conceptual model (Figure 4-1) presents five mechanisms for the release of an herbicide into the environment: direct spray, off-site-drift, wind erosion, surface runoff, and accidental spills. These release mechanisms may occur as the terrestrial herbicide is applied to the application area by aerial or ground methods.

As indicated in the conceptual model figure, direct spray may result in herbicide exposure for wildlife, non-target terrestrial plants or waterbodies adjacent to the application area. Receptors like wildlife or terrestrial plants may be directly sprayed during the application, or herbicide exposure may be the result of contact with the contaminated water in the pond or steam (i.e., aquatic plants, fish, aquatic invertebrates). Terrestrial wildlife may also be exposed to the herbicide by brushing against sprayed vegetation or by ingesting contaminated food items.

Off-site drift may occur when herbicides are applied under normal conditions and a portion of the herbicide drifts outside of the treatment area. In these cases, the herbicide may deposit onto non-target receptors such as non-target terrestrial plants or nearby waterbodies. This results in potential direct exposure to the herbicide for terrestrial and aquatic plants, fish, and aquatic invertebrates. Piscivorous birds may also be impacted by ingesting contaminated fish from an exposed pond.

Wind erosion describes the transport mechanism in which dry conditions and wind allow movement of the herbicide from the application area as wind-blown dust. This may result in the direct exposure of non-target plants to the herbicide that is deposited on the plant itself.

Precipitation may result in the transport of herbicides via surface runoff and root-zone groundwater. The seeds of terrestrial plants may be exposed to the herbicide in the runoff or root-zone groundwater. Herbicide transport to the adjacent waterbodies may also occur through these mechanisms. This may result in the exposure of aquatic plants, fish, and aquatic invertebrates to impacted water. Piscivorous birds may also be impacted by ingesting contaminated fish from an exposed pond.

Accidental spills may also occur during normal herbicide applications. Spills represent the worst-case transport mechanism for herbicide exposure. An accidental spill to a waterbody would result in exposure for aquatic plants, fish, and aquatic invertebrates to impacted water.

4.2 Analysis Phase

The analysis phase of an ERA consists of two principal steps: the characterization of exposure and the characterization of ecological effects. The exposure characterization describes the source, fate, and distribution of the herbicide using standard models that predict concentrations in various environmental media (e.g., GLEAMS). All EECs predicted by the models are presented in Appendix B. The ecological effects characterization consisted of compiling exposure-response relationships from all available toxicity studies on the herbicide.

4.2.1 Characterization of Exposure

The BLM uses herbicides in a variety of programs (e.g., maintenance of rights of way and recreational sites) with several different application methods (e.g., backpack/horseback sprayer, ATV/truck-mounted boom/broadcast sprayer). In order to assess the potential ecological impacts of these herbicide uses, a variety of exposure scenarios were considered. These scenarios, which were selected based on actual BLM herbicide usage under a variety of conditions, are described in Section 4.1.3.

When considering the exposure scenarios and the associated predicted concentrations, it is important to recall the frequency and duration of the various scenarios are not equal. For example, exposures associated with accidental spills will be very rare, while off-site drift associated with application will be relatively common. Similarly, off-site drift events will be short-lived (i.e., migration occurs within minutes), while erosion of herbicide-containing soil may occur over weeks or months following application. The ERA has generally treated these differences in a conservative manner (i.e., potential risks are presented despite their likely rarity and/or transience). Thus, tables and figures summarizing RQs may present both relatively common and very rare exposure scenarios. Additional perspective on the frequency and duration of exposures are provided in the narrative below.

As described in Section 4.1.3, the following ecological receptor groups were selected to address the potential risks due to unintended exposure to tebuthiuron: terrestrial animals, terrestrial plants, and aquatic species. A set of generic terrestrial animal receptors, listed below, were selected to cover a variety of species and feeding guilds that might be found on BLM-managed lands. Unless otherwise noted, receptor BWs were selected from the *Wildlife Exposure Factors Handbook* (USEPA 1993a). This list includes surrogate species, although not all of these surrogate species will be present within each application area:

- A pollinating insect with a BW of 0.093 grams (g). The honeybee (*Apis mellifera*) was selected as the surrogate species to represent pollinating insects. This BW was based on the estimated weight of receptors required for testing in 40CFR158.590.

- A small mammal with a BW of 20 g that feeds on fruit (e.g., berries). The deer mouse (*Peromyscus maniculatus*) was selected as the surrogate species to represent small mammalian omnivores consuming berries. .

- A large mammal with a BW of 70 kg that feeds on plants. The mule deer (*Odocolieus hemionus*) was selected as the surrogate species to represent large mammalian herbivores, including wild horses and burros (Hurt and Grossenheider 1976).

- A large mammal with a BW of 12 kg that feeds on small mammals. The coyote (*Canis latrans*) was selected as the surrogate species to represent large mammalian carnivores (Hurt and Grossenheider 1976).

- A small bird with a BW of 80 g that feeds on insects. The American robin (*Turdus migratorius*) was selected as the surrogate species to represent small avian insectivores.

- A large bird with a BW of approximately 3.5 kg that feeds on vegetation. The Canada goose (*Branta canadensis*) was selected as the surrogate species to represent large avian herbivores.

- A large bird with a BW of approximately 5 kg that feeds on fish in the pond. The Northern subspecies of the bald eagle (*Haliaeetus leucocephalus alascanus*) was selected as the surrogate species to represent large avian piscivores (Brown and Amadon 1968[2]).

[2] As cited on the Virginia Tech Conservation Management Institute Endangered Species Information System website (http://fwie.fw.vt.edu/WWW/esis/).

In addition, potential impacts to non-target terrestrial plants were considered by evaluating two plant receptors: the "typical" non-target species, and the RTE non-target species. Cabbage (*Brassica sp.*) was the surrogate species chosen to represent typical and RTE terrestrial plants (toxicity data are only available for vegetable crop species). Tebuthiuron is registered for woody plant (i.e., trees, shrubs, vines) and herbaceous broadleaf plant (i.e., clover) control, so the use of cabbage, a broadleaf species, as a surrogate receptor is appropriately sensitive. Impacts to rangeland and non-cropland species may be overestimated by the used of toxicity data based on broadleaf species such as cabbage and other vegetables.

Aquatic exposure pathways were evaluated using fish, aquatic invertebrates, and non-target aquatic plants in a pond or stream habitat (as defined in Section 4.1.3). Bluegill sunfish (*Lepomis macrochirus*) and the fathead minnow (*Pimephales promelas*) were surrogates for fish, the water flea (*Ceriodaphnia dubia*) and snail were surrogates for aquatic invertebrates, and non-target aquatic plants and algae were represented by green algae (*Selenastrum*).

Section 3.0 of the Methods Document (ENSR 2004c) presents the details of the exposure scenarios considered in the risk assessments. The following scenarios were evaluated for tebuthiuron:

4.2.1.1 Direct Spray

Plant and wildlife species may be unintentionally impacted during normal application of a terrestrial herbicide as a result of a direct spray of the receptor or the waterbody inhabited by the receptor, indirect contact with dislodgeable foliar residue after herbicide application, or consumption of food items sprayed during application. These exposures may occur within the application area (consumption of food items) or outside of the application area (waterbodies accidentally sprayed during application of terrestrial herbicide). Generally, impacts outside of the intended application area are accidental exposures and are not typical of BLM application practices. The following direct spray scenarios were evaluated:

Exposure Scenarios Within the Application Area

- Direct Spray of Terrestrial Wildlife
- Indirect Contact With Foliage After Direct Spray
- Ingestion of Food Items Contaminated by Direct Spray
- Direct Spray of Non-Target Terrestrial Plants

Exposure Scenarios Outside the Application Area

- Accidental Direct Spray Over Pond
- Accidental Direct Spray Over Stream

4.2.1.2 Off-Site Drift

During normal application of herbicides, it is possible for a portion of the herbicide to drift outside of the treatment area and deposit onto non-target receptors. To simulate off-site herbicide transport as spray drift, AgDRIFT® software was used to evaluate a number of possible scenarios. To reflect actual BLM uses, ground applications were modeled using a low- and high-placed boom. Tebuthiuron may be applied aerially, however AgDRIFT® is unable to model the pellet form of tebuthiuron that is used for these types of application. Therefore, only ground applications have been considered in this evaluation. It is unlikely that the pellet form would be significantly dispersed by off-site drift due to the weight of the pellets. Ground applications were modeled using either a high boom (spray boom height set at 50 inches above the ground) or a low boom (spray boom height set at 20 inches above the ground). Deposition rates vary by the height of the boom (the higher the height of the spray boom, the greater the off-site drift). The following off-site drift scenarios were considered:

- Off-Site Drift to Plants
- Off-Site Drift to Pond
- Off-Site Drift to Stream
- Consumption of Fish From Contaminated Pond

4.2.1.3 Surface and Groundwater Runoff

Precipitation may result in the transport of herbicides bound to soils from the application area via surface runoff and root-zone groundwater flow. This transport to off-site soils or waterbodies was modeled using GLEAMS software. It should be noted that both surface runoff (i.e., soil erosion and soluble-phase transport) and loading in root-zone groundwater were assumed to affect the waterbodies in question. In the application of GLEAMS, it was assumed that root-zone loading of herbicide would be transported directly to a nearby water body. This is a feasible scenario in several settings, but is very conservative in situations in which the depth to the water table might be many feet. In particular, it is common in much of the arid and semi-arid western states for the water table to be well below the ground surface and for there to be little, if any, groundwater discharge to surface water features.

The GLEAMS variables include soil type, annual precipitation, size of application area, hydraulic slope, surface roughness, and vegetation type. These variables were altered to predict soil concentrations of the herbicides in various watershed types at both the typical and maximum application rates. The following surface runoff scenarios were evaluated:

- Surface Runoff to Off-Site Soils
- Surface Runoff to Off-Site Pond
- Surface Runoff to Off-Site Stream
- Consumption of Fish From Contaminated Pond

4.2.1.4 Wind Erosion and Transport Off-Site

Dry conditions and wind may also allow transport of the herbicide from the application area as wind-blown dust onto non-target plants some distance away. This transport by wind erosion of the surface soil was modeled using CALPUFF software. Five distinct watersheds were evaluated to determine herbicide concentrations in dust deposited on plants after a wind event, with dust deposition estimates calculated 1.5 to 100 km from the application area.

4.2.1.5 Accidental Spill to Pond

To represent worst-case potential impacts to the pond, two spill scenarios were considered. These consist of a truck or a helicopter spilling entire loads (200 gallon [gal] spill and 140 gal spill (equivalent to 650 pounds of pellets), respectively) of herbicide mixed for the maximum application rate into the 1/4 acre, 1 m deep pond. The helicopter load was based on a pellet formulation, not a spray formulation, since that is the formulation used for aerial applications of tebuthiuron.

4.2.2 Effects Characterization

The ecological effects characterization phase entailed a compilation and analysis of the stressor-response relationships and any other evidence of adverse impacts from exposure to tebuthiuron. For the most part, available data consisted of toxicity studies conducted in support of USEPA pesticide registration described in Section 3.1. TRVs selected for use in the ERA are presented in Table 3-1. Appendix A presents the full set of toxicity information identified for tebuthiuron.

In order to address potential risks to ecological receptors, RQs were calculated by dividing the EEC for each of the previously described scenarios by the appropriate TRV presented in Table 3-1. An RQ was calculated by dividing the EEC for a particular scenario by an herbicide specific TRV. The TRV may be a surface water or surface soil effects concentration, or a species-specific toxicity value derived from the literature.

The RQs were then compared to LOCs established by the USEPA OPP to assess potential risk to non-target organisms. Table 4-1 presents the LOCs established for this assessment. Distinct USEPA LOCs are currently defined for the following risk presumption categories:

- **Acute high risk** - the potential for acute risk is high.
- **Acute restricted use** - the potential for acute risk is high, but may be mitigated through a restricted use designation.
- **Acute endangered species** – the potential for acute risk to endangered species is high.
- **Chronic risk** - the potential for chronic risk is high.

Additional uncertainty factors may also be applied to the standard LOCs to reflect uncertainties inherent in extrapolating from surrogate species toxicity data to obtain RQs (see Sections 6.3 and 7.0 for a discussion of uncertainty). A "chronic endangered species" risk presumption category for aquatic animals was added for this risk assessment. The LOC for this category was set to 0.5 to reflect the conservative two-fold difference in contaminant sensitivity between RTE and surrogate test fishes (Sappington et al. 2001). Risk quotients predicted for acute scenarios (e.g., direct spray, accidental spill) were compared to the three acute LOCs, and the RQs predicted for chronic scenarios (e.g., long term ingestion) were compared to the two chronic LOCs. If all RQs were less than the most conservative LOC for a particular receptor, comparisons against other, more elevated LOCs were not necessary.

The RQ approach used in this ERA provides a conservative measure of the potential for risk based on a "snapshot" of environmental conditions (i.e., rainfall, slope) and receptor assumptions (i.e., BW, ingestion rates). Sections 6.3 and 7.0 discuss several of the uncertainties inherent in the RQ methodology.

To specifically address potential impacts to RTE species, two types of RQ evaluations were conducted. For RTE terrestrial plant species, the RQ was calculated using different toxicity endpoints but keeping the same LOC (set at 1) for all scenarios. The plant toxicity endpoints were selected to provide extra protection to the RTE species. In the direct spray, spray drift, and wind erosion scenarios, the selected toxicity endpoints were an EC_{25} for "typical" species and a NOAEL for RTE species. In runoff scenarios, high and low germination NOAELs were selected to evaluate exposure for typical and RTE species, respectively.

The evaluation of RTE terrestrial wildlife and aquatic species is addressed using a second type of RQ evaluation. The same toxicity endpoint was used for both typical and RTE species in all scenarios, but the LOC was lowered for RTE species.

4.3 Risk Characterization

The ecological risk characterization integrates the results of the exposure and effects phases (i.e., risk analysis), and provides comprehensive estimates of actual or potential risks to ecological receptors. Estimated exposure concentrations are presented in Appendix B; RQs are summarized in Tables 4-2 to 4-5 and presented graphically in Figures 4-3 to 4-18. The results are discussed below for each of the evaluated exposure scenarios. The risk assessment calculated RQs based on a typical application rate of 0.5 lbs a.i./ac and a maximum application rate of 4.0 lbs a.i./ac. However, for some programs (i.e., Energy and Mineral Sites; Recreation Areas; see Table 2-1) the typical application rate is also listed at 4.0 lbs a.i./ac. Therefore, the typical rate RQs calculated in this section would not apply to those sites, but the maximum rate RQs would be appropriate for evaluating risk at those sites.

Box plots are used to graphically display the range of RQs obtained from evaluating each receptor and exposure scenario combination (Figures 4-3 to 4-18). These plots illustrate how RQ data are distributed about the mean and their relative relationships with LOCs. Outliers (data points outside the 90th or 10th percentile) were not discarded in this ERA; all RQ data presented in these plots were included in the risk assessment.

4.3.1 Direct Spray

As described in Section 4.2.1, potential impacts from direct spray were evaluated for exposure that could occur within the terrestrial application area (accidental direct spray of terrestrial wildlife and non-target terrestrial plants, indirect contact with foliage, ingestion of contaminated food items) and outside the intended application area (accidental direct spray over pond and stream). Table 4-2 presents the RQs for the above scenarios. Figures 4-3 to 4-7 present graphic representations of the range of RQs and associated LOCs.

4.3.1.1 Terrestrial Wildlife

RQs for the pollinating insect were above the most conservative LOC of 0.1 (acute endangered species) for impacts from direct spray of the insect (typical and maximum application rates) and indirect contact with foliage after direct spray (maximum application rate). However, this is a very conservative evaluation because it assumes that the insect absorbs 100% of the herbicide and that there is no degradation or limitations to the uptake. It is likely that this overestimates the risk to the insect due to direct spray and contact with foliage (since it is assumed to be directly proportional to the direct spray RQ). However, these results suggest there may be potential for risk to pollinating insects due to direct spray and indirect contact with foliage.

Acute and chronic RQs for terrestrial wildlife (Figure 4-3) impacted by the typical application rate were all below the most conservative LOC of 0.1 (acute endangered species). At the maximum application rate, three acute exposure scenarios (ingestion of contaminated food by small and large mammalian herbivores and the large avian herbivore) predicted RQs above the most conservative LOC (0.1; acute endangered species). The small mammalian herbivore acute RQ of 1.86 was also above the 'acute high risk' LOC of 0.5. Two chronic exposure scenarios (ingestion of contaminated food by the small and large mammalian herbivores) were above the chronic LOC of 1, with RQs of 3.58 and 3.79, respectively, at the maximum application rate. These results indicate that direct spray impacts are not likely to pose a risk to terrestrial animals at the typical application rate. Acute and chronic risk to avian and mammalian herbivores is predicted using the maximum application rate.

4.3.1.2 Non-target Plants – Terrestrial and Aquatic

RQs for non-target terrestrial plants (Figure 4-4) ranged from 16.7 to 400. RQs for non-target aquatic plants in the pond ranged from 1.12 to 39.5, and RQs for non-target aquatic plants in the stream ranged from 5.6 to 172 (Table 4-2; Figure 4.5). As expected because of the mode of action of herbicides, all of the RQs were above the plant LOC of 1, indicating that direct spray impacts pose a risk to plants in both aquatic and terrestrial environments. It may be noted that the aquatic scenarios are particularly conservative because they evaluate an instantaneous concentration and do not consider flow, adsorption to particles, or degradation that may occur over time within the pond or stream.

4.3.1.3 Fish and Aquatic Invertebrates

Acute and chronic toxicity RQs for fish (Figure 4-6), and acute toxicity RQs for aquatic invertebrates (Figure 4-7) were below the most conservative LOC of 0.05 (acute endangered species), indicating that direct spray impacts are not likely to pose a risk to these species in the pond or stream.

The chronic RQs for the aquatic invertebrates for the accidental direct spray ranged from 0.56 to 4.48 for the pond scenario and from 2.8 to 22.4 for the stream scenario. These values were greater than the LOC for chronic risk to endangered species (0.5), indicating the potential for risk to these receptors. It may be noted that this accidental spray scenario is very conservative because it does not consider flow, adsorption to particles, or degradation that may occur over time within the stream. The herbicide concentrations in the pond and stream are the instantaneous concentrations at the moment of the direct spray. The volume of the pond and the impacted segment of the stream were calculated

and the mass of herbicide was calculated based on the surface area of the waterbody. There was no dilution due to degradation or stream flow. In addition, it is assumed that the pond and stream are adjacent to the herbicide application area. However, these results suggest that impacts from direct spray may pose a chronic risk to endangered aquatic invertebrates in the pond or stream.

4.3.2 Off-site Drift

As described in Section 4.2.1, AgDRIFT® software was used to evaluate a number of possible scenarios in which a portion of the applied herbicide drifts outside of the treatment area and deposits onto non-target receptors. Ground applications of tebuthiuron were modeled using both a low- and high-placed boom (spray boom height set at 20 and 50 inches above the ground, respectively), and drift deposition was modeled at 25, 100, and 900 ft from the application area. Tebuthiuron may be applied aerially, however AgDRIFT® is unable to model the pellet form of tebuthiuron that is used for these types of application. Therefore, only ground applications have been considered in this evaluation. It is unlikely that the pellet form would be significantly dispersed by off-site drift because of the weight of the pellets.

Table 4-3 presents the RQs for the following scenarios: off-site drift to soil, off-site drift to pond, off-site drift to stream, and consumption of fish from the contaminated pond. Figures 4-8 to 4-12 present graphic representations of the range of RQs and associated LOCs.

4.3.2.1 Non-target Plants – Terrestrial and Aquatic

The majority of the RQs for non-target terrestrial plants (Figure 4-8) affected by off-site drift to soil were below the plant LOC of 1. However, RQs for six of the twenty four application scenarios did exceed the LOC, with RQs between 1.04 and 6.59 (Table 4-3). Elevated RQs for typical non-target terrestrial plant species were predicted at the maximum application rate due to off-site drift 25 ft from the ground application using a low or a high boom. Elevated RQs were predicted for RTE species impacted by off-site drift in the following situations: 25 ft from the ground application using a high boom at the typical application rate; 25 ft from the ground application using a low or a high boom at the maximum application rate; and 100 ft from the ground application using a high boom at the maximum application rate.

All of the acute and chronic toxicity RQs for non-target aquatic plants (Figure 4-9) affected by off-site drift in the pond and stream were below the plant LOC of 1. It may be noted that the aquatic scenarios are particularly conservative because they do not consider adsorption to particles or degradation of the herbicide over time. These results indicate that impacts from off-site drift are not likely to pose acute or chronic risk to aquatic plants.

4.3.2.2 Fish and Aquatic Invertebrates

Acute toxicity RQs for fish and aquatic invertebrates (Figures 4-10 and 4-11) were all below the most conservative LOC of 0.05 (acute endangered species). All chronic RQs were well below the LOC for chronic risk to endangered species (0.5). These results indicate that impacts from off-site drift are not likely to pose acute or chronic risk to these aquatic species.

4.3.2.3 Piscivorous Birds

Risk to piscivorous birds was assessed by evaluating impacts from consumption of fish from a pond contaminated by off-site drift. RQs for the piscivorous bird (Figure 4-12) were all well below the most conservative terrestrial animal LOC (0.1), indicating that this scenario is not likely to pose a risk to piscivorous birds.

4.3.3 Surface Runoff

As described in Section 4.2.1, surface runoff and root-zone groundwater transport of herbicides from the application area to off-site soils and waterbodies was modeled using GLEAMS software. A total of 42 GLEAMS simulations

were performed with different combinations of GLEAMS variables (i.e., soil type, soil erodability factor, annual precipitation, size of application area, hydraulic slope, surface roughness, and vegetation type) to account for a wide range of possible watersheds encountered on BLM-managed lands. In 24 simulations, soil type and precipitation values were altered, while the rest of the variables were held constant in a "base watershed" condition. In the remaining 18 simulations, precipitation was held constant, while the other six variables (each with three levels) were altered.

Table 4-4 presents the RQs for the following scenarios: surface runoff to off-site soils, overland flow to off-site pond, overland flow to off-site stream, and consumption of fish from contaminated pond. Figures 4-13 to 4-17 present graphic representations of the range of RQs and associated LOCs. A number of the GLEAMS scenarios, primarily those with minimal precipitation (e.g., 5 inches of precipitation per year), resulted in no predicted herbicide transport from the application area. Accordingly, these conditions do not result in associated off-site risk. RQs are discussed below for those scenarios predicting off-site transport and RQs greater than zero.

4.3.3.1 Non-target Plants – Terrestrial and Aquatic

RQs for typical non-target terrestrial plant species affected by surface runoff to off-site soil (Table 4-4) were all below the plant LOC of 1 (Figure 4-13), indicating that transport due to surface runoff is not likely to pose a risk to these species. RQs for RTE species were elevated for four scenarios at the typical application rate: runoff from the base watershed with clay soil and annual precipitation of 100, 150, 200, and 250 inches (RQs ranged from 1.24 to 1.43). RQs for RTE species were elevated for eight scenarios at the maximum application rate: runoff from the base watershed with clay soil and annual precipitation of 50, 100, 150, 200, and 250 inches, and runoff from the base watershed with and annual precipitation of 50 inches and three different soil types - silt loam, silt, and clay loam (RQs ranged from 1.34 to 11.5). These risk scenarios involve high levels of precipitation (50 inches and greater), and, therefore, are not likely on most BLM lands, which experience arid and semi-arid conditions.

Acute RQs for non-target aquatic plants in the pond impacted by overland flow (runoff) of herbicide (Figure 4-14) were generally below the plant LOC of 1 at the typical application rate. However, elevated acute RQs were predicted at the typical application rate in the base watershed with sandy soil and precipitation > 10 inches per year, in the base watershed with clay soil and precipitation of 50 to 100 inches per year, and in the clay loam variation of the base watershed with 50 inches of precipitation per year (no other precipitation levels modeled for this watershed). At the maximum application rate, elevated RQs were predicted in all but five modeled scenarios. These results indicate there is potential for acute impacts to aquatic plants in the pond under selected conditions at the typical application rate and under most conditions at the maximum application rate.

Chronic RQs for non-target aquatic plants in the pond were elevated above the plant LOC in several scenarios. At the typical application rate, 10 of the 42 RQs were above the plant LOC (ranging from 1.29 to 10.2). The majority of these exceedances occurred in sandy watersheds. At the maximum application rate, 37 of the 42 RQs were above the plant LOC. These results suggest the potential for chronic impacts to aquatic plants in the pond under selected conditions at the typical application rate and under most conditions at the maximum application rate.

Acute RQs for non-target aquatic plants in the stream impacted by overland flow of herbicide (Figure 4-14) were all below the plant LOC of 1 at the typical application rate. At the maximum application rate, elevated acute RQs were predicted in the base watershed with sandy soil and more than 50 inches of precipitation per year, in the base watershed with clay soil and more than 100 inches of precipitation per year, and in the loam watershed at 50 inches of precipitation per year when the application area was increased to 100 and 1,000 acres (all of which are high precipitation scenarios that are uncommon on most BLM-managed lands). Chronic RQs for non-target aquatic plants in the stream were below the LOC in all scenarios. These results indicate the potential for acute, but not chronic, impacts to aquatic plants in the stream under selected conditions at the maximum application rate.

4.3.3.2 Fish and Aquatic Invertebrates

Acute toxicity RQs for fish and aquatic invertebrates (Figure 4-15 and Figures 4-16) were all below the most conservative LOC of 0.05 (acute endangered species) for all pond and stream scenarios, indicating that surface runoff of tebuthiuron is not likely to pose acute risks to these aquatic species.

Chronic risk RQs for fish were well below the LOC for chronic risk to endangered species (0.5) in both pond and stream scenarios. At the typical application rate, chronic risk RQs for aquatic invertebrates were below the LOC for chronic risk to endangered species (0.5) in all but one modeled scenario (RQ of 1.28 for base watershed with sand soil and 10 inches of precipitation per year). At the maximum application rate in the pond scenario, chronic RQs for aquatic invertebrates were elevated above the LOC for chronic risk to endangered species (0.5) in 31 of 42 scenarios. However, only 11 of the 42 pond RQs were above the chronic risk LOC (1), indicating less risk to typical aquatic invertebrate species. The majority of these elevated RQs occurred in watersheds with sandy soil. No RQs for aquatic invertebrates in the stream scenario were above their LOCs.

These results indicate that these scenarios are not likely to result in long-term risk to fish in the stream or pond or to aquatic invertebrates in the stream. Long-term impacts to aquatic invertebrates in the pond, especially RTE species, may occur at the maximum application rate.

4.3.3.3 Piscivorous Birds

Risk to piscivorous birds (Figure 4-17) was assessed by evaluating impacts from consumption of fish from a pond contaminated by surface runoff. RQs for the piscivorous bird were all well below the most conservative terrestrial animal LOC (0.1), indicating that this scenario is not likely to pose a risk to piscivorous birds.

4.3.4 Wind Erosion and Transport Off-site

As described in Section 4.2.1, five distinct watersheds were modeled using CALPUFF to determine herbicide concentrations in dust deposited on plants after a wind event with dust deposition estimates calculated at 1.5, 10, and 100 km from the application area. Deposition results for Winnemucca, NV and Tucson, AZ were not listed because the meteorological conditions (i.e., wind speed) that must be met to trigger particulate emissions for the land cover conditions assumed for these sites did not occur for any hour of the selected year. Therefore, it was assumed herbicide migration by windblown soil would not occur at those locations during that year.

The soil type assumed for Winnemucca, NV and Tucson, AZ was undisturbed sandy loam, which has a higher friction velocity (i.e., is harder for wind to pick up as dust) than the soil types of the other locations. As further explained in Section 5.3, friction velocity is a function of the measured wind speed and the surface roughness, a property affected by land use and vegetative cover. The threshold friction velocities at the other three sites (103 or 150 centimeters per second [cm/sec]) were much lower, based on differences in the assumed soil types. At these sites, wind and land cover conditions combined to predict that the soil would be eroded on several days. Soils of similar properties at Winnemucca and Tucson, if present, would also have been predicted to be subject to erosion under weather conditions encountered there.

Table 4-5 summarizes the RQs for typical and RTE terrestrial plant species exposed to contaminated dust within the three remaining watersheds at typical and maximum application rates. Figure 4-18 presents a graphic representation of the range of RQs and associated LOCs. RQs for typical and RTE terrestrial plants were all well below the plant LOC (1), indicating that wind erosion is not likely to pose a risk to non-target terrestrial plants.

4.3.5 Accidental Spill to Pond

As described in Section 4.2.1, two spill scenarios were considered. These consist of a truck or a helicopter spilling entire loads (200 gal spill and 650 pounds of pellets, respectively) of herbicide mixed for the maximum application rate into the 1/4 acre, 1 m deep pond. The herbicide concentration in the pond was the instantaneous concentration at

the moment of the spill. The volume of the pond was determined and the volume of herbicide in the truck and helicopter, respectively, were mixed into the pond volume.

Risk quotients for the truck spill scenario (Table 4-2) ranged from 0.048 for aquatic invertebrates (Figure 4-7) to 287 for non-target aquatic plants (Figure 4-5). Risk quotients for the helicopter spill scenario (Table 4-2) were higher, ranging from 0.196 for aquatic invertebrates (Figure 4-7) to 1,170 for non-target aquatic plants (Figure 4-5). Potential risk to fish and non-target aquatic plants was indicated for the truck spill and risk to fish, aquatic invertebrates, and non-target aquatic plants was indicated for the helicopter spill. However, these scenarios are highly conservative and represent unlikely and worst case conditions (limited waterbody volume, tank mixed for maximum application prior to transport).

4.3.6 Potential Risk to Salmonids from Indirect Effects

In addition to direct effects of herbicides on salmonids and other fish species in stream habitats (i.e., mortality due to herbicide concentrations in surface water), reduction in vegetative cover or food supply may indirectly impact individuals or populations. No literature studies were identified that explicitly evaluated the indirect effects of tebuthiuron to salmonids and their habitat; therefore, only qualitative estimates of indirect effects are possible. These estimates were made by evaluating predicted impacts to prey items and vegetative cover in the stream scenarios discussed above. These scenarios include accidental direct spray over the stream and transport to the stream via off-site drift and surface runoff. An evaluation of impacts to non-target terrestrial plants was also included as part of the discussion of vegetative cover within the riparian zone. Food items for salmonids and other potential RTE species may include other fish species, aquatic invertebrates, or aquatic plants. Additional discussion of RTE species is provided in Section 6.0.

4.3.6.1 Qualitative Evaluation of Impacts to Prey

Fish species were evaluated directly in the ERA using acute and chronic TRVs based on the most sensitive warm- or coldwater species identified during the literature search. Salmonid species, primarily rainbow trout, were included in the TRV derivation review. However, the lowest acute and chronic toxicity results were observed for warmwater fish species. This indicates that direct risks to salmonids may be overestimated in the ERA since the trout toxicity values were higher than the fish TRV used in the ERA. Aquatic invertebrates were also evaluated directly using acute and chronic TRVs based on the most sensitive aquatic invertebrate species. No RQs in excess of the appropriate acute or chronic LOCs were observed for fish or aquatic invertebrates in any of the stream scenarios associated with off-site drift or surface runoff. However, chronic RQs for invertebrates were elevated over the associated chronic LOC for the accidental direct spray scenario. However, this is an extremely conservative scenario in which it is assumed that a stream is accidentally directly sprayed by a terrestrial herbicide. In addition, no reduction in herbicide concentration is calculated as a result of stream flow in this scenario. Stream flow would be likely to dilute the herbicide concentration and reduce potential impacts. Because fish and aquatic invertebrates are not predicted to be directly impacted by herbicide concentrations in the stream during *normal* application of tebuthiuron, salmonids are not likely to be indirectly affected by a reduction in these prey items.

4.3.6.2 Qualitative Evaluation of Impacts to Vegetative Cover

A qualitative evaluation of indirect impacts to salmonids due to destruction of riparian vegetation and reduction of available cover was made by considering impacts to terrestrial and aquatic plants. Aquatic plant RQs for accidental direct spray scenarios were above the plant LOC at both the typical and maximum application rates, indicating the potential for a reduction in the aquatic plant community. However, this is an extremely conservative scenario in which it is assumed that a stream is accidentally directly sprayed by a terrestrial herbicide, and in which no reduction in herbicide concentration is calculated as a result of stream flow. However, there is the potential for indirect impacts to salmonids due to a reduction in available cover if the stream is accidentally sprayed.

No elevated aquatic plant RQs were observed resulting from off-site drift to the stream. Acute RQs in excess of the LOC were observed for aquatic plant species in the stream for selected surface runoff scenarios at the maximum

application rate, most strongly within sandy watersheds. No chronic RQs were elevated in the surface runoff scenarios. These results indicate the potential for a reduction in cover due to surface runoff when the herbicide is applied at the maximum rate.

Although not specifically evaluated in the stream scenarios of the ERA, terrestrial plants were evaluated for their potential to provide overhanging cover for salmonids. A reduction in the riparian cover has the potential to indirectly impact salmonids within the stream. RQs for terrestrial plants were elevated above the LOC for accidental direct spray scenarios at both the typical and maximum application rates, indicating the potential for a reduction in this plant community. However, this scenario represents a worst-case scenario in which the riparian zone is directly sprayed with the terrestrial herbicide

RQs for typical terrestrial plants were also observed above the plant LOC (ranging from 1.11 to 2.20) as a result of off-site drift 25 ft from the ground application of the herbicide at the maximum rate using a low or a high boom. Elevated RQs at the typical application rate were observed for RTE species at 25 ft from the ground application using a high boom. Elevated RQs at the maximum application rate were observed for RTE species at 25 ft from the ground application using a low or a high boom, and 100 ft from the ground application using a high boom. These results indicate the potential for a reduction in riparian cover under selected conditions.

No RQs in excess of the LOC were observed for typical terrestrial plant species for any of the surface runoff scenarios. Elevated RQs were observed for RTE terrestrial plant species in 4 of 42 scenarios at the typical application rate and 8 of 42 scenarios at the maximum application rate. These results indicate the potential for a reduction in riparian cover under selected conditions.

4.3.6.3 Conclusions

This qualitative evaluation indicates that salmonids are not likely to be indirectly impacted by a reduction in food supply (i.e., fish and aquatic invertebrates). However, a reduction in vegetative cover may occur under limited conditions. Accidental direct spray, off-site drift, and surface runoff may negatively impact terrestrial and/or aquatic plants, reducing the cover available to salmonids within the stream. However, increasing the buffer zone, reducing the application rate and avoidance of accidental application on non-target areas would reduce the likelihood of these impacts.

In addition, the effects of terrestrial herbicides in water are expected to be relatively transient and stream flow is likely to reduce herbicide concentrations over time. In a review of potential impacts of another terrestrial herbicide to threatened and endangered salmonids, USEPA OPP indicated that “for most pesticides applied to terrestrial environment, the effects in water, even lentic water, will be relatively transient” (Turner 2003). Only very persistent pesticides would be expected to have effects beyond the year of their application. The OPP report indicated that if a listed salmonid is not present during the year of application, there would likely be no concern (Turner 2003). Therefore, it is expected that potential adverse impacts to food and cover would not occur beyond the season of application (except for cover provided by impacted riparian plants).

TABLE 4-1
Levels of Concern

Risk Presumption		RQ	LOC
Terrestrial Animals [1]			
Birds	Acute High Risk	EEC/LC_{50}	0.5
	Acute Restricted Use	EEC/LC_{50}	0.2
	Acute Endangered Species	EEC/LC_{50}	0.1
	Chronic Risk	EEC/NOAEL	1
Wild Mammals	Acute High Risk	EEC/LC_{50}	0.5
	Acute Restricted Use	EEC/LC_{50}	0.2
	Acute Endangered Species	EEC/LC_{50}	0.1
	Chronic Risk	EEC/NOAEL	1
Aquatic Animals [2]			
Fish and Aquatic Invertebrates	Acute High 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/NOAEL	1
	Chronic Risk, Endangered Species	EEC/NOAEL	0.5
Plants [3]			
Terrestrial/semi-aquatic Plants	Acute High Risk	EEC/EC_{25}	1
	Acute Endangered Species	EEC/NOAEL	1
Aquatic Plants	Acute High Risk	EEC/EC_{50}	1
	Acute Endangered Species	EEC/NOAEL	1

[1] Estimated Environmental Concentration (EEC) is in mg prey/kg body weight for acute scenarios and mg prey/kg body weight/day for chronic scenarios.
[2] EEC is in mg/L.
[3] EEC is in lbs/ac.

TABLE 4-2
Risk Quotients for Direct Spray and Spill Scenarios

Terrestrial Animals	Typical Application Rate	Maximum Application Rate
Direct Spray of Terrestrial Wildlife		
Small mammal - 100% absorption	6.51E-04	5.21E-03
Pollinating insect - 100% absorption	**2.45E-01**	**1.96E+00**
Small mammal - 1st order dermal adsorption	6.38E-05	5.10E-04
Indirect Contact With Foliage After Direct Spray		
Small mammal - 100% absorption	6.51E-05	5.21E-04
Pollinating insect - 100% absorption	2.45E-02	**1.96E-01**
Small mammal - 1st order dermal adsorption	6.38E-06	5.10E-05
Ingestion of Food Items Contaminated by Direct Spray		
Small mammalian herbivore - acute exposure	3.09E-02	**1.86E+00**
Small mammalian herbivore - chronic exposure	5.93E-02	**3.58E+00**
Large mammalian herbivore - acute exposure	5.05E-03	**2.21E-01**
Large mammalian herbivore - chronic exposure	8.66E-02	**3.79E+00**
Small avian insectivore - acute exposure	6.61E-04	4.11E-02
Small avian insectivore - chronic exposure	4.17E-03	2.60E-01
Large avian herbivore - acute exposure	1.69E-03	**1.14E-01**
Large avian herbivore - chronic exposure	1.81E-03	1.22E-01
Large mammalian carnivore - acute exposure	3.29E-03	2.63E-02
Large mammalian carnivore - chronic exposure	1.26E-02	1.01E-01

TABLE 4-2 (Cont.)
Risk Quotients for Direct Spray and Spill Scenarios

Terrestrial Plants	Typical Species		Rare, Threatened, and Endangered Species	
	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Direct Spray of Non-Target Terrestrial Plants				
Accidental direct spray	**1.67E+01**	**1.33E+02**	**5.00E+01**	**4.00E+02**

Aquatic Species	Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Accidental Direct Spray Over Pond						
Acute	5.00E-04	4.00E-03	1.89E-04	1.51E-03	**1.12E+00**	**8.97E+00**
Chronic	6.03E-03	4.82E-02	**5.60E-01**	**4.48E+00**	**4.31E+00**	**3.45E+01**
Accidental Direct Spray Over Stream						
Acute	2.50E-03	2.00E-02	9.43E-04	7.55E-03	**5.60E+00**	**4.48E+01**
Chronic	3.01E-02	2.41E-01	**2.80E+00**	**2.24E+01**	**2.16E+01**	**1.72E+02**
Accidental spill						
Truck spill into pond	--	**1.28E-01**	--	4.83E-02	--	**2.87E+02**
Helicopter spill into pond	--	**5.20E-01**	--	**1.96E-01**	--	**1.17E+03**

Shading and boldface indicates plant RQs greater than 1 (LOC for all plant risks).
Shading and boldface indicates acute RQs greater than 0.05 for fish and invertebrates (LOC for acute risk to endangered species - most conservative).
Shading and boldface indicates chronic RQs greater than 0.5 for fish and invertebrates (LOC for chronic risk to endangered species).
RTE – Rare, threatened, and endangered.
-- indicates the scenario was not evaluated.

TABLE 4-3
Risk Quotients for Off-Site Drift Scenarios

Potential Risk to Non-Target Terrestrial Plants						
			Typical Species		RTE Species	
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Spray Drift to Off-Site Soil						
Ground	Low Boom	25	2.10E-01	**1.11E+00**	6.30E-01	**3.33E+00**
Ground	Low Boom	100	7.33E-02	3.20E-01	2.20E-01	9.60E-01
Ground	Low Boom	900	1.00E-02	4.00E-02	3.00E-02	1.20E-01
Ground	High Boom	25	3.47E-01	**2.20E+00**	**1.04E+00**	**6.59E+00**
Ground	High Boom	100	1.17E-01	5.90E-01	3.50E-01	**1.77E+00**
Ground	High Boom	900	1.33E-02	5.67E-02	4.00E-02	1.70E-01

TABLE 4-3 (Cont.)
Risk Quotients for Off-Site Drift Scenarios

Potential Risk to Aquatic Receptors								
			Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Off-Site Drift to Pond								
Acute Toxicity								
Ground	Low Boom	25	3.04E-06	1.41E-05	1.15E-06	5.32E-06	6.82E-03	3.16E-02
Ground	Low Boom	100	1.67E-06	7.01E-06	6.30E-07	2.64E-06	3.74E-03	1.57E-02
Ground	Low Boom	900	3.22E-07	1.17E-06	1.22E-07	4.41E-07	7.22E-04	2.62E-03
Ground	High Boom	25	4.88E-06	2.68E-05	1.84E-06	1.01E-05	1.09E-02	6.00E-02
Ground	High Boom	100	2.57E-06	1.25E-05	9.70E-07	4.71E-06	5.76E-03	2.80E-02
Ground	High Boom	900	4.09E-07	1.56E-06	1.54E-07	5.89E-07	9.16E-04	3.50E-03
Chronic Toxicity								
Ground	Low Boom	25	3.67E-05	1.70E-04	3.41E-03	1.58E-02	2.62E-02	1.22E-01
Ground	Low Boom	100	2.01E-05	8.44E-05	1.87E-03	7.85E-03	1.44E-02	6.04E-02
Ground	Low Boom	900	3.88E-06	1.41E-05	3.61E-04	1.31E-03	2.78E-03	1.01E-02
Ground	High Boom	25	5.88E-05	3.23E-04	5.47E-03	3.00E-02	4.21E-02	2.31E-01
Ground	High Boom	100	3.10E-05	1.51E-04	2.88E-03	1.40E-02	2.22E-02	1.08E-01
Ground	High Boom	900	4.92E-06	1.88E-05	4.58E-04	1.75E-03	3.52E-03	1.35E-02

TABLE 4-3 (Cont.)
Risk Quotients for Off-Site Drift Scenarios

Potential Risk to Aquatic Receptors								
			Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Off-Site Drift to Stream								
Acute Toxicity								
Ground	Low Boom	25	5.48E-06	4.38E-05	2.06E-06	1.65E-05	1.23E-02	9.81E-02
Ground	Low Boom	100	1.60E-06	1.28E-05	6.05E-07	4.84E-06	3.59E-03	2.87E-02
Ground	Low Boom	900	1.66E-07	1.33E-06	6.26E-08	5.01E-07	3.72E-04	2.98E-03
Ground	High Boom	25	9.17E-06	7.34E-05	3.46E-06	2.77E-05	2.05E-02	1.64E-01
Ground	High Boom	100	2.60E-06	2.08E-05	9.79E-07	7.84E-06	5.82E-03	4.65E-02
Ground	High Boom	900	2.20E-07	1.76E-06	8.28E-08	6.62E-07	4.92E-04	3.93E-03
Chronic Toxicity								
Ground	Low Boom	25	6.59E-05	5.28E-04	6.13E-03	4.91E-02	4.72E-02	3.77E-01
Ground	Low Boom	100	1.93E-05	1.55E-04	1.80E-03	1.44E-02	1.38E-02	1.11E-01
Ground	Low Boom	900	2.00E-06	1.60E-05	1.86E-04	1.49E-03	1.43E-03	1.14E-02
Ground	High Boom	25	1.10E-04	8.84E-04	1.03E-02	8.22E-02	7.90E-02	6.32E-01
Ground	High Boom	100	3.13E-05	2.50E-04	2.91E-03	2.33E-02	2.24E-02	1.79E-01
Ground	High Boom	900	2.64E-06	2.12E-05	2.46E-04	1.97E-03	1.89E-03	1.51E-02

TABLE 4-3 (Cont.)
Risk Quotients for Off-Site Drift Scenarios

Potential Risk to Piscivorous Bird from Ingestion of Fish from Contaminated Pond				
Mode of Application	**Application Height or Type**	**Distance From Receptor (ft)**	**Typical Application Rate**	**Maximum Application Rate**
Ground	Low Boom	25	7.09E-08	3.29E-07
Ground	Low Boom	100	3.89E-08	1.63E-07
Ground	Low Boom	900	7.51E-09	2.72E-08
Ground	High Boom	25	1.14E-07	6.24E-07
Ground	High Boom	100	5.99E-08	2.91E-07
Ground	High Boom	900	9.52E-09	3.64E-08

Shading and boldface indicates plant RQs greater than 1 (LOC for all plant risks).
Shading and boldface indicates acute RQs greater than 0.05 for fish and invertebrates (LOC for acute risk to endangered species - most conservative).
Shading and boldface indicates chronic RQs greater than 0.5 for fish and invertebrates (LOC for chronic risk to endangered species).Shading and boldface indicates terrestrial animal acute scenario RQs greater than 0.1 (LOC for acute risk to endangered species - most conservative).
Shading and boldface indicates terrestrial animal chronic scenario RQs greater than 1 (LOC for chronic risk).

TABLE 4-4
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Non-Target Terrestrial Plants										
							Typical Species		RTE Species	
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Surface Runoff to Off-Site Soils										
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.09E-05	8.75E-05	6.56E-03	5.25E-02
10	10	0.05	0.015	0.401	Weeds (78)	Loam	5.81E-08	4.65E-07	3.49E-05	2.79E-04
25	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
25	10	0.05	0.015	0.401	Weeds (78)	Clay	1.43E-04	1.15E-03	8.60E-02	6.88E-01
25	10	0.05	0.015	0.401	Weeds (78)	Loam	1.73E-07	1.39E-06	1.04E-04	8.33E-04
50	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
50	10	0.05	0.015	0.401	Weeds (78)	Clay	8.29E-04	6.63E-03	4.97E-01	**3.98E+00**
50	10	0.05	0.015	0.401	Weeds (78)	Loam	2.62E-05	2.10E-04	1.57E-02	1.26E-01
100	10	0.05	0.015	0.401	Weeds (78)	Sand	1.06E-11	8.50E-11	6.37E-09	5.10E-08
100	10	0.05	0.015	0.401	Weeds (78)	Clay	2.12E-03	1.69E-02	**1.27E+00**	**1.02E+01**
100	10	0.05	0.015	0.401	Weeds (78)	Loam	3.48E-05	2.79E-04	2.09E-02	1.67E-01
150	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
150	10	0.05	0.015	0.401	Weeds (78)	Clay	2.39E-03	1.91E-02	**1.43E+00**	**1.15E+01**
150	10	0.05	0.015	0.401	Weeds (78)	Loam	3.46E-05	2.77E-04	2.08E-02	1.66E-01
200	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
200	10	0.05	0.015	0.401	Weeds (78)	Clay	2.29E-03	1.83E-02	**1.37E+00**	**1.10E+01**
200	10	0.05	0.015	0.401	Weeds (78)	Loam	2.55E-05	2.04E-04	1.53E-02	1.23E-01

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Non-Target Terrestrial Plants										
							Typical Species		RTE Species	
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Surface Runoff to Off-Site Soils										
250	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
250	10	0.05	0.015	0.401	Weeds (78)	Clay	2.06E-03	1.65E-02	**1.24E+00**	**9.89E+00**
250	10	0.05	0.015	0.401	Weeds (78)	Loam	1.74E-05	1.40E-04	1.05E-02	8.37E-02
50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.57E-05	2.06E-04	1.54E-02	1.24E-01
50	100	0.05	0.015	0.401	Weeds (78)	Loam	2.57E-05	2.06E-04	1.54E-02	1.24E-01
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	2.57E-05	2.06E-04	1.54E-02	1.23E-01
50	10	0.05	0.015	0.05	Weeds (78)	Loam	2.57E-05	2.05E-04	1.54E-02	1.23E-01
50	10	0.05	0.015	0.2	Weeds (78)	Loam	2.58E-05	2.06E-04	1.55E-02	1.24E-01
50	10	0.05	0.015	0.5	Weeds (78)	Loam	2.61E-05	2.09E-04	1.57E-02	1.25E-01
50	10	0.05	0.023	0.401	Weeds (78)	Loam	2.58E-05	2.06E-04	1.55E-02	1.24E-01
50	10	0.05	0.046	0.401	Weeds (78)	Loam	2.57E-05	2.06E-04	1.54E-02	1.24E-01
50	10	0.05	0.15	0.401	Weeds (78)	Loam	2.56E-05	2.05E-04	1.54E-02	1.23E-01
50	10	0.005	0.015	0.401	Weeds (78)	Loam	2.56E-05	2.05E-04	1.54E-02	1.23E-01
50	10	0.01	0.015	0.401	Weeds (78)	Loam	2.57E-05	2.05E-04	1.54E-02	1.23E-01
50	10	0.1	0.015	0.401	Weeds (78)	Loam	2.60E-05	2.08E-04	1.56E-02	1.25E-01
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	2.92E-04	2.33E-03	1.75E-01	**1.40E+00**
50	10	0.05	0.015	0.401	Weeds (78)	Silt	2.78E-04	2.23E-03	1.67E-01	**1.34E+00**
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	7.13E-04	5.70E-03	4.28E-01	**3.42E+00**
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	2.58E-05	2.06E-04	1.55E-02	1.24E-01
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	2.58E-05	2.06E-04	1.55E-02	1.24E-01
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	3.39E-05	2.71E-04	2.04E-02	1.63E-01

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Aquatic Receptors												
							Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Surface Runoff to Off-Site Pond												
Acute Toxicity												
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	1.26E-03	1.01E-02	4.76E-04	3.81E-03	**2.83E+00**	**2.26E+01**
10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.80E-05	1.44E-04	6.78E-06	5.42E-05	4.03E-02	3.22E-01
10	10	0.05	0.015	0.401	Weeds (78)	Loam	2.10E-06	1.68E-05	7.92E-07	6.34E-06	4.71E-03	3.76E-02
25	10	0.05	0.015	0.401	Weeds (78)	Sand	1.57E-04	1.26E-03	5.93E-05	4.74E-04	3.52E-01	**2.82E+00**
25	10	0.05	0.015	0.401	Weeds (78)	Clay	3.33E-04	2.66E-03	1.26E-04	1.00E-03	7.46E-01	**5.97E+00**
25	10	0.05	0.015	0.401	Weeds (78)	Loam	3.29E-04	2.63E-03	1.24E-04	9.91E-04	7.36E-01	**5.89E+00**
50	10	0.05	0.015	0.401	Weeds (78)	Sand	9.10E-04	7.28E-03	3.43E-04	2.75E-03	**2.04E+00**	**1.63E+01**
50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.15E-03	9.17E-03	4.32E-04	3.46E-03	**2.57E+00**	**2.05E+01**
50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.53E-04	1.22E-03	5.76E-05	4.61E-04	3.42E-01	**2.74E+00**
100	10	0.05	0.015	0.401	Weeds (78)	Sand	8.84E-04	7.08E-03	3.34E-04	2.67E-03	**1.98E+00**	**1.58E+01**
100	10	0.05	0.015	0.401	Weeds (78)	Clay	5.92E-04	4.74E-03	2.23E-04	1.79E-03	**1.33E+00**	**1.06E+01**
100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.22E-04	9.75E-04	4.60E-05	3.68E-04	2.73E-01	**2.18E+00**
150	10	0.05	0.015	0.401	Weeds (78)	Sand	8.06E-04	6.45E-03	3.04E-04	2.43E-03	**1.81E+00**	**1.44E+01**
150	10	0.05	0.015	0.401	Weeds (78)	Clay	2.59E-04	2.07E-03	9.77E-05	7.82E-04	5.80E-01	**4.64E+00**
150	10	0.05	0.015	0.401	Weeds (78)	Loam	2.38E-04	1.90E-03	8.97E-05	7.18E-04	5.33E-01	**4.26E+00**
200	10	0.05	0.015	0.401	Weeds (78)	Sand	7.29E-04	5.84E-03	2.75E-04	2.20E-03	**1.63E+00**	**1.31E+01**
200	10	0.05	0.015	0.401	Weeds (78)	Clay	2.76E-04	2.21E-03	1.04E-04	8.32E-04	6.18E-01	**4.94E+00**
200	10	0.05	0.015	0.401	Weeds (78)	Loam	2.61E-04	2.09E-03	9.85E-05	7.88E-04	5.85E-01	**4.68E+00**
250	10	0.05	0.015	0.401	Weeds (78)	Sand	7.24E-04	5.79E-03	2.73E-04	2.18E-03	**1.62E+00**	**1.30E+01**
250	10	0.05	0.015	0.401	Weeds (78)	Clay	3.67E-04	2.93E-03	1.38E-04	1.11E-03	8.21E-01	**6.57E+00**

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Aquatic Receptors												
							Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Surface Runoff to Off-Site Pond Acute Toxicity												
250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.64E-04	2.11E-03	9.96E-05	7.97E-04	5.92E-01	**4.74E+00**
50	1	0.05	0.015	0.401	Weeds (78)	Loam	1.07E-04	8.59E-04	4.05E-05	3.24E-04	2.41E-01	**1.92E+00**
50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.64E-04	1.31E-03	6.19E-05	4.95E-04	3.68E-01	**2.94E+00**
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	1.85E-04	1.48E-03	6.99E-05	5.59E-04	4.15E-01	**3.32E+00**
50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.53E-04	1.22E-03	5.76E-05	4.61E-04	3.42E-01	**2.74E+00**
50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.53E-04	1.22E-03	5.76E-05	4.61E-04	3.42E-01	**2.74E+00**
50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.53E-04	1.22E-03	5.76E-05	4.61E-04	3.42E-01	**2.74E+00**
50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.53E-04	1.22E-03	5.76E-05	4.61E-04	3.42E-01	**2.74E+00**
50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.53E-04	1.22E-03	5.76E-05	4.61E-04	3.42E-01	**2.74E+00**
50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.53E-04	1.22E-03	5.76E-05	4.61E-04	3.42E-01	**2.74E+00**
50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.53E-04	1.22E-03	5.76E-05	4.61E-04	3.42E-01	**2.74E+00**
50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.53E-04	1.22E-03	5.76E-05	4.61E-04	3.42E-01	**2.74E+00**
50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.53E-04	1.22E-03	5.76E-05	4.61E-04	3.42E-01	**2.74E+00**
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	3.78E-04	3.02E-03	1.42E-04	1.14E-03	8.46E-01	**6.77E+00**
50	10	0.05	0.015	0.401	Weeds (78)	Silt	3.35E-04	2.68E-03	1.26E-04	1.01E-03	7.51E-01	**6.01E+00**
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	6.59E-04	5.27E-03	2.48E-04	1.99E-03	**1.48E+00**	**1.18E+01**
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.53E-04	1.22E-03	5.76E-05	4.61E-04	3.42E-01	**2.74E+00**
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.53E-04	1.22E-03	5.76E-05	4.61E-04	3.42E-01	**2.74E+00**
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	9.98E-05	7.99E-04	3.76E-05	3.01E-04	2.24E-01	**1.79E+00**

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

							Potential Risk to Aquatic Receptors					
							Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Surface Runoff to Off-Site Pond Chronic Toxicity												
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	1.37E-02	1.10E-01	**1.28E+00**	**1.02E+01**	**9.82E+00**	**7.86E+01**
10	10	0.05	0.015	0.401	Weeds (78)	Clay	3.81E-05	3.05E-04	3.54E-03	2.83E-02	2.73E-02	2.18E-01
10	10	0.05	0.015	0.401	Weeds (78)	Loam	2.22E-05	1.77E-04	2.06E-03	1.65E-02	1.59E-02	1.27E-01
25	10	0.05	0.015	0.401	Weeds (78)	Sand	4.39E-04	3.51E-03	4.08E-02	3.26E-01	3.14E-01	**2.51E+00**
25	10	0.05	0.015	0.401	Weeds (78)	Clay	1.83E-03	1.47E-02	1.70E-01	**1.36E+00**	**1.31E+00**	**1.05E+01**
25	10	0.05	0.015	0.401	Weeds (78)	Loam	3.67E-03	2.93E-02	3.41E-01	**2.73E+00**	**2.62E+00**	**2.10E+01**
50	10	0.05	0.015	0.401	Weeds (78)	Sand	2.33E-03	1.86E-02	2.16E-01	**1.73E+00**	3.14E-01	**1.33E+01**
50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.86E-03	1.49E-02	1.73E-01	**1.39E+00**	**1.33E+00**	**1.07E+01**
50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.18E-03	9.46E-03	1.10E-01	**8.80E-01**	8.46E-01	**6.77E+00**
100	10	0.05	0.015	0.401	Weeds (78)	Sand	4.38E-03	3.51E-02	4.08E-01	**3.26E+00**	**3.14E+00**	**2.51E+01**
100	10	0.05	0.015	0.401	Weeds (78)	Clay	1.02E-03	8.18E-03	9.52E-02	**7.61E-01**	7.32E-01	**5.86E+00**
100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.78E-04	1.42E-03	1.66E-02	1.33E-01	1.27E-01	**1.02E+00**
150	10	0.05	0.015	0.401	Weeds (78)	Sand	3.31E-03	2.65E-02	3.08E-01	**2.47E+00**	**2.37E+00**	**1.90E+01**
150	10	0.05	0.015	0.401	Weeds (78)	Clay	7.79E-04	6.23E-03	7.25E-02	**5.80E-01**	5.57E-01	**4.46E+00**
150	10	0.05	0.015	0.401	Weeds (78)	Loam	4.69E-04	3.75E-03	4.36E-02	3.49E-01	3.35E-01	**2.68E+00**
200	10	0.05	0.015	0.401	Weeds (78)	Sand	2.10E-03	1.68E-02	1.95E-01	**1.56E+00**	**1.50E+00**	**1.20E+01**
200	10	0.05	0.015	0.401	Weeds (78)	Clay	6.63E-04	5.30E-03	6.17E-02	4.93E-01	4.74E-01	**3.79E+00**
200	10	0.05	0.015	0.401	Weeds (78)	Loam	7.06E-04	5.65E-03	6.57E-02	**5.26E-01**	5.05E-01	**4.04E+00**
250	10	0.05	0.015	0.401	Weeds (78)	Sand	1.29E-03	1.04E-02	1.20E-01	**9.63E-01**	9.26E-01	**7.41E+00**
250	10	0.05	0.015	0.401	Weeds (78)	Clay	5.91E-04	4.73E-03	5.50E-02	4.40E-01	4.23E-01	**3.38E+00**

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Aquatic Receptors												
							Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Surface Runoff to Off-Site Pond Chronic Toxicity												
250	10	0.05	0.015	0.401	Weeds (78)	Loam	8.52E-04	6.81E-03	7.92E-02	**6.34E-01**	6.09E-01	**4.87E+00**
50	1	0.05	0.015	0.401	Weeds (78)	Loam	1.13E-03	9.03E-03	1.05E-01	**8.40E-01**	8.08E-01	**6.46E+00**
50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.21E-03	9.67E-03	1.12E-01	**8.99E-01**	8.65E-01	**6.92E+00**
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	1.21E-03	9.71E-03	1.13E-01	**9.03E-01**	8.68E-01	**6.95E+00**
50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.18E-03	9.45E-03	1.10E-01	**8.79E-01**	8.45E-01	**6.76E+00**
50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.18E-03	9.46E-03	1.10E-01	**8.80E-01**	8.46E-01	**6.77E+00**
50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.18E-03	9.46E-03	1.10E-01	**8.80E-01**	8.46E-01	**6.77E+00**
50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.18E-03	9.46E-03	1.10E-01	**8.80E-01**	8.46E-01	**6.77E+00**
50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.18E-03	9.45E-03	1.10E-01	**8.79E-01**	8.45E-01	**6.76E+00**
50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.18E-03	9.45E-03	1.10E-01	**8.79E-01**	8.45E-01	**6.76E+00**
50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.18E-03	9.45E-03	1.10E-01	**8.79E-01**	8.45E-01	**6.76E+00**
50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.18E-03	9.45E-03	1.10E-01	**8.79E-01**	8.45E-01	**6.76E+00**
50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.18E-03	9.46E-03	1.10E-01	**8.80E-01**	8.46E-01	**6.77E+00**
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.96E-03	1.57E-02	1.82E-01	**1.46E+00**	**1.40E+00**	**1.12E+01**
50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.73E-03	1.39E-02	1.61E-01	**1.29E+00**	**1.24E+00**	**9.93E+00**
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	1.83E-03	1.47E-02	1.70E-01	**1.36E+00**	**1.31E+00**	**1.05E+01**
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.18E-03	9.46E-03	1.10E-01	**8.80E-01**	8.46E-01	**6.77E+00**
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.18E-03	9.46E-03	1.10E-01	**8.80E-01**	8.46E-01	**6.77E+00**
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	6.66E-04	5.33E-03	6.20E-02	4.96E-01	4.77E-01	**3.81E+00**

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

							Potential Risk to Aquatic Receptors					
							Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Surface Runoff to Off-Site Stream Acute Toxicity												
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	5.03E-05	4.03E-04	1.90E-05	1.52E-04	1.13E-01	9.02E-01
10	10	0.05	0.015	0.401	Weeds (78)	Clay	5.80E-07	4.64E-06	2.19E-07	1.75E-06	1.30E-03	1.04E-02
10	10	0.05	0.015	0.401	Weeds (78)	Loam	4.58E-08	3.67E-07	1.73E-08	1.38E-07	1.03E-04	8.22E-04
25	10	0.05	0.015	0.401	Weeds (78)	Sand	6.44E-06	5.15E-05	2.43E-06	1.94E-05	1.44E-02	1.15E-01
25	10	0.05	0.015	0.401	Weeds (78)	Clay	7.79E-06	6.23E-05	2.94E-06	2.35E-05	1.75E-02	1.40E-01
25	10	0.05	0.015	0.401	Weeds (78)	Loam	2.46E-05	1.96E-04	9.26E-06	7.41E-05	5.50E-02	4.40E-01
50	10	0.05	0.015	0.401	Weeds (78)	Sand	7.52E-05	6.01E-04	2.84E-05	2.27E-04	1.68E-01	**1.35E+00**
50	10	0.05	0.015	0.401	Weeds (78)	Clay	4.06E-05	3.25E-04	1.53E-05	1.23E-04	9.10E-02	7.28E-01
50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.67E-05	1.34E-04	6.31E-06	5.05E-05	3.75E-02	3.00E-01
100	10	0.05	0.015	0.401	Weeds (78)	Sand	5.74E-05	4.59E-04	2.16E-05	1.73E-04	1.29E-01	**1.03E+00**
100	10	0.05	0.015	0.401	Weeds (78)	Clay	8.29E-05	6.64E-04	3.13E-05	2.50E-04	1.86E-01	**1.49E+00**
100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.18E-05	9.41E-05	4.43E-06	3.55E-05	2.63E-02	2.11E-01
150	10	0.05	0.015	0.401	Weeds (78)	Sand	1.04E-04	8.34E-04	3.93E-05	3.15E-04	2.34E-01	**1.87E+00**
150	10	0.05	0.015	0.401	Weeds (78)	Clay	7.71E-05	6.16E-04	2.91E-05	2.32E-04	1.73E-01	**1.38E+00**
150	10	0.05	0.015	0.401	Weeds (78)	Loam	2.57E-05	2.06E-04	9.70E-06	7.76E-05	5.76E-02	4.61E-01
200	10	0.05	0.015	0.401	Weeds (78)	Sand	1.19E-04	9.54E-04	4.49E-05	3.60E-04	2.67E-01	**2.14E+00**
200	10	0.05	0.015	0.401	Weeds (78)	Clay	6.39E-05	5.11E-04	2.41E-05	1.93E-04	1.43E-01	**1.15E+00**
200	10	0.05	0.015	0.401	Weeds (78)	Loam	3.08E-05	2.47E-04	1.16E-05	9.30E-05	6.90E-02	5.52E-01
250	10	0.05	0.015	0.401	Weeds (78)	Sand	1.16E-04	9.27E-04	4.37E-05	3.49E-04	2.60E-01	**2.08E+00**
250	10	0.05	0.015	0.401	Weeds (78)	Clay	5.21E-05	4.17E-04	1.96E-05	1.57E-04	1.17E-01	9.34E-01

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

							Potential Risk to Aquatic Receptors					
							Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Surface Runoff to Off-Site Stream Acute Toxicity												
250	10	0.05	0.015	0.401	Weeds (78)	Loam	3.18E-05	2.54E-04	1.20E-05	9.60E-05	7.13E-02	5.70E-01
50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.36E-06	1.88E-05	8.88E-07	7.11E-06	5.28E-03	4.22E-02
50	100	0.05	0.015	0.401	Weeds (78)	Loam	6.05E-05	4.84E-04	2.28E-05	1.83E-04	1.36E-01	**1.08E+00**
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	1.28E-04	1.02E-03	4.83E-05	3.86E-04	2.87E-01	**2.30E+00**
50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.67E-05	1.34E-04	6.31E-06	5.05E-05	3.75E-02	3.00E-01
50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.67E-05	1.34E-04	6.31E-06	5.05E-05	3.75E-02	3.00E-01
50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.67E-05	1.34E-04	6.31E-06	5.05E-05	3.75E-02	3.00E-01
50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.67E-05	1.34E-04	6.31E-06	5.05E-05	3.75E-02	3.00E-01
50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.67E-05	1.34E-04	6.31E-06	5.05E-05	3.75E-02	3.00E-01
50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.67E-05	1.34E-04	6.31E-06	5.05E-05	3.75E-02	3.00E-01
50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.67E-05	1.34E-04	6.31E-06	5.05E-05	3.75E-02	3.00E-01
50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.67E-05	1.34E-04	6.31E-06	5.05E-05	3.75E-02	3.00E-01
50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.67E-05	1.34E-04	6.31E-06	5.05E-05	3.75E-02	3.00E-01
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	2.00E-05	1.60E-04	7.55E-06	6.04E-05	4.49E-02	3.59E-01
50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.91E-05	1.53E-04	7.22E-06	5.77E-05	4.29E-02	3.43E-01
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	3.78E-05	3.02E-04	1.43E-05	1.14E-04	8.47E-02	6.77E-01
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.67E-05	1.34E-04	6.31E-06	5.05E-05	3.75E-02	3.00E-01
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.67E-05	1.34E-04	6.31E-06	5.05E-05	3.75E-02	3.00E-01
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	1.13E-05	9.04E-05	4.26E-06	3.41E-05	2.53E-02	2.03E-01

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

							Potential Risk to Aquatic Receptors					
							Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Surface Runoff to Off-Site Stream Chronic Toxicity												
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	8.58E-06	6.86E-05	7.98E-04	6.38E-03	6.14E-03	4.91E-02
10	10	0.05	0.015	0.401	Weeds (78)	Clay	5.88E-08	4.70E-07	5.47E-06	4.37E-05	4.20E-05	3.36E-04
10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.10E-08	8.83E-08	1.03E-06	8.21E-06	7.89E-06	6.31E-05
25	10	0.05	0.015	0.401	Weeds (78)	Sand	2.28E-06	1.82E-05	2.12E-04	1.70E-03	1.63E-03	1.30E-02
25	10	0.05	0.015	0.401	Weeds (78)	Clay	4.67E-06	3.74E-05	4.34E-04	3.48E-03	3.34E-03	2.67E-02
25	10	0.05	0.015	0.401	Weeds (78)	Loam	1.10E-05	8.81E-05	1.02E-03	8.19E-03	7.88E-03	6.30E-02
50	10	0.05	0.015	0.401	Weeds (78)	Sand	2.52E-05	2.01E-04	2.34E-03	1.87E-02	1.80E-02	1.44E-01
50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.53E-05	1.22E-04	1.42E-03	1.14E-02	1.09E-02	8.75E-02
50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.01E-05	8.08E-05	9.40E-04	7.52E-03	7.23E-03	5.78E-02
100	10	0.05	0.015	0.401	Weeds (78)	Sand	4.82E-05	3.86E-04	4.48E-03	3.59E-02	3.45E-02	2.76E-01
100	10	0.05	0.015	0.401	Weeds (78)	Clay	2.06E-05	1.65E-04	1.92E-03	1.54E-02	1.48E-02	1.18E-01
100	10	0.05	0.015	0.401	Weeds (78)	Loam	3.76E-06	3.01E-05	3.50E-04	2.80E-03	2.69E-03	2.15E-02
150	10	0.05	0.015	0.401	Weeds (78)	Sand	4.73E-05	3.78E-04	4.40E-03	3.52E-02	3.38E-02	2.71E-01
150	10	0.05	0.015	0.401	Weeds (78)	Clay	2.01E-05	1.61E-04	1.87E-03	1.50E-02	1.44E-02	1.15E-01
150	10	0.05	0.015	0.401	Weeds (78)	Loam	1.18E-05	9.40E-05	1.09E-03	8.74E-03	8.41E-03	6.73E-02
200	10	0.05	0.015	0.401	Weeds (78)	Sand	4.46E-05	3.57E-04	4.15E-03	3.32E-02	3.19E-02	2.55E-01
200	10	0.05	0.015	0.401	Weeds (78)	Clay	1.88E-05	1.50E-04	1.75E-03	1.40E-02	1.35E-02	1.08E-01
200	10	0.05	0.015	0.401	Weeds (78)	Loam	2.00E-05	1.60E-04	1.86E-03	1.49E-02	1.43E-02	1.14E-01
250	10	0.05	0.015	0.401	Weeds (78)	Sand	4.18E-05	3.35E-04	3.89E-03	3.11E-02	2.99E-02	2.39E-01
250	10	0.05	0.015	0.401	Weeds (78)	Clay	1.78E-05	1.42E-04	1.65E-03	1.32E-02	1.27E-02	1.02E-01

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

							Potential Risk to Aquatic Receptors					
							Fish		Aquatic Invertebrates		Non-Target Aquatic Plants	
Annual Precipitation Rate (in/yr)	Application Area (ac)	Hydraulic Slope	Surface Roughness	USLE Soil Erodibility Factor[1]	Vegetation Type	Soil Type	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Surface Runoff to Off-Site Stream Chronic Toxicity												
250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.61E-05	2.09E-04	2.42E-03	1.94E-02	1.87E-02	1.49E-01
50	1	0.05	0.015	0.401	Weeds (78)	Loam	1.15E-06	9.17E-06	1.07E-04	8.53E-04	8.20E-04	6.56E-03
50	100	0.05	0.015	0.401	Weeds (78)	Loam	5.90E-05	4.72E-04	5.49E-03	4.39E-02	4.22E-02	3.38E-01
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	1.59E-04	1.27E-03	1.48E-02	1.18E-01	1.14E-01	9.10E-01
50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.01E-05	8.08E-05	9.39E-04	7.51E-03	7.22E-03	5.78E-02
50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.01E-05	8.08E-05	9.39E-04	7.51E-03	7.22E-03	5.78E-02
50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.01E-05	8.08E-05	9.39E-04	7.51E-03	7.22E-03	5.78E-02
50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.01E-05	8.08E-05	9.39E-04	7.51E-03	7.22E-03	5.78E-02
50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.01E-05	8.08E-05	9.39E-04	7.51E-03	7.22E-03	5.78E-02
50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.01E-05	8.08E-05	9.39E-04	7.51E-03	7.22E-03	5.78E-02
50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.01E-05	8.08E-05	9.39E-04	7.51E-03	7.22E-03	5.78E-02
50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.01E-05	8.08E-05	9.39E-04	7.51E-03	7.22E-03	5.78E-02
50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.01E-05	8.08E-05	9.39E-04	7.51E-03	7.22E-03	5.78E-02
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.51E-05	1.21E-04	1.40E-03	1.12E-02	1.08E-02	8.64E-02
50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.40E-05	1.12E-04	1.30E-03	1.04E-02	9.99E-03	7.99E-02
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	1.50E-05	1.20E-04	1.39E-03	1.11E-02	1.07E-02	8.58E-02
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.01E-05	8.08E-05	9.39E-04	7.51E-03	7.22E-03	5.78E-02
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.01E-05	8.08E-05	9.39E-04	7.51E-03	7.22E-03	5.78E-02
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	6.91E-06	5.53E-05	6.43E-04	5.14E-03	4.95E-03	3.96E-02

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Piscivorous Bird from Ingestion of Fish from Contaminated Pond								
Annual Precipitation Rate (in/yr)	**Application Area (ac)**	**Hydraulic Slope**	**Surface Roughness**	**USLE Soil Erodibility Factor[1]**	**Vegetation Type**	**Soil Type**	**Typical Application Rate**	**Maximum Application Rate**
5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00
5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00
10	10	0.05	0.015	0.401	Weeds (78)	Sand	2.65E-05	2.12E-04
10	10	0.05	0.015	0.401	Weeds (78)	Clay	7.37E-08	5.89E-07
10	10	0.05	0.015	0.401	Weeds (78)	Loam	4.29E-08	3.43E-07
25	10	0.05	0.015	0.401	Weeds (78)	Sand	8.48E-07	6.79E-06
25	10	0.05	0.015	0.401	Weeds (78)	Clay	3.54E-06	2.83E-05
25	10	0.05	0.015	0.401	Weeds (78)	Loam	7.09E-06	5.67E-05
50	10	0.05	0.015	0.401	Weeds (78)	Sand	4.50E-06	3.60E-05
50	10	0.05	0.015	0.401	Weeds (78)	Clay	3.60E-06	2.88E-05
50	10	0.05	0.015	0.401	Weeds (78)	Loam	2.29E-06	1.83E-05
100	10	0.05	0.015	0.401	Weeds (78)	Sand	8.47E-06	6.78E-05
100	10	0.05	0.015	0.401	Weeds (78)	Clay	1.98E-06	1.58E-05
100	10	0.05	0.015	0.401	Weeds (78)	Loam	3.44E-07	2.76E-06
150	10	0.05	0.015	0.401	Weeds (78)	Sand	6.41E-06	5.13E-05
150	10	0.05	0.015	0.401	Weeds (78)	Clay	1.51E-06	1.21E-05
150	10	0.05	0.015	0.401	Weeds (78)	Loam	9.06E-07	7.25E-06
200	10	0.05	0.015	0.401	Weeds (78)	Sand	4.06E-06	3.25E-05
200	10	0.05	0.015	0.401	Weeds (78)	Clay	1.28E-06	1.03E-05
200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.37E-06	1.09E-05
250	10	0.05	0.015	0.401	Weeds (78)	Sand	2.50E-06	2.00E-05
250	10	0.05	0.015	0.401	Weeds (78)	Clay	1.14E-06	9.14E-06
250	10	0.05	0.015	0.401	Weeds (78)	Loam	1.65E-06	1.32E-05
50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.18E-06	1.75E-05
50	100	0.05	0.015	0.401	Weeds (78)	Loam	2.34E-06	1.87E-05
50	1000	0.05	0.015	0.401	Weeds (78)	Loam	2.35E-06	1.88E-05
50	10	0.05	0.015	0.05	Weeds (78)	Loam	2.29E-06	1.83E-05

TABLE 4-4 (Cont.)
Risk Quotients for Surface Runoff Scenarios

Potential Risk to Piscivorous Bird from Ingestion of Fish from Contaminated Pond								
Annual Precipitation Rate (in/yr)	**Application Area (ac)**	**Hydraulic Slope**	**Surface Roughness**	**USLE Soil Erodibility Factor[1]**	**Vegetation Type**	**Soil Type**	**Typical Application Rate**	**Maximum Application Rate**
50	10	0.05	0.015	0.2	Weeds (78)	Loam	2.29E-06	1.83E-05
50	10	0.05	0.015	0.5	Weeds (78)	Loam	2.29E-06	1.83E-05
50	10	0.05	0.023	0.401	Weeds (78)	Loam	2.29E-06	1.83E-05
50	10	0.05	0.046	0.401	Weeds (78)	Loam	2.29E-06	1.83E-05
50	10	0.05	0.15	0.401	Weeds (78)	Loam	2.29E-06	1.83E-05
50	10	0.005	0.015	0.401	Weeds (78)	Loam	2.29E-06	1.83E-05
50	10	0.01	0.015	0.401	Weeds (78)	Loam	2.29E-06	1.83E-05
50	10	0.1	0.015	0.401	Weeds (78)	Loam	2.29E-06	1.83E-05
50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	3.79E-06	3.03E-05
50	10	0.05	0.015	0.401	Weeds (78)	Silt	3.35E-06	2.68E-05
50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	3.54E-06	2.84E-05
50	10	0.05	0.015	0.401	Shrubs (79)	Loam	2.29E-06	1.83E-05
50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	2.29E-06	1.83E-05
50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	1.29E-06	1.03E-05

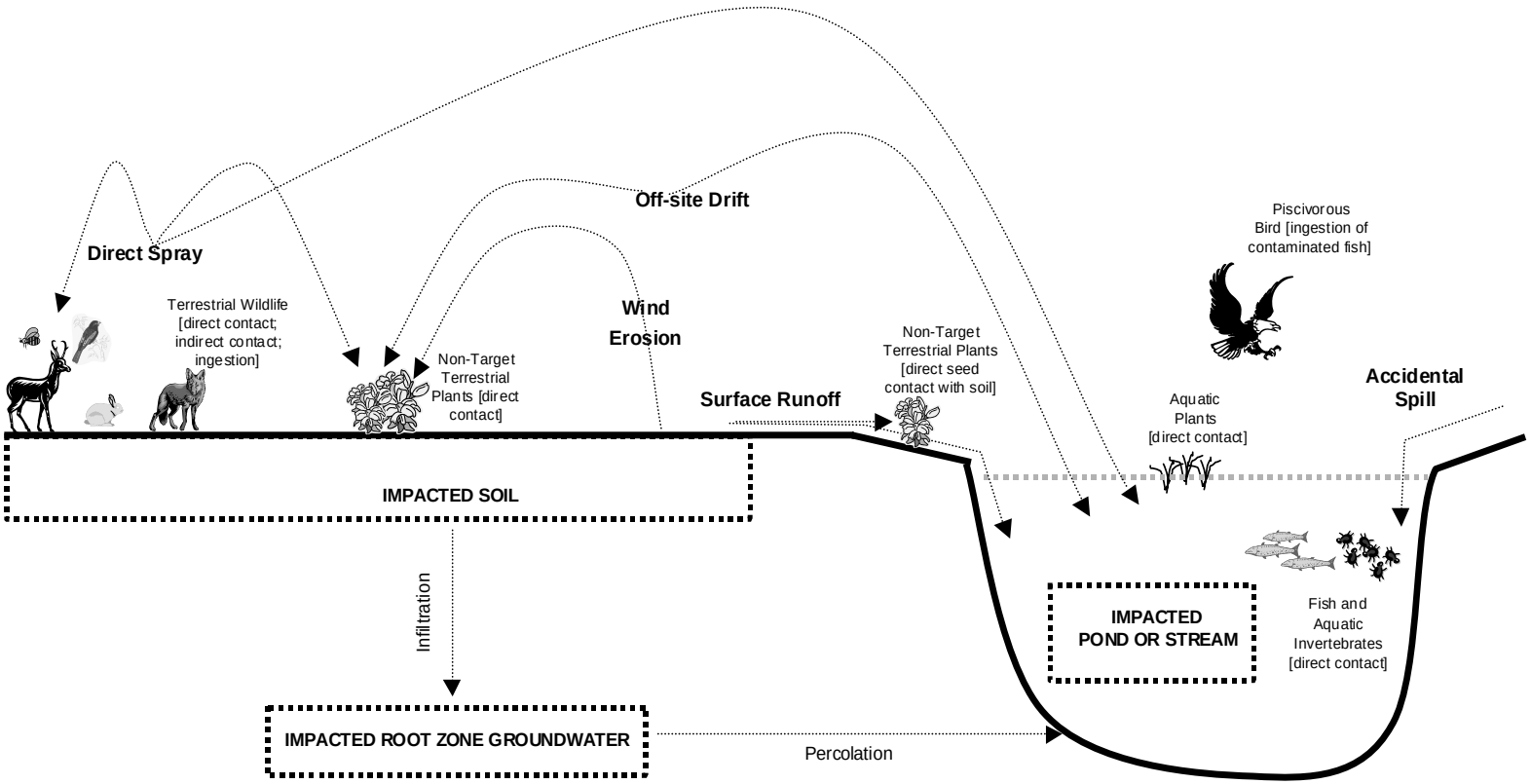
[1]USLE=Universal Soil Loss Equation.
Shading and boldface indicates plant RQs greater than 1.
Shading and boldface indicates acute RQs greater than 0.05 for fish and invertebrates.
Shading and boldface indicates chronic RQs greater than 0.5 for fish and invertebrates.
Shading and boldface indicates terrestrial animal RQs greater than 0.1 (LOC for acute risk to endangered species - most conservative).

TABLE 4-5
Risk Quotients for Wind Erosion and Transport Off-Site Scenarios

Transport of wind-blown dust to off-site soil: potential risk to non-target terrestrial plants					
		Typical Species		RTE Species	
Watershed Location	Distance from Receptor (km)	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Montana	1.5	8.96E-05	7.17E-04	2.69E-04	2.15E-03
Montana	10	5.07E-05	4.06E-04	1.52E-04	1.22E-03
Montana	100	6.08E-09	5.48E-08	1.82E-08	1.64E-07
Oregon	1.5	5.13E-05	4.10E-04	1.54E-04	1.23E-03
Oregon	10	1.96E-05	1.56E-04	5.87E-05	4.69E-04
Oregon	100	6.88E-09	5.51E-08	2.07E-08	1.65E-07
Wyoming	1.5	1.01E-05	8.11E-05	3.04E-05	2.43E-04
Wyoming	10	6.99E-06	5.59E-05	2.10E-05	1.68E-04
Wyoming	100	1.72E-09	1.38E-08	5.16E-09	4.13E-08

Shading and boldface indicates plant RQs greater than 1 (LOC for all plant risks).

FIGURE 4-1. Conceptual Model for Terrestrial Herbicides.



Application of terrestrial herbicides may occur by aerial (i.e., plane, helicopter) or ground (I.e., truck, backpack) methods.

See Figure 4-2 for simplified food web & evaluated receptors.

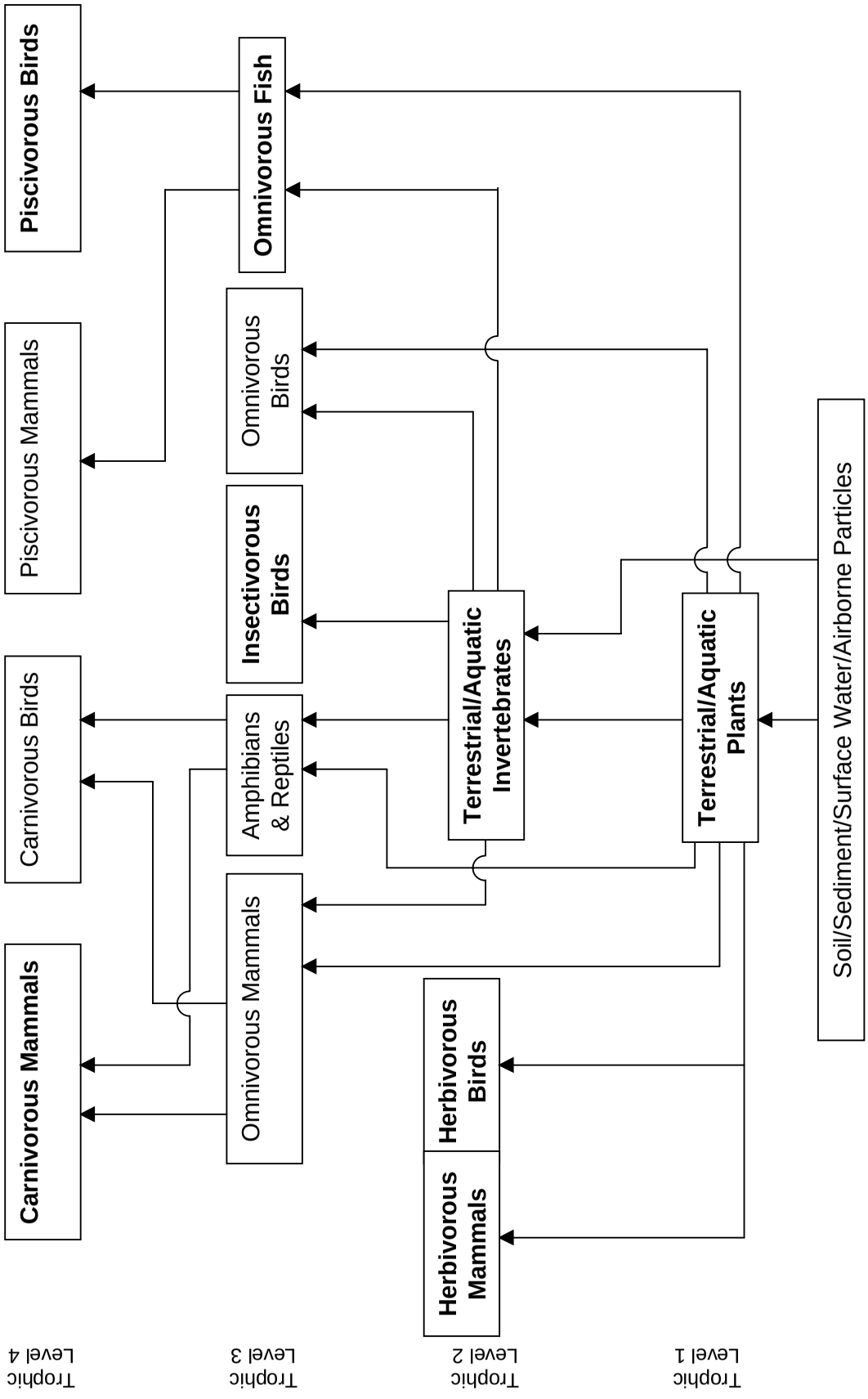


FIGURE 4-2. Simplified Food Web.

FIGURE 4-3. Direct Spray - Risk Quotients for Terrestrial Animals.

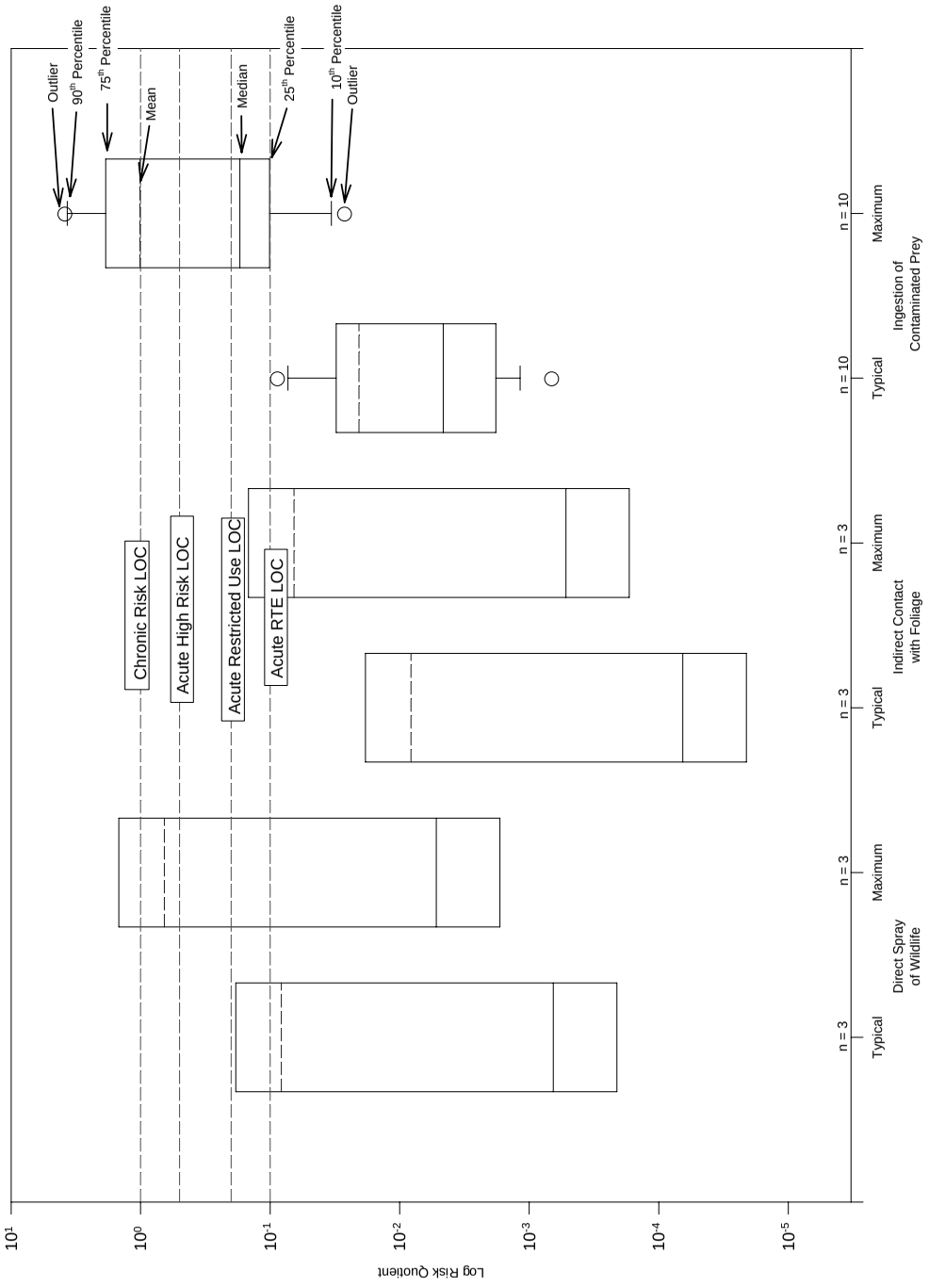


FIGURE 4-4. Direct Spray - Risk Quotients for Non-Target Terrestrial Plants.

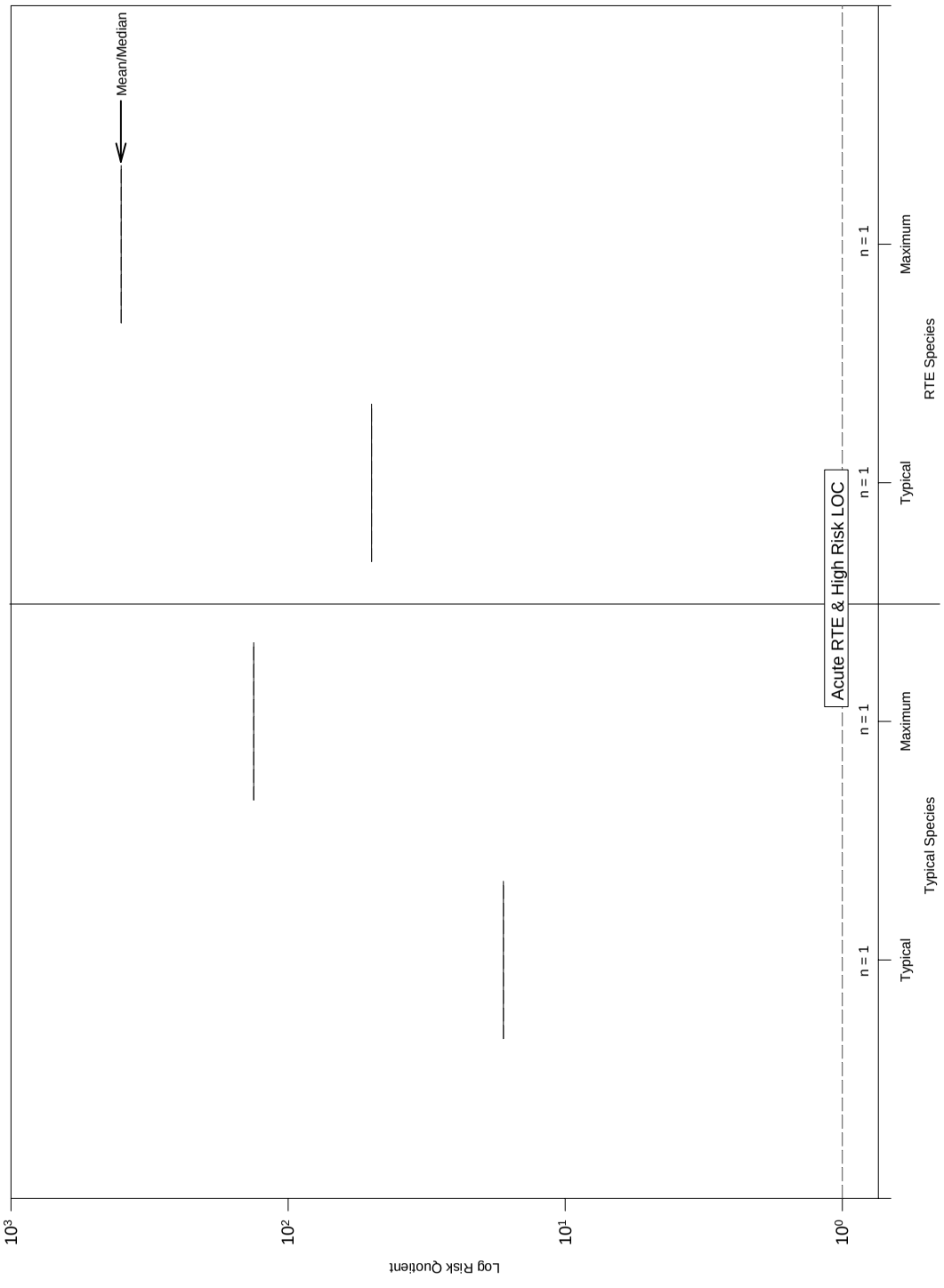


FIGURE 4-5. Accidental Direct Spray and Spills - Risk Quotients for Non-Target Aquatic Plants.

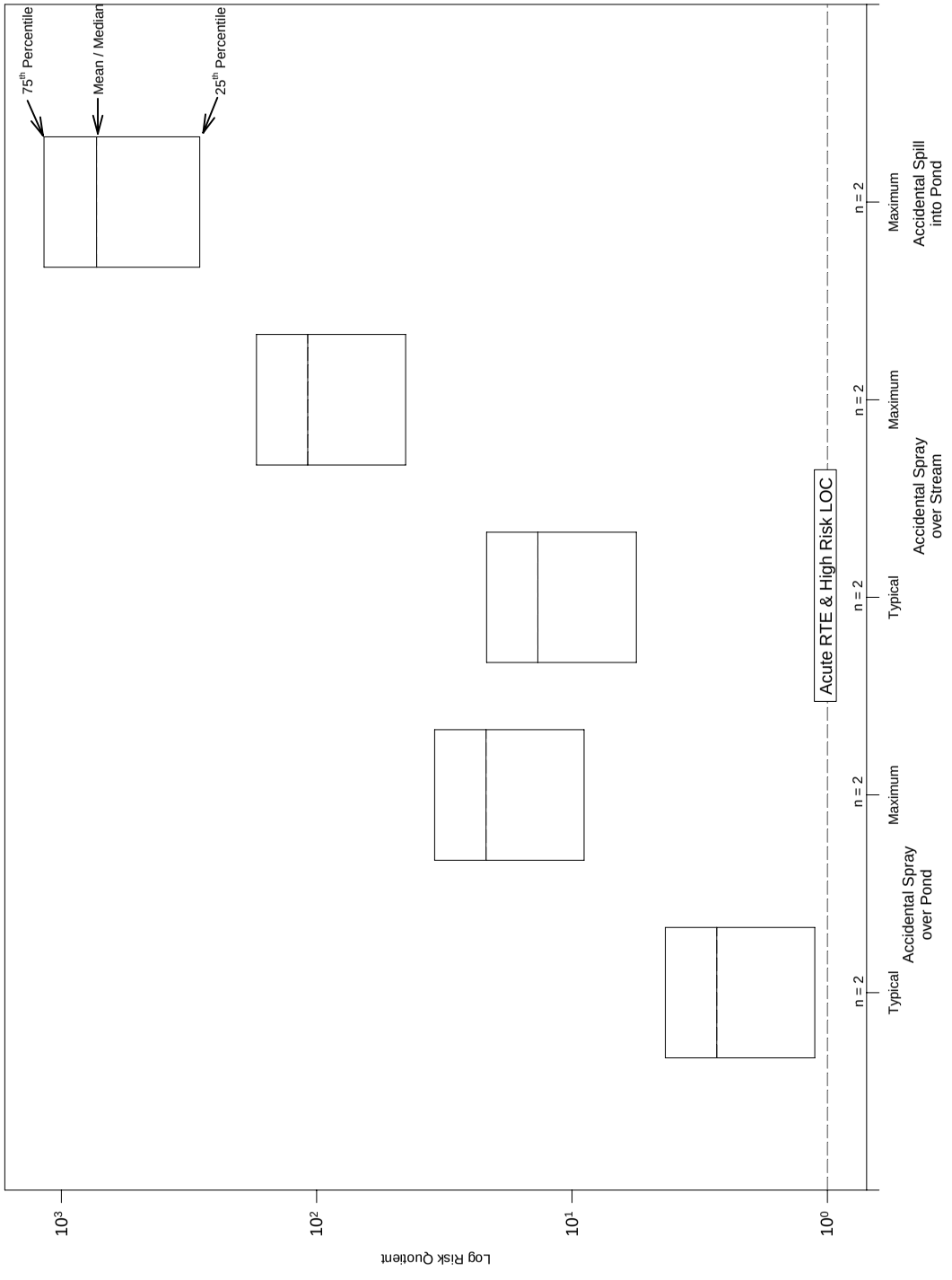


FIGURE 4-6. Accidental Direct Spray and Spills - Risk Quotients for Fish.

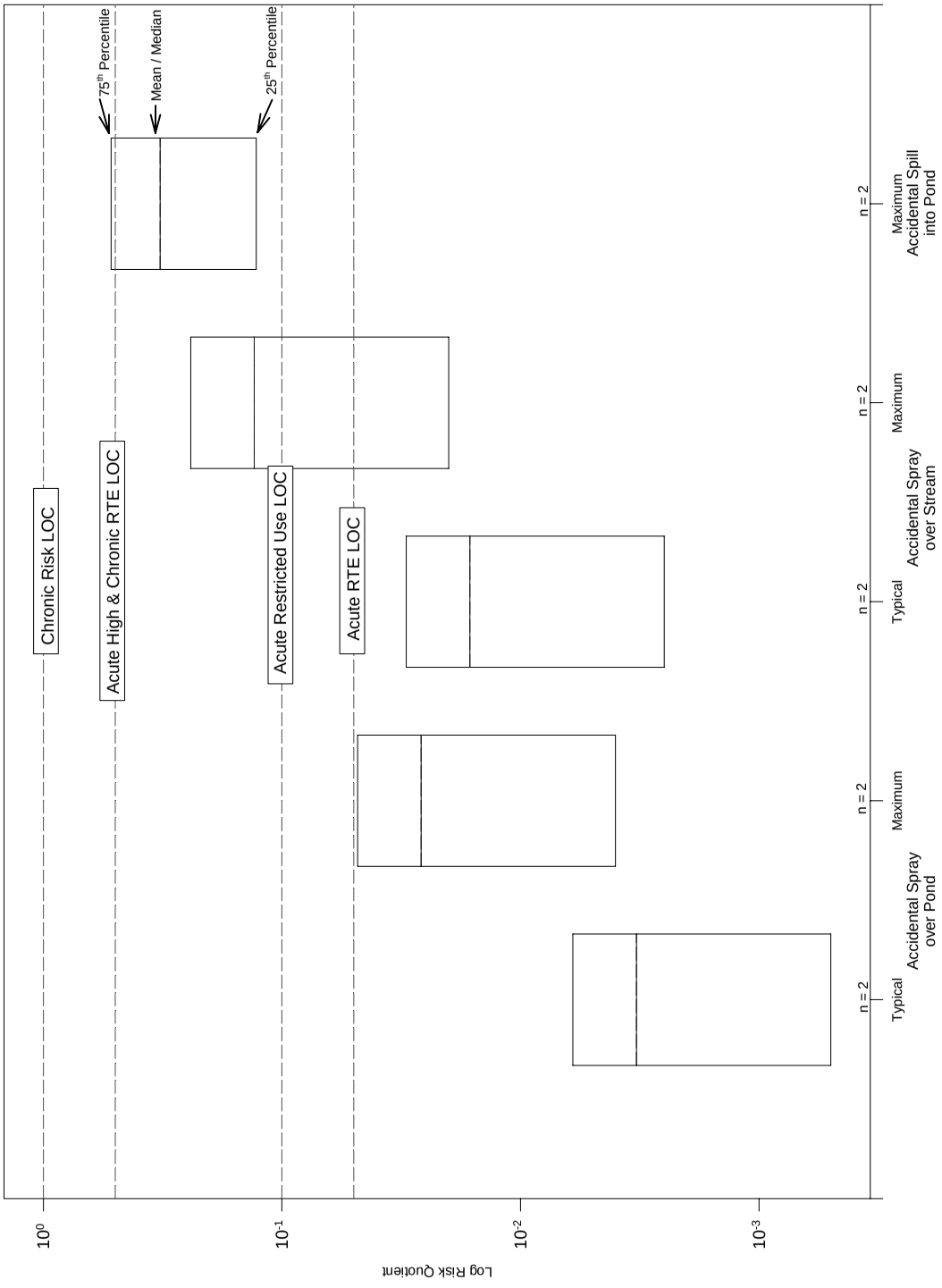
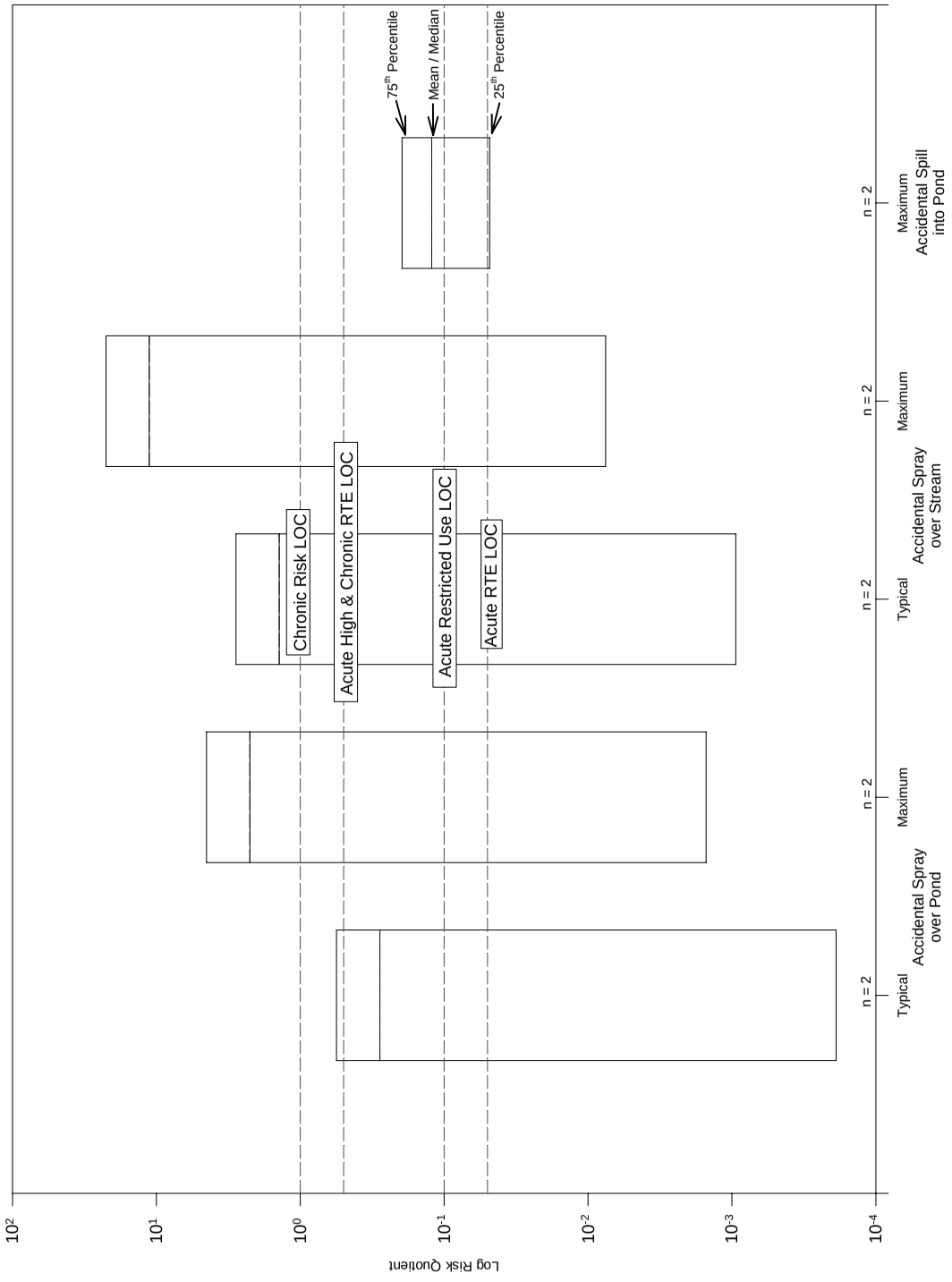


FIGURE 4-7. Accidental Direct Spray and Spills - Risk Quotients for Aquatic Invertebrates.



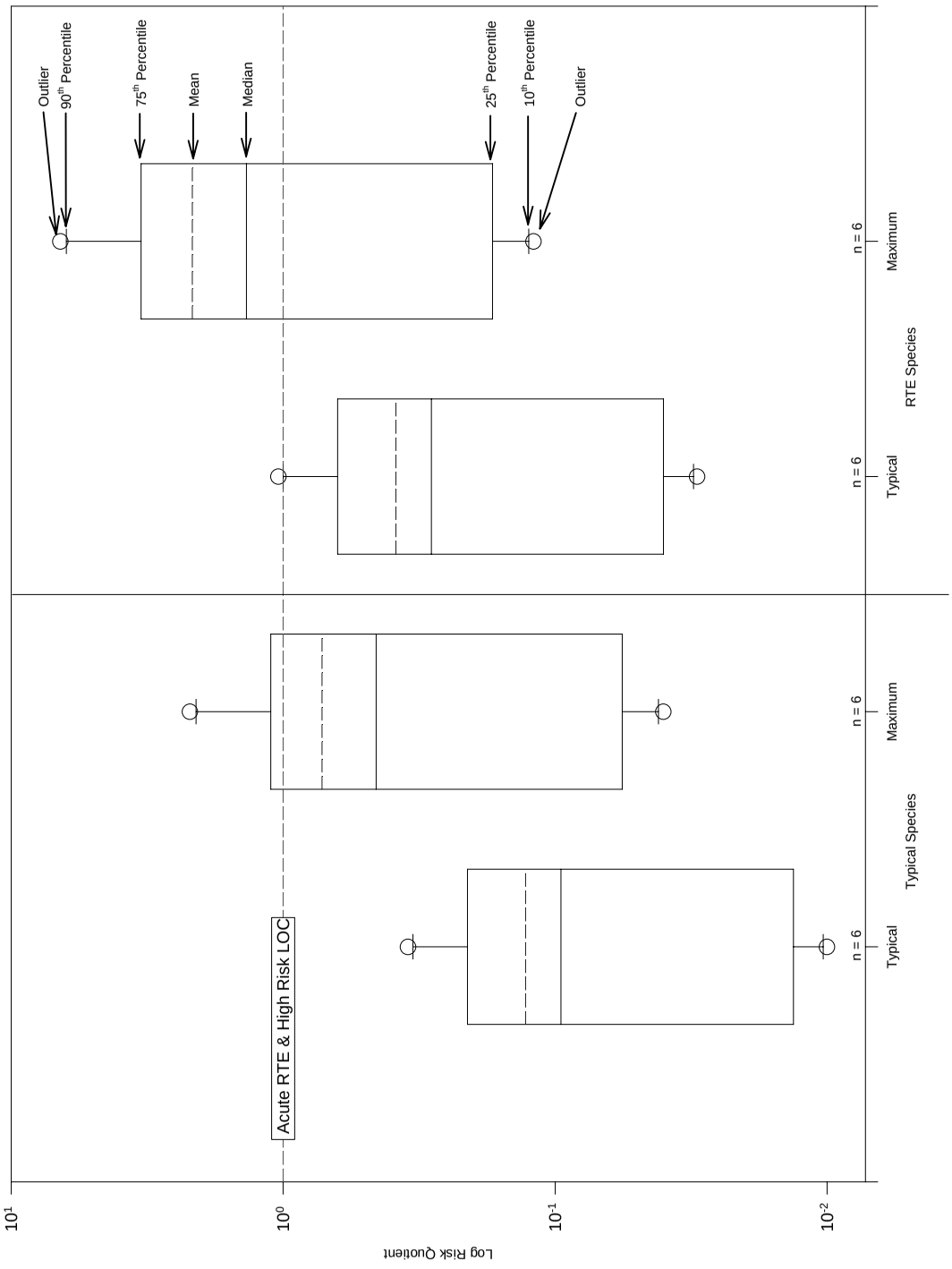


FIGURE 4-8. Off-Site Drift - Risk Quotients for Non-Target Terrestrial Plants.

FIGURE 4-9. Off-Site Drift - Risk Quotients for Non-Target Aquatic Plants.

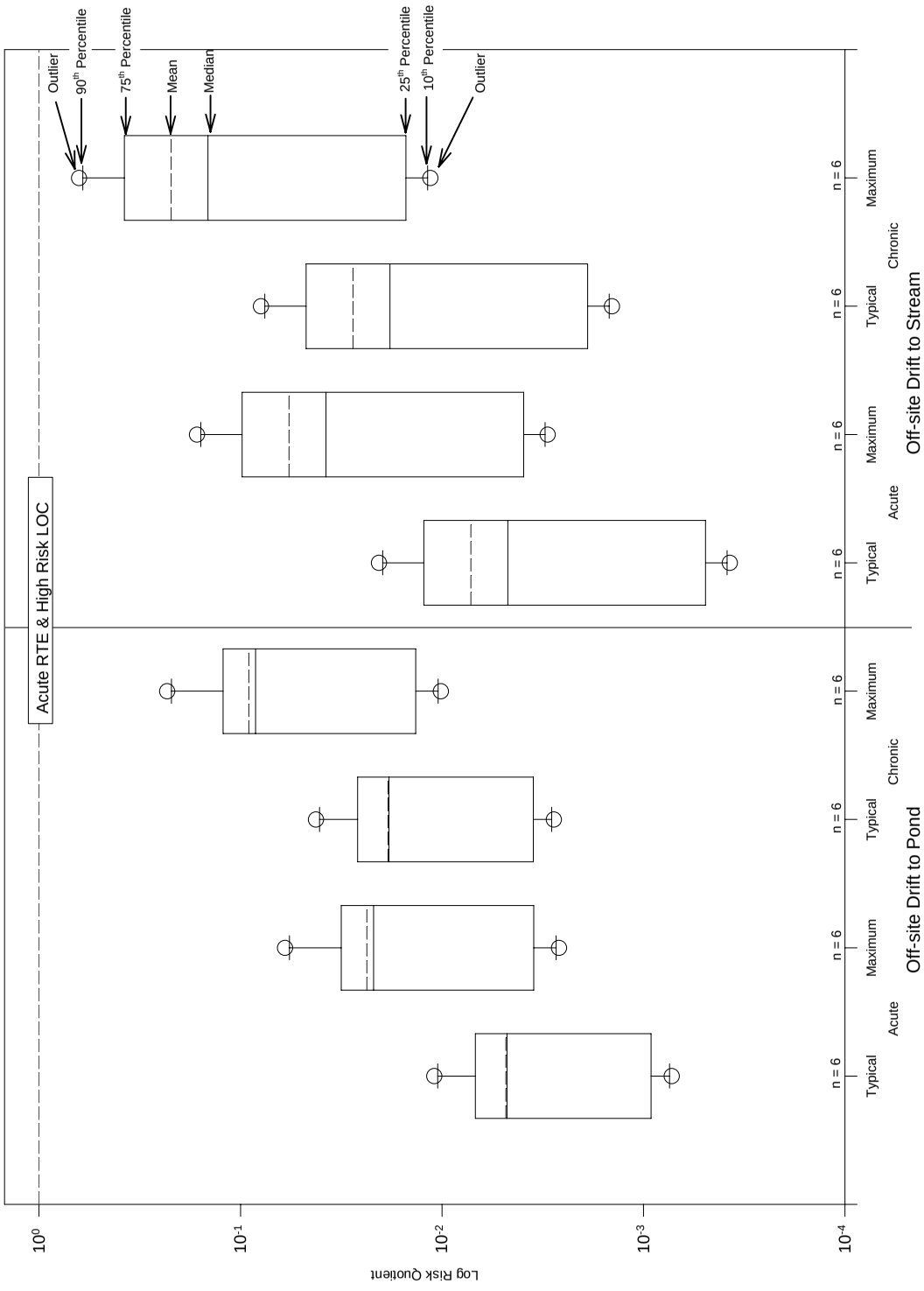


FIGURE 4-10. Off-Site Drift - Risk Quotients for Fish.

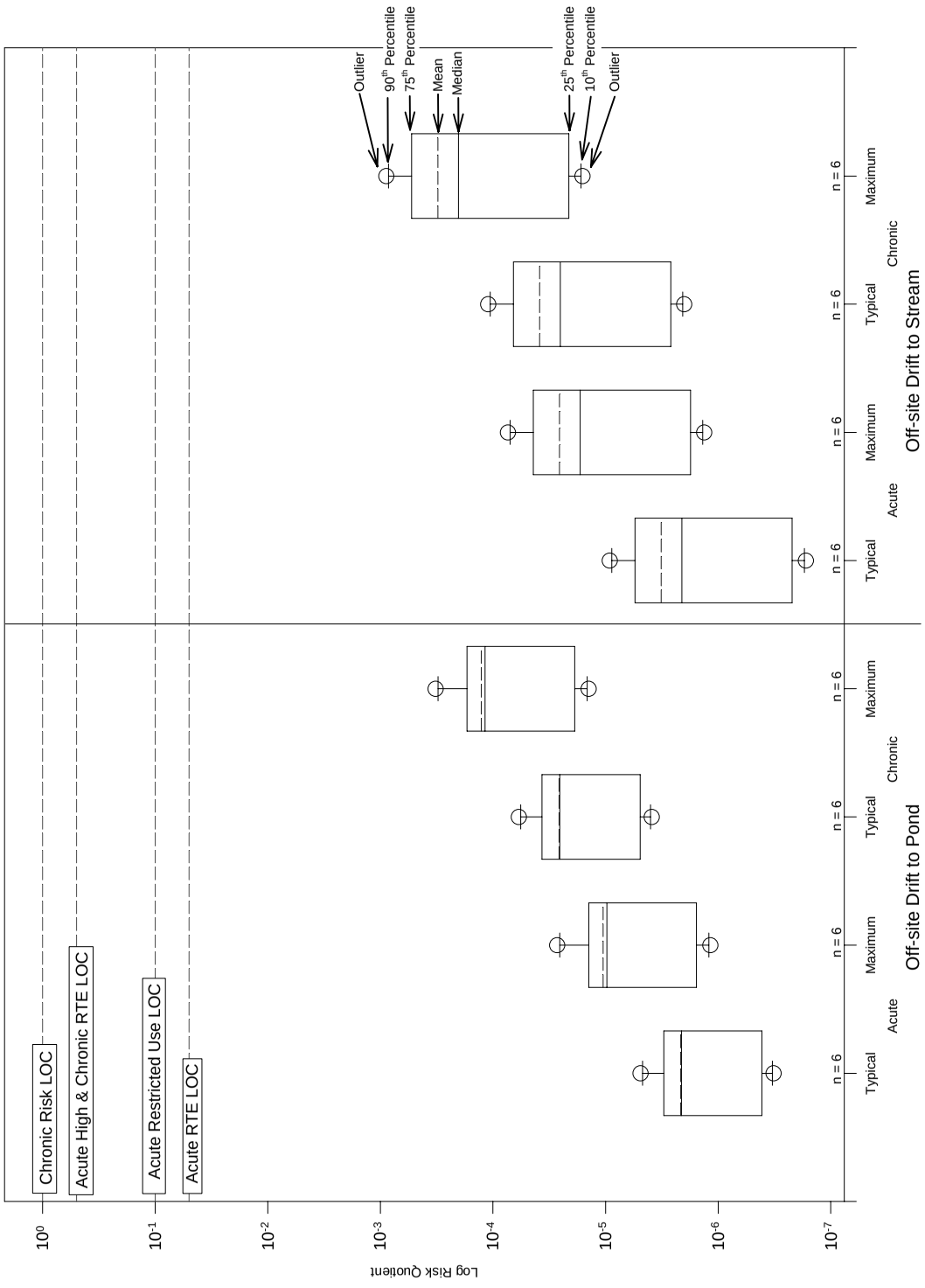


FIGURE 4-11. Off-Site Drift - Risk Quotients for Aquatic Invertebrates.

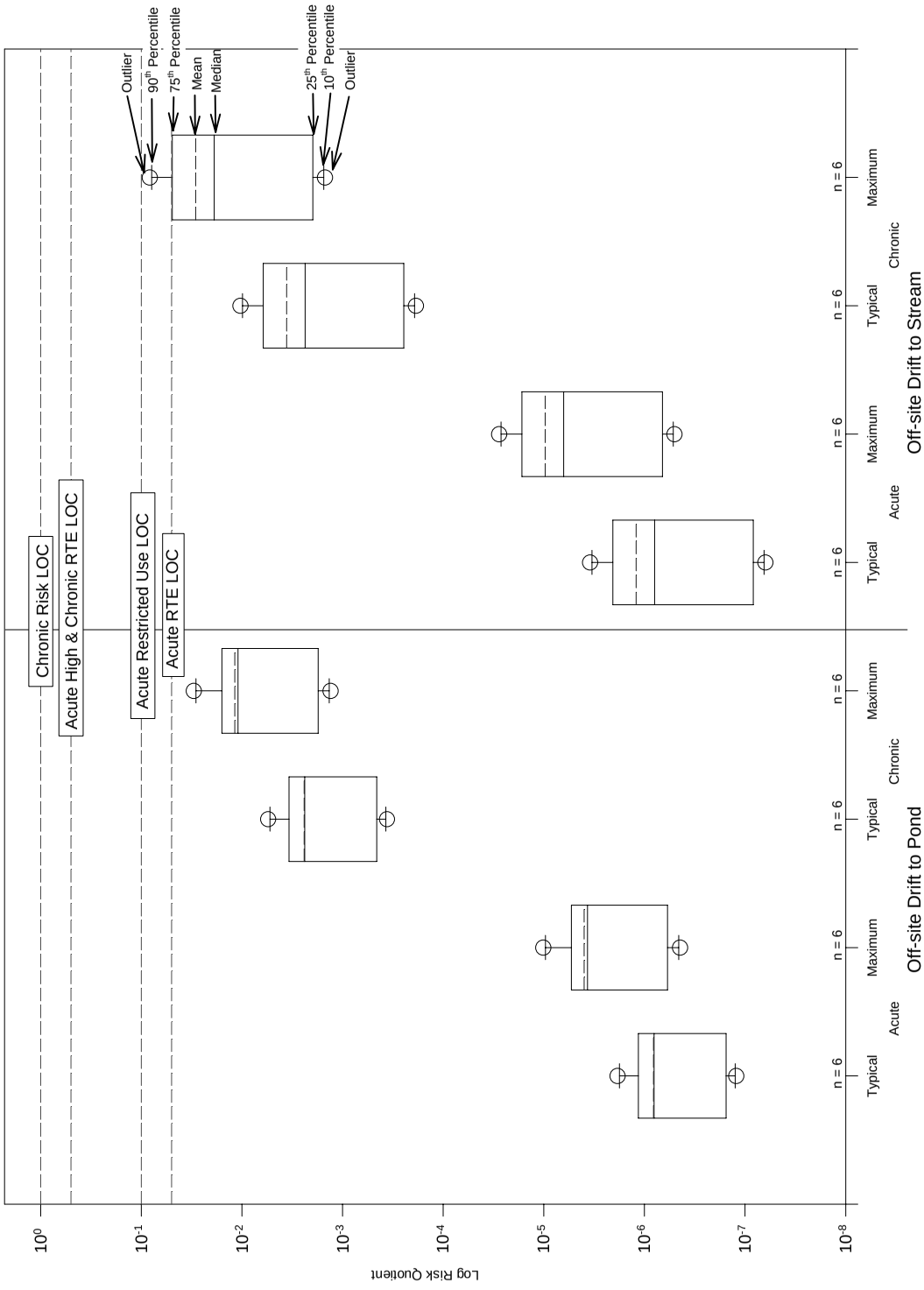


FIGURE 4-12. Off-Site Drift - Risk Quotients for Piscivorous Birds.

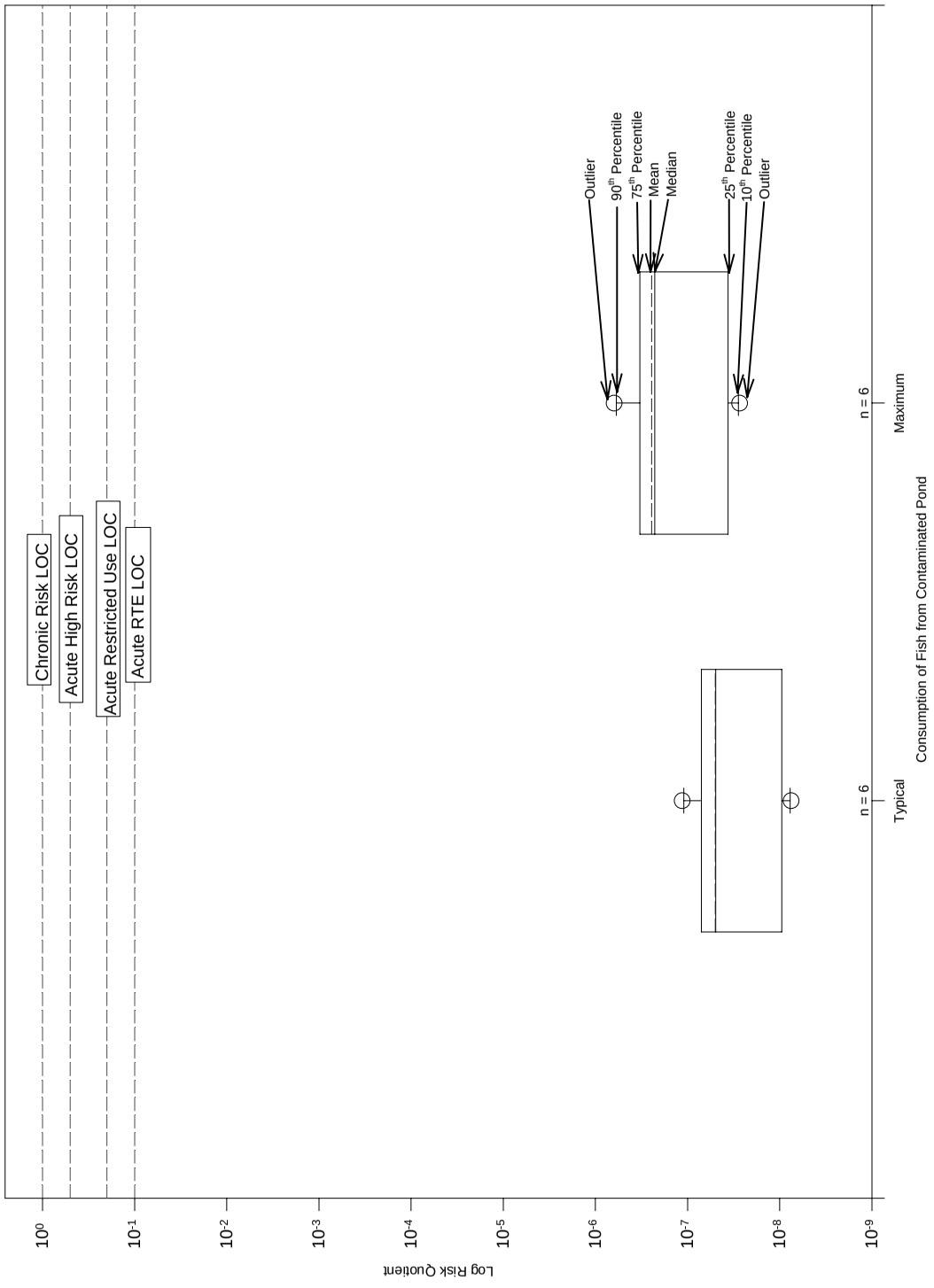
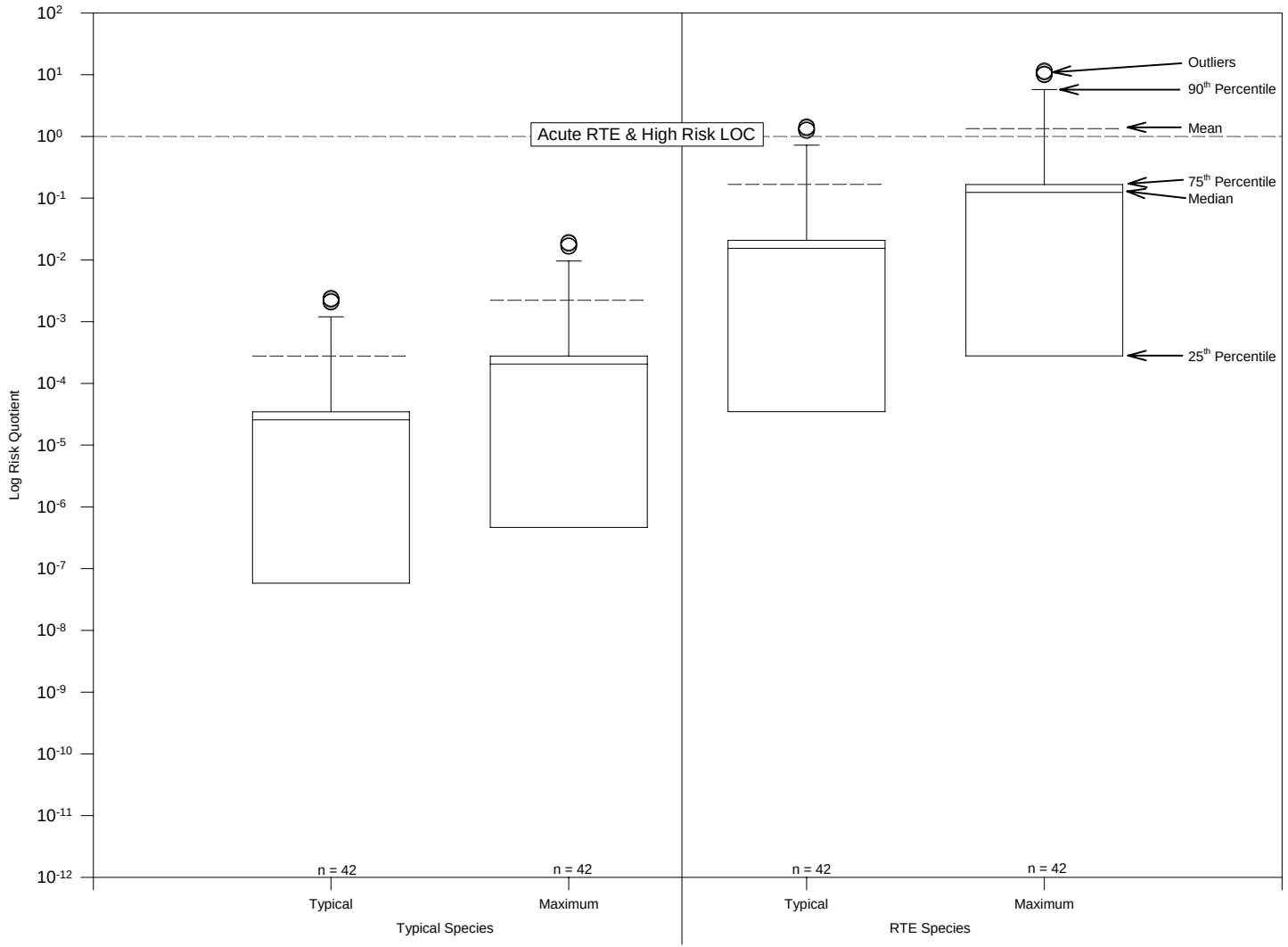


FIGURE 4-13. Surface Runoff - Risk Quotients for Non-Target Terrestrial Plants.



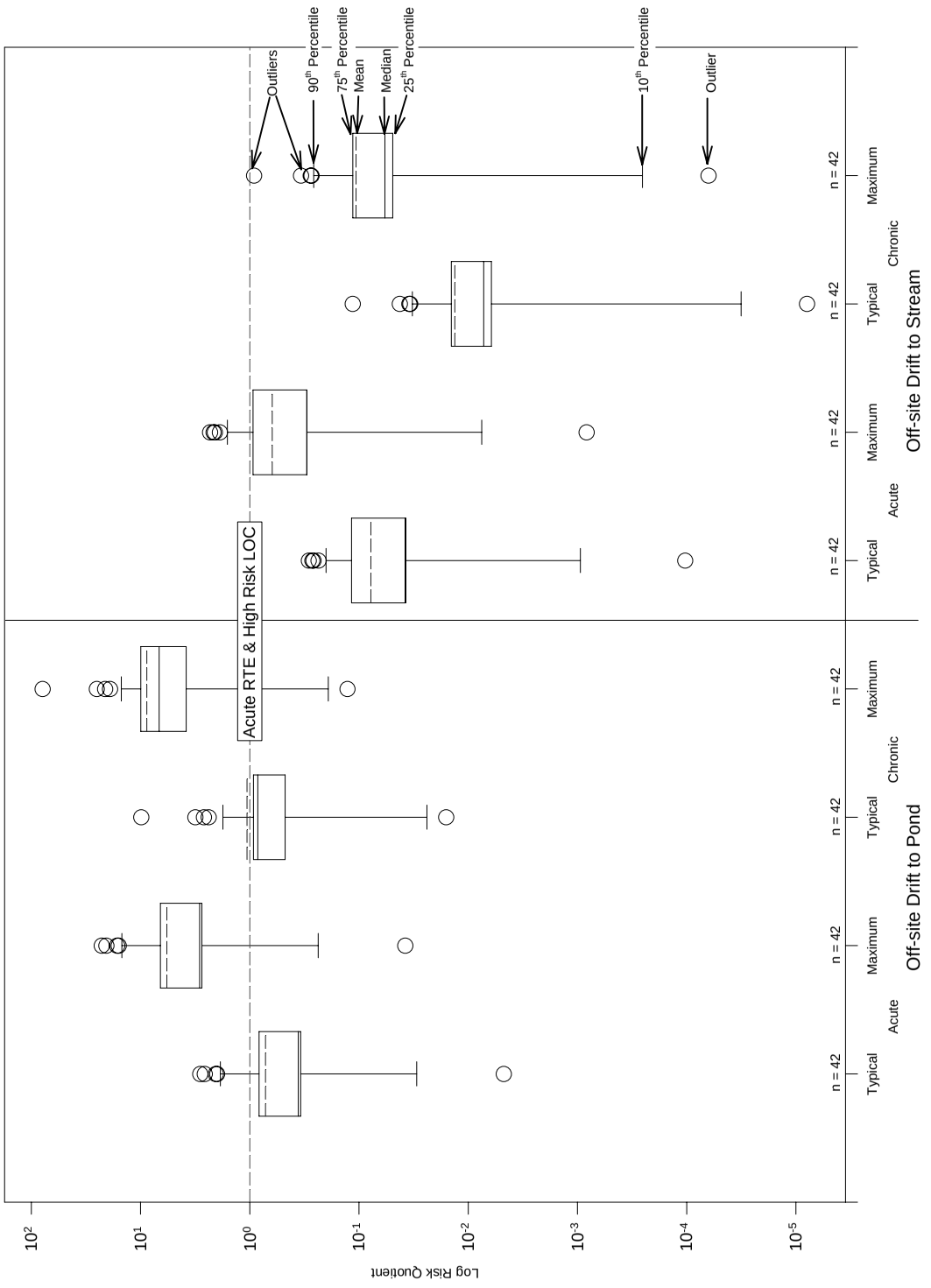


FIGURE 4-14. Surface Runoff - Risk Quotients for Non-Target Aquatic Plants.

FIGURE 4-15. Surface Runoff - Risk Quotients for Fish.

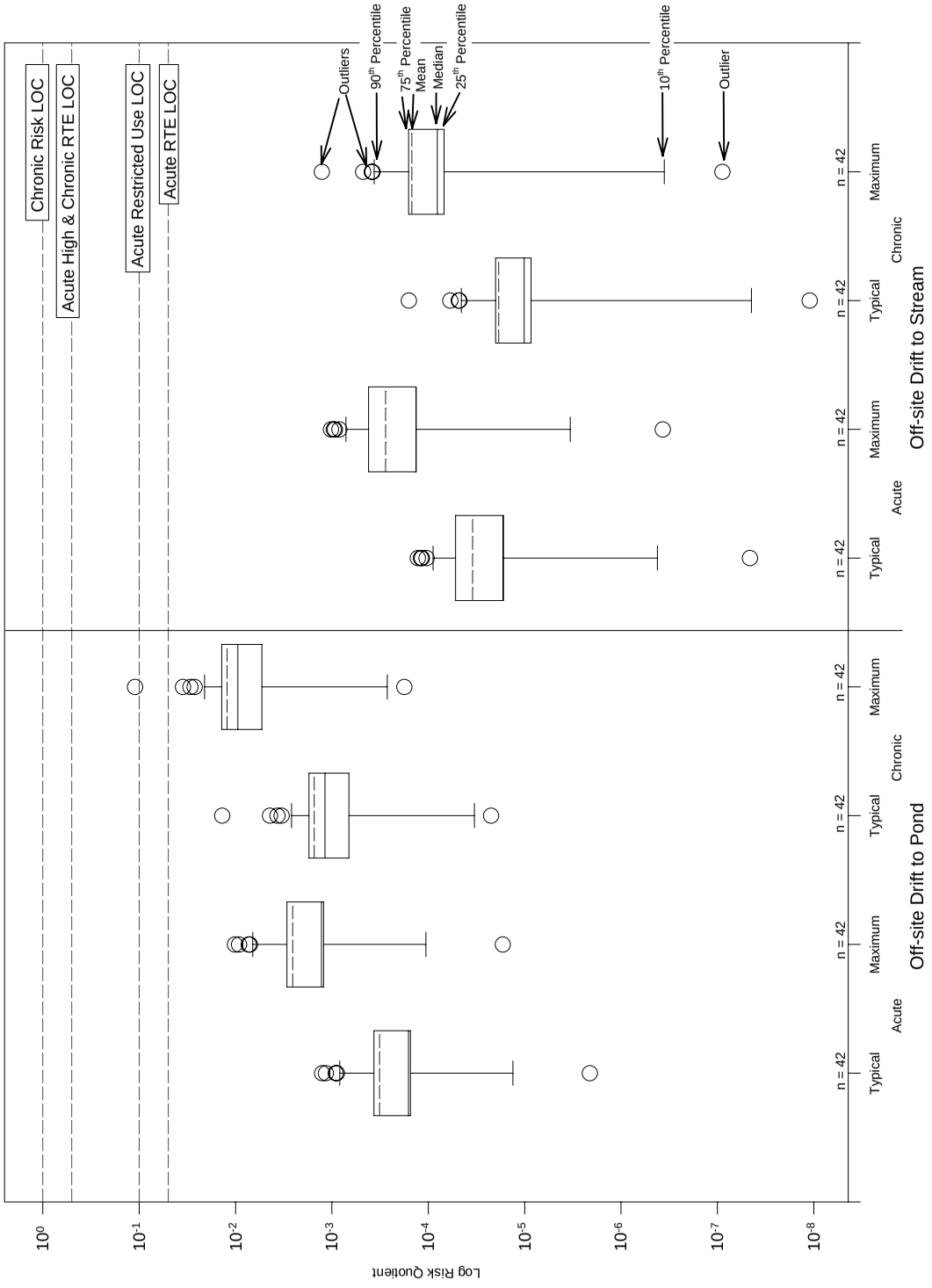


FIGURE 4-16. Surface Runoff - Risk Quotients for Aquatic Invertebrates.

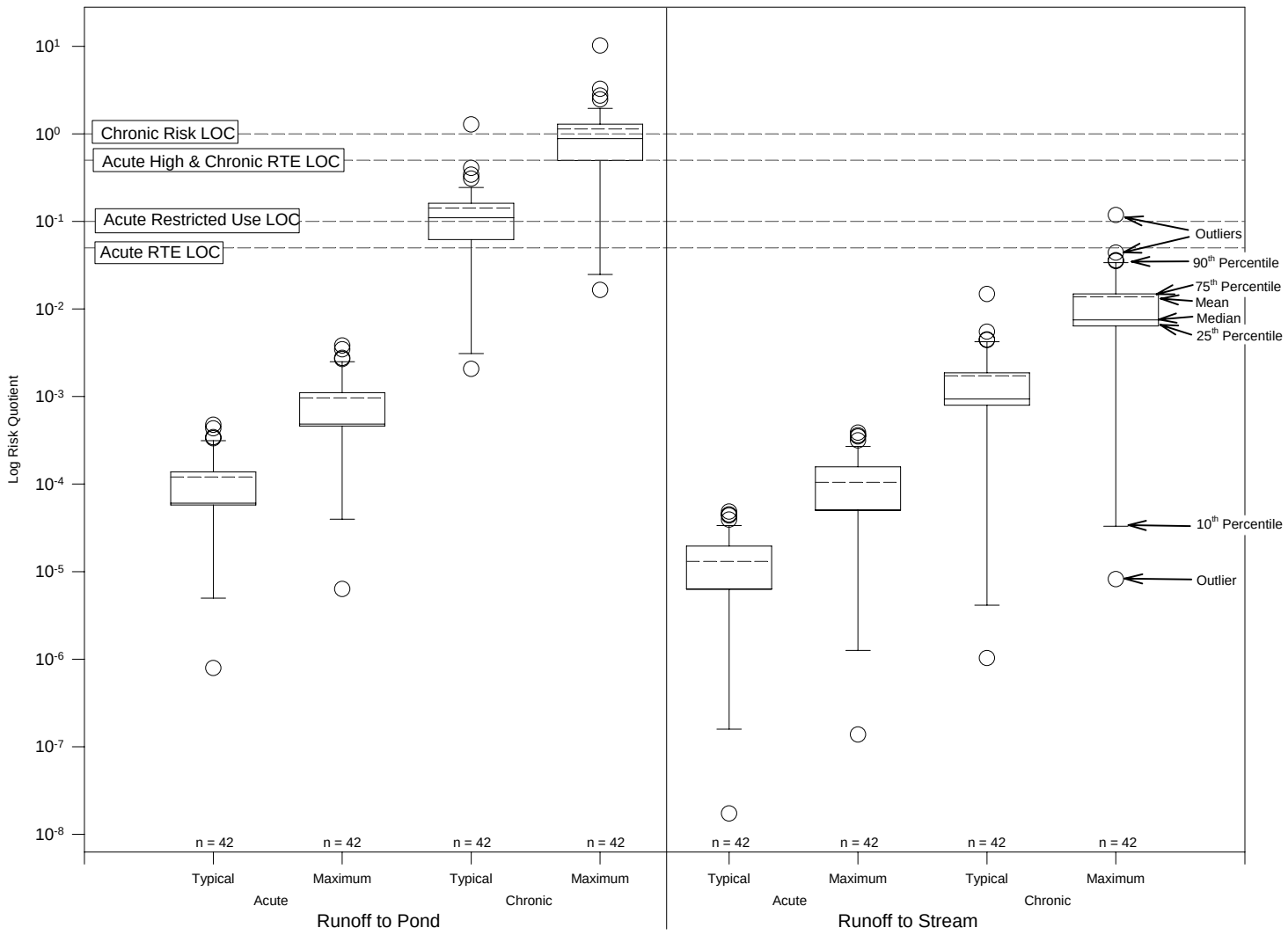


FIGURE 4-17. Surface Runoff - Risk Quotients for Piscivorous Birds.

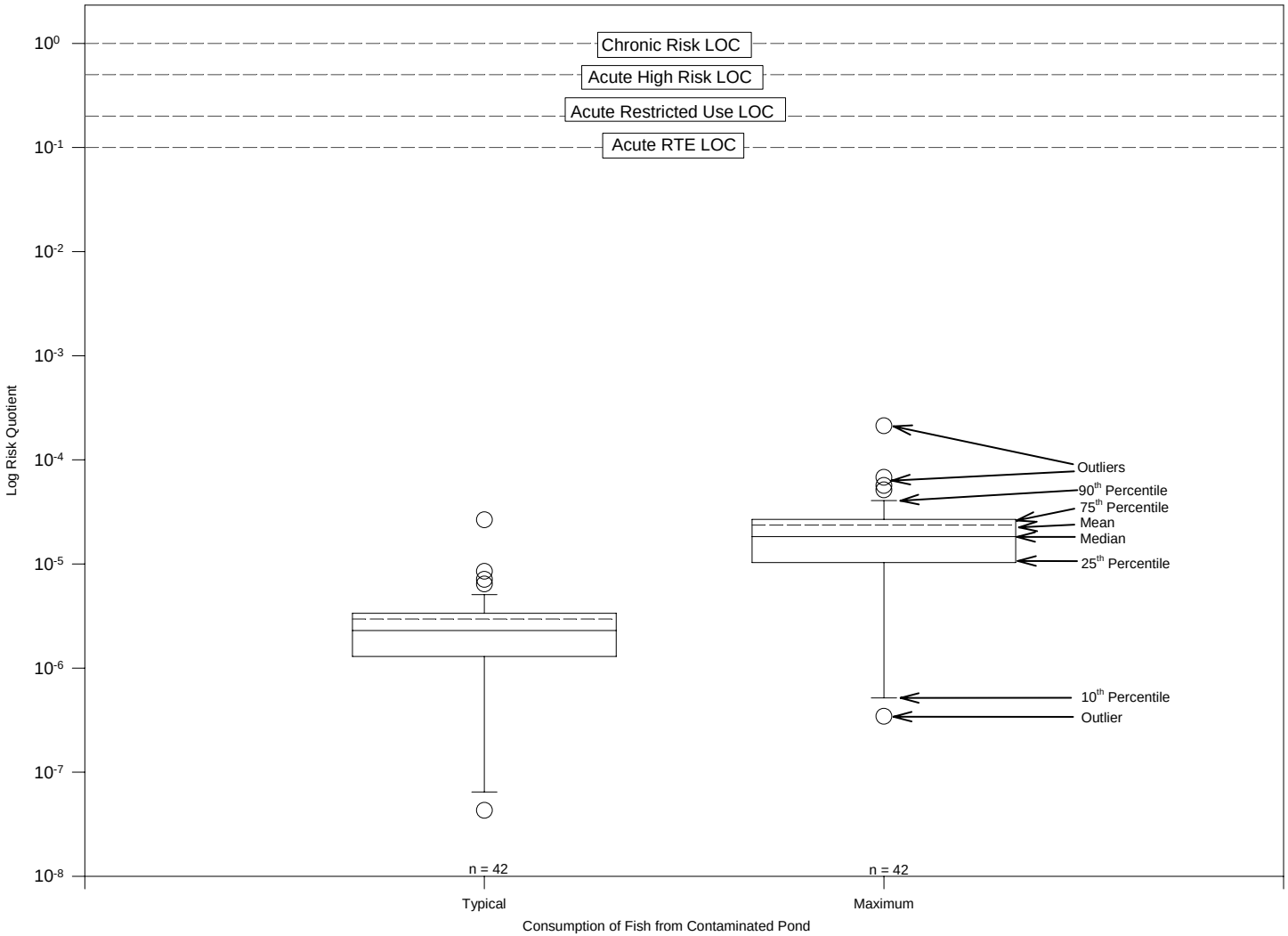
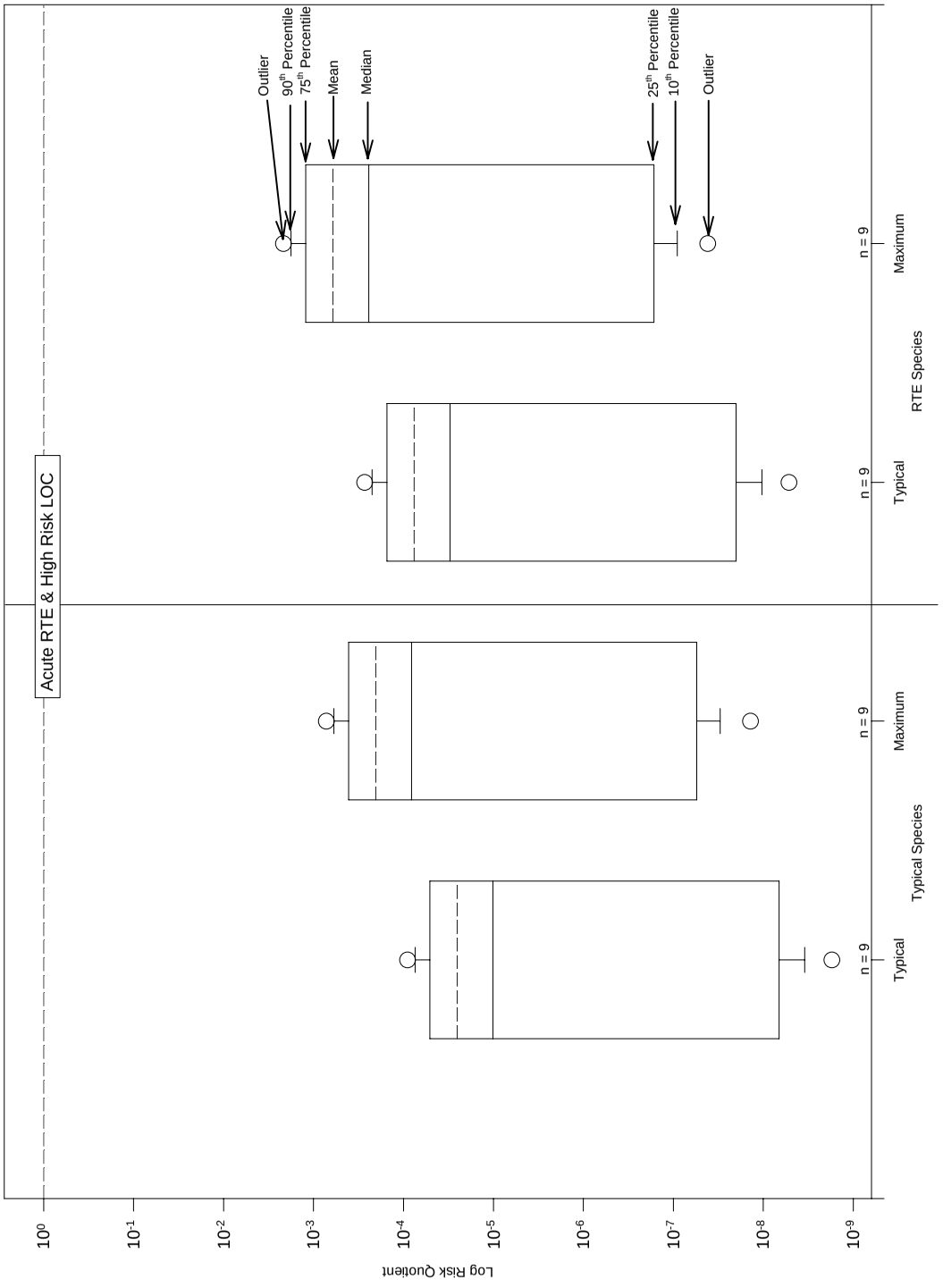


FIGURE 4-18. Wind Erosion and Transport Off-Site - Risk Quotients for Non-Target Terrestrial Plants.



5.0 SENSITIVITY ANALYSIS

The sensitivity analysis was designed to determine which factors, from three models used to predict exposure concentrations (GLEAMS, AgDRIFT®, and CALPUFF), most greatly affect exposure concentrations. A base case for each model was established. Input factors were changed independently, thereby resulting in an estimate of the importance of that factor on exposure concentrations.

Information regarding each model, their specific use and any inputs and assumptions made during the application of these models are provided in the Methods Document (ENSR 2004c). This section provides information specific to the sensitivity of each of these models to select input variables.

5.1 GLEAMS

The GLEAMS is a model developed for field-sized areas to evaluate the effects of agricultural management systems on the movement of agricultural chemicals within and through the plant root zone (Leonard et al. 1987). The model simulates surface runoff and groundwater flow of herbicide resulting from edge-of-field and bottom-of-root-zone loadings of water, sediment, pesticides, and plant nutrients as a result of complex climate-soil-management interactions. Agricultural pesticides are simulated by GLEAMS using three major components: hydrology, erosion, and pesticides. This section describes the sensitivity of model output variables controlling environmental conditions (e.g., precipitation, soil type). The goal of the sensitivity analysis was to investigate the control that measurable watershed variables have on the predicted outcome of a GLEAMS simulation.

5.1.1 GLEAMS Sensitivity Variables

A total of eight variables were selected for the sensitivity analysis of the GLEAMS model. The variables were selected because of their potential to affect the outcome of a simulation and the likelihood that these variables would change from site to site. These variables are generally those that have the greatest variability among field application areas. The following is a list of parameters that were included in the model sensitivity analysis:

1. *Annual Precipitation* - The effect of variation in annual precipitation on herbicide export rates was investigated to determine the effect of runoff on predicted stream and pond concentrations. It is expected that the greater the amount of precipitation, the greater the expected exposure concentration. However, this relationship is not linear because it is influenced by additional factors, such as evapotranspiration. The lowest and highest precipitation values evaluated were 25 and 100 inches per year, respectively (this represents one half and two times the precipitation level considered in the base watershed in the ERA).

2. *Application Area* – The effect of variation in field size on herbicide export rates was investigated to determine its influence on predicted stream and pond concentrations. The lowest and highest values for application areas evaluated were 1 and 1,000 acres, respectively.

3. *Field Slope* – Variation in field slope was investigated to determine its effect on herbicide export. The slope of the application field affects predicted runoff, percolation, and the degree of sediment erosion resulting from rainfall events. The lowest and highest values for slope evaluated were 0.005 and 0.1 (unitless), respectively.

4. *Surface Roughness* – The Manning Roughness value, a measure of surface roughness, was used in the GLEAMS model to predict runoff intensity and erosion of sediment. The Manning Roughness value is not measured directly but can be estimated using the general surficial characteristics of the application area. The lowest and highest values for surface roughness evaluated were 0.015 and 0.15 (unitless), respectively.

5. *Erodibility* – Variation in soil erodibility was investigated to determine its effect on predicted river and pond concentrations. The soil erodibility factor is a lumped parameter representing an integrated average annual value of the total soil and soil profile reaction to a large number of erosive and hydrologic processes. These processes consist of soil detachment and transport by raindrop impact and surface flow, localized redeposition due to topography and tillage-induced roughness, and rainwater infiltration into the soil profile. The lowest and highest values for erodibility evaluated were 0.05 and 0.5 (tons per acre per English EI), respectively.

6. *Pond Volume or Stream Flow Rate* – The effect of variability in pond volume and stream flow on herbicide concentrations was evaluated. The lowest and highest pond volumes evaluated were 0.41 and 1,640 cubic meters, respectively. The lowest and highest stream flow values evaluated were 0.05 and 100 cms, respectively.

7. *Soil Type* – The influence that soil characteristics have on predicted herbicide export rates and concentration was investigated by simulating different soil types within the application area. In this sensitivity analysis, clay, loam, and sand were evaluated.

8. *Vegetation Type* – Because vegetation type strongly affects the evapotranspiration rate, this parameter was expected to have a large influence on the hydrologic budget. Plants that cover a greater proportion of the application area for longer periods of the growing season will remove more water from the subsurface, and therefore, will result in diminished percolation rates through the soil. Vegetation types evaluated in this sensitivity analysis were weeds, shrubs, rye grass, and conifers and hardwoods.

5.1.2 GLEAMS Results

The effects of the eight different input model variables were evaluated to determine the relative effect of each variable on model output concentrations. A base case was established using the following values:

- annual precipitation rate of 50 inches per year;
- application area of 10 acres;
- slope of 0.05;
- roughness of 0.015;
- erodibility of 0.401 tons per acre per English EI;
- vegetation type of weeds; and
- loam soils.

While certain parameters used in the base case for the GLEAMS sensitivity analysis may not be representative of typical BLM lands, the base case values were selected to maximize changes in the other variables during the sensitivity analysis. For each variable, Table 5-1 provides the difference in predicted exposure concentrations in the stream and the pond using the highest and lowest input values, with all other variables held constant. Any increase in herbicide concentration results in an increase in RQs and ecological risk. The ratio of herbicide concentrations for the high and low variable inputs (high value: low value) represents the relative increase/decrease in ecological risk, where values > 1.0 denote a positive relationship between herbicide concentration and the variable (increase in RQ), and values < 1.0 denote a negative relationship (decrease in RQ). A similar table was created for the non-numerical variables soil and vegetation type (Table 5-2). This table presents the difference in concentration under different soil and vegetation types relative to the base case. A ratio was created by dividing the adjusted variable concentration by the base case concentration. Values farther away from 1.0, either positive or negative, indicate that predicted concentrations are more susceptible to changes within that particular variable.

Two separate results are presented 1) relative change in average annual stream or pond concentration and 2) relative change in maximum three-day average concentration. From this assessment it appears that exposure concentrations, and therefore RQs, decrease with increased precipitation (Table 5-1). However, this is not the always the case. It is true that predicted exposure concentrations for stream and pond scenarios decreased for precipitation levels between 10 and 100 inches. However, herbicide concentrations at precipitation levels from 0 to 25 inches per year increased and then began to decrease with precipitation up until 100 inches per year. Predicted concentrations began to increase again with precipitation levels from 100 to 200 inches per year. It is hypothesized that the water partitioning coefficient and soil half life properties of tebuthiuron cause this fluctuation in predicted concentrations with precipitation. Precipitation rates appear to be an important factor in determining exposure concentrations and ecological risk. Size of the application area, soil type, and flow rate are also important variables in predicting stream concentrations. Pond volume and soil type were important variables in predicting herbicide concentrations in ponds. The remaining variables resulted in moderate to negligible effects under both stream and pond scenarios.

5.2 AgDRIFT®

Changes to individual input parameters of predictive models have the potential to substantially influence the results of an analysis such as that conducted in this ERA. This is particularly true for models such as AgDRIFT®, which are intended to represent complex problems such as the prediction of off-target spray drift of herbicides. Predicted off-target spray drift and downwind deposition can be substantially altered by a number of variables intended to represent the herbicide application process, including, but not limited to: nozzle type used in the spray application of an herbicide mixture, ambient wind speed, release height (application boom height), and evaporation. Hypothetically, any variable in the model that is intended to represent some part of the physical process of spray drift and deposition can substantially alter predicted downwind drift and deposition patterns. This section will present the changes that occur to the EEC with changes to important input parameters and assumptions used in the AgDRIFT® model. It is important to note that changes in the EEC directly affect the estimated RQ. Thus, this information is presented in order to help local land managers understand the factors that are likely to be related to higher potential ecological risk. Table 5.3 summarizes the relative change in exposure concentrations, and therefore ecological risk, based on specific model input parameters (e.g., mode of application, application rate).

Factors that are thought to have the greatest influence on downwind drift and deposition are: spray drop-size distribution, release height, and wind speed (Teske and Barry 1993; Teske et al. 1998; Teske and Thistle 1999, *as cited in SDTF 2002*). To better quantify the influence of these and other parameters, a sensitivity analysis was undertaken by the SDTF and documented in the AgDRIFT® user's manual. In this analysis AgDRIFT® Tier II model input parameters (model input parameters are discussed in Appendix B of the HHRA) were varied by 10% above and below the default assumptions (four different drop-size distributions were evaluated). The findings of this analysis indicate the following:

- The largest variation in predicted downwind drift and deposition patterns occurred as a result of changes in the shape and content of the spray drop size distribution.
- The next greatest change in predicted downwind drift and deposition patterns occurred as a result of changes in boom height (the release height of the spray mixture).
- Changes in spray boom length resulted in significant variations in drift and deposition within 200 ft downwind of the hypothetical application area.
- Changes in the assumed ambient temperature and relative humidity resulted in small variation in drift and deposition at distances > 200 ft downwind of the hypothetical application area.
- Varying the assumed number of application swaths (aircraft flight lines), application swath width, and wind speed resulted in little change in predicted downwind drift and deposition.
- Variation in nonvolatile fraction of the spray mixture showed no effect on downwind drift and deposition.

These results, except for the minor to negligible influence of varying wind speed and nonvolatile fraction, were consistent with previous observations. The 10% variation in wind speed and nonvolatile fraction was likely too small to produce substantial changes in downwind drift and deposition. It is expected that varying these factors by a larger percentage would eventually produce some effect. In addition, changes in wind speed resulted in changes in application swath width and swath offset, which masked the effect of wind speed alone on downwind drift and deposition.

Based on these findings, and historic field observations, the hierarchy of parameters that have the greatest influence on downwind drift and deposition patterns is as follows:

1. Spray drop size distribution
2. Application boom height
3. Wind speed
4. Spray boom length
5. Relative humidity
6. Ambient temperature
7. Nonvolatile fraction

An additional limitation of the AgDRIFT® user's manual sensitivity analysis is the focus on distances < 200 ft downwind of a hypothetical application area. From a land management perspective, distance downwind from the point of deposition may be considered to represent a hypothetical buffer zone between the application area and a potentially sensitive habitat. In this ERA, distances as great as 900 ft downwind of a hypothetical application were considered. In an effort to expand on the existing AgDRIFT® sensitivity analysis provided in the user's manual, the sensitivity of mode of application, application height or vegetation type, and application rate were evaluated. Results of this supplemental analysis are provided in Tables 5-3 and 5-4.

The results of the expanded sensitivity analysis indicate that deposition and corresponding ecological risk drop off substantially between 300 and 900 ft downwind of hypothetical application area. Thus, from a land management perspective, the size of a hypothetical buffer zone (the downwind distance from a hypothetical application area to a potentially sensitive habitat) may be the single most controllable variable (other than the application equipment and herbicide mixtures chosen) that has a substantial impact on ecological risk (Table 5-4).

The most conservation case (using the smallest downwind distance measured in this ERA – 25 ft) was then evaluated using two boom heights. Predicted concentrations were higher with high vs. low boom height (Table 5-3). The effect of application rate was analyzed (maximum vs. typical), and, as expected, predicted concentrations increase with application rates (Table 5-3). Maximum application rates increased exposure concentrations by 5.5 to 8.0 times the typical application concentrations. In general, the evaluation presented in Table 5-4 indicates that there is a decrease in herbicide migration and associated ecological risk, with increased downward distance (i.e., buffer zone) and an increase in herbicide migration with increasing application height.

5.3 CALPUFF

To determine the downwind deposition of herbicide that might occur as a result of dust-borne herbicide migration, the CALPUFF model was used with one year of meteorological data for selected example locations: Glasgow, Montana; Medford, Oregon; and Lander, Wyoming. For this analysis, certain meteorological triggers were considered to determine whether herbicide migration was possible (ENSR 2004c). Herbicide migration is not likely during periods of sub-freezing temperatures, precipitation events, and periods with snow cover. For example, it was assumed herbicide migration would not be possible if the hourly ambient temperature was at or below 28 degrees Fahrenheit because the local ground would be frozen and would be very resistant to soil erosion. Deposition rates predicted by

the model are most affected by the meteorological conditions and the surface roughness or land use at each of the sites.

Higher surface roughness lengths (a measure of the height of obstacles to the wind flow) result in higher deposition simply because deposition is more likely to occur on obstacles to wind flow (e.g., trees) than on a smooth surface. Therefore, the type of land use affects deposition as predicted by CALPUFF. In addition, a disturbed surface (e.g., through activities such as bulldozing) is more subject to wind erosion because the surface soil is exposed and loosened. The surface roughness in the CALPUFF analysis has been selected to represent bare or poorly vegetated soils. This leads to relatively high estimates of ground level wind speed in the application area. Such an assumption is likely to be reasonable in recently burned areas or sparsely vegetated rangeland. In grasslands, scrub habitat, and forests such an assumption likely leads to an over-prediction of herbicide scour and subsequent deposition.

CALPUFF uses hourly meteorological data, in conjunction with the site surface roughness, to calculate deposition velocities that are used to determine deposition rates at downwind distances. The amount of deposition at a particular distance is especially dependent on the "friction velocity." The friction velocity is the square root of the surface shearing stress divided by the air density (a quantity with units of wind speed). Surface shearing stress is related to the vertical transfer of momentum from the air to the Earth's surface. Shearing stress, and therefore friction velocity, increases with increasing wind speed and with increased surface roughness. Higher friction velocities result in higher deposition rates. Because the friction velocity is calculated from hourly observed wind speeds, meteorological conditions at a particular location greatly influence deposition rates as predicted by CALPUFF.

The threshold friction velocity is that ground level wind speed (accounting for surface roughness) that is assumed to lead to soil (and herbicide) scour. The threshold friction velocity is a function of the vegetative cover and soil type. Finer grained, less dense, and poorly vegetated soils tend to have lower threshold friction velocities. As the threshold friction velocity declines, wind events capable of scouring soil become more common. In fact, given the typical temporal distributions of wind speed, scour events would be predicted to be much more common as the threshold friction velocity declines from rare events to relatively common ones. The threshold wind speeds selected for the CALPUFF modeling effort are based on typical, unvegetated soils in the example areas. In the event that very fine soils or ash are present at the site, the threshold wind speed could be lower and scouring wind events more common. This, in turn, would lead to greater soil and herbicide erosion with greater subsequent downwind deposition.

The size of the treatment area also impacts the predicted herbicide migration and deposition results. The size of the treatment area is directly proportional to the total amount of herbicide that can be moved via soil erosion. Because a fixed amount of herbicide per unit area is required for treatment, a larger treatment area would yield a larger amount of herbicide that could migrate. In addition, increased herbicide mass would lead to increased downwind deposition.

In summary:

- Herbicide migration does not occur unless the surface wind speed is high enough to produce a friction velocity that can lift soil particles into the air.
- The presence of surface "roughness elements" (buildings, trees and other vegetation) has an effect upon the deposition rate. Areas of higher roughness will result in more intense vertical eddies that can mix down suspended particles more effectively than smoother surfaces can. Thus, higher deposition of suspended soil and herbicide are predicted for areas with high roughness.
- Disturbed surfaces, such as areas recently burned, and large treatment areas will experience greater herbicide migration and deposition.

TABLE 5-1
Relative Effects of GLEAMS Input Variables on Herbicide Exposure Concentrations using Typical BLM Application Rate

Stream Scenarios											
				Low Value Predicted Concentration		High Value Predicted Concentration		Concentration $_H$ / Concentration $_L$		Relative Change in Concentration	
Input Variable	Units	Input Low Value (L)	Input High Value (H)	Average Annual Stream	Maximum 3 Day Avg. Stream	Average Annual Stream	Maximum 3 Day Avg. Stream	Average Annual Stream	Maximum 3 Day Avg. Stream	Average Annual Stream	Maximum 3 Day Avg. Stream
Precipitation	inches	25	100	1.02E-04	2.75E-03	3.50E-05	1.32E-03	0.34	0.48	-	-
Area	acres	1	1,000	1.07E-05	2.64E-04	1.48E-03	1.43E-02	138.79	54.38	+	+
Slope	unitless	0.005	0.1	9.39E-05	1.87E-03	9.40E-05	1.87E-03	1.001	1.000	+	No Change
Erodibility	tons/acre per English EI	0.05	0.5	9.39E-05	1.87E-03	9.39E-05	1.87E-03	1.000	1.000	No Change	No Change
Roughness	unitless	0.015	0.15	9.40E-05	1.87E-03	9.39E-05	1.87E-03	0.999	1.000	-	No Change
Flow Rate	m^3/sec	0.05	100	1.97E-04	3.27E-03	1.30E-07	3.33E-06	0.001	0.001	-	-
Pond Scenarios											
				Low Value Predicted Concentration		High Value Predicted Concentration		Concentration $_H$ / Concentration $_L$		Relative Change in Concentration	
Input Variable	Units	Input Low Value (L)	Input High Value (H)	Average Annual Pond	Maximum 3 Day Avg. Pond	Average Annual Pond	Maximum 3 Day Avg. Pond	Average Annual Pond	Maximum 3 Day Avg. Pond	Average Annual Pond	Maximum 3 Day Avg. Pond
Precipitation	inches	25	100	3.41E-02	3.68E-02	1.66E-03	1.37E-02	0.05	0.37	-	-
Area	acres	1	1,000	1.05E-02	1.20E-02	1.13E-02	2.08E-02	1.08	1.73	+	+
Slope	unitless	0.005	0.1	1.10E-02	1.71E-02	1.10E-02	1.71E-02	1.000	1.000	No Change	No Change
Erodibility	tons/acre per English EI	0.05	0.5	1.10E-02	1.71E-02	1.10E-02	1.71E-02	1.000	1.000	No Change	No Change
Roughness	unitless	0.015	0.15	1.10E-02	1.71E-02	1.10E-02	1.71E-02	1.000	1.000	No Change	No Change
Pond Volume	ac/ft	0.05	100	1.11E-02	1.84E-02	1.24E-04	1.68E-04	0.011	0.009	-	-

Concentrations were based on the average application rate.
"+" = Increase in concentration from low to high input value = increase in RQ = increase in ecological risk.
"-" = Decrease in concentration from low to high input value = decrease in RQ = decrease in ecological risk.

TABLE 5-2
Relative Effects of Soil and Vegetation Type on Herbicide Exposure Concentrations using Typical BLM Application Rate

	Predicted Concentration				Concentration $_{X\ Soil\ Type}$ / Concentration $_{Loam}$				Relative Change in Concentration			
Soil Type	**Avg. Annual Stream**	**Max. 3 Day Avg. Stream**	**Avg. Annual Pond**	**Max. 3 Day Avg. Pond**	**Avg. Annual Stream**	**Max. 3 Day Avg. Stream**	**Avg. Annual Pond**	**Max. 3 Day Avg. Pond**	**Avg. Annual Stream**	**Max. 3 Day Avg. Stream**	**Avg. Annual Pond**	**Max. 3 Day Avg. Pond**
***Loam*[1]**	***9.40E-05***	***1.87E-03***	***1.10E-02***	***1.71E-02***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Sand	2.34E-04	8.42E-03	2.16E-02	1.02E-01	2.4902	4.4931	1.9677	5.9620	+	+	+	+
Clay	1.42E-04	4.55E-03	1.73E-02	1.29E-01	1.5136	2.4304	1.5762	7.5146	+	+	+	+
Clay Loam	1.40E-04	4.30E-03	1.71E-02	7.50E-02	1.4886	2.2962	1.5521	4.3860	+	+	+	+
Silt Loam	1.41E-04	2.27E-03	1.83E-02	4.28E-02	1.4960	1.2092	1.6598	2.5000	+	+	+	+
Silt	1.30E-04	2.17E-03	1.61E-02	3.80E-02	1.3837	1.1569	1.4679	2.2219	+	+	+	+
	Predicted Concentration				**Concentration $_{X\ Veg\ Type}$ / Concentration $_{Weeds}$**				**Relative Change in Concentration**			
Vegetation Type	**Avg. Annual Stream**	**Max. 3 Day Avg. Stream**	**Avg. Annual Pond**	**Max. 3 Day Avg. Pond**	**Avg. Annual Stream**	**Max. 3 Day Avg. Stream**	**Avg. Annual Pond**	**Max. 3 Day Avg. Pond**	**Avg. Annual Stream**	**Max. 3 Day Avg. Stream**	**Avg. Annual Pond**	**Max. 3 Day Avg. Pond**
***Weeds*[1]**	***9.40E-05***	***1.87E-03***	***1.10E-02***	***1.71E-02***	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Conif + Hrdwd	6.43E-05	1.27E-03	6.20E-03	1.12E-02	0.6844	0.6756	0.5634	0.6538	-	-	-	-
Shrubs	9.40E-05	1.87E-03	1.10E-02	1.71E-02	1.0000	1.0000	1.0000	1.0000	No Change	No Change	No Change	No Change
Rye Grass	9.40E-05	1.87E-03	1.10E-02	1.71E-02	1.0000	1.0000	1.0000	1.0000	No Change	No Change	No Change	No Change

[1] ***Base Case***
Concentrations were based on the average application rate.
"+" = Increase in concentration from base case = increase in RQ = increase in ecological risk.
"-" = Decrease in concentration from base case = decrease in RQ = decrease in ecological risk.

TABLE 5-3
Herbicide Exposure Concentrations used during the Supplemental AgDRIFT® Sensitivity Analysis

Mode of Application	Application Height/Veg. Type	Minimum Downwind Distance (ft)	Maximum Downwind Distance (ft)	Minimum Downwind Distance Concentration			Maximum Downwind Distance Concentration		
				Terrestrial (lb/ac)	Stream (mg/L)	Pond (mg/L)	Terrestrial (lb/ac)	Stream (mg/L)	Pond (mg/L)
Typical Application Rate									
Plane	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Helicopter	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Ground	Low Boom	25	900	6.30E-03	3.13E-03	3.41E-04	3.00E-04	9.49E-05	3.61E-05
	High Boom	25	900	1.04E-02	5.24E-03	5.47E-04	4.00E-04	1.25E-04	4.58E-05
Maximum Application Rate									
Plane	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Helicopter	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Ground	Low Boom	25	900	3.33E-02	2.50E-02	1.58E-03	1.20E-03	7.59E-04	1.31E-04
	High Boom	25	900	6.59E-02	4.19E-02	3.00E-03	1.70E-03	1.00E-03	1.75E-04

TABLE 5-3 (Cont.)
Herbicide Exposure Concentrations used during the Supplemental AgDRIFT® Sensitivity Analysis

Effect of Downwind Distance

Mode of Application	Application Height or Vegetation Type	Minimum Buffer	Maximum Buffer	Concentration $_{900}$/Concentration $_{25 \text{ or } 100}$			Relative Change in Concentration		
				Terrestrial	Stream	Pond	Terrestrial	Stream	Pond
Typical Application Rate									
Plane	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Helicopter	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Ground	Low Boom	25	900	0.0476	0.0303	0.1059	-	-	-
	High Boom	25	900	0.0385	0.0239	0.0837	-	-	-
Maximum Application Rate									
Plane	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Helicopter	Forest	100	900	NA	NA	NA	NA	NA	NA
	Non-Forest	100	900	NA	NA	NA	NA	NA	NA
Ground	Low Boom	25	900	0.0360	0.0303	0.0829	-	-	-
	High Boom	25	900	0.0258	0.0239	0.0583	-	-	-

TABLE 5-3 (Cont.)
Herbicide Exposure Concentrations used during the Supplemental AgDRIFT® Sensitivity Analysis

Effect of Application Height (Vegetation Type or Boom Height)

Mode of Application	Application Height or Vegetation Type	Concentration Ratio[1]			Relative Change in Concentration		
		Terrestrial	Stream	Pond	Terrestrial	Stream	Pond
Typical Application Rate							
Plane	Forest/ Non-Forest	NA	NA	NA	NA	NA	NA
Helicopter	Forest/ Non-Forest	NA	NA	NA	NA	NA	NA
Ground	High/Low Boom	1.6508	1.6749	1.6041	+	+	+
Maximum Application Rate							
Plane	Forest/ Non-Forest	NA	NA	NA	NA	NA	NA
Helicopter	Forest/ Non-Forest	NA	NA	NA	NA	NA	NA
Ground	High/Low Boom	1.9790	1.6749	1.8987	+	+	+

Effect of Application Rate

	Concentration Rato[3]			Relative Change in Concentration		
	Terrestrial	Stream	Pond	Terrestrial	Stream	Pond
Maximum vs. Typical	6.3365	8.0000	5.4845	+	+	+

(1) using minimum buffer width concentrations.
(2) using minimum buffer width and high boom concentrations.
(3) using ground dispersal, minimum buffer width and high boom concentrations.
"+" = Increase in concentration = increase in RQ = increase in ecological risk.
"-" = Decrease in concentration = decrease in RQ = decrease in ecological risk.

6.0 RARE, THREATENED, AND ENDANGERED SPECIES

Rare, threatened, and endangered (RTE) species have the potential to be impacted by herbicides applied for vegetation control. RTE species are of potential increased concern to screening level ERAs, which utilize surrogate species and generic assessment endpoints to evaluate potential risk, rather than examining site- and species-specific effects to individual RTE species. Several factors complicate our ability to evaluate site- and species-specific effects:

- Toxicological data specific to the species (and sometimes even class) of organism are often absent from the literature.
- The other assumptions involved in the ERA (e.g., rate of food consumption, surface-to-volume ratio) may differ for RTE species relative to selected surrogates and/or data for RTE species may be unavailable.
- The high level of protection afforded RTE species by regulation and policy suggests that secondary effects (e.g., potential loss of prey or cover), as well as site-specific circumstances that might result in higher rates of exposure, should receive more attention.

A common response to these issues is to design screening level ERAs, including this one, to be highly conservative. This includes assumptions such as 100% exposure to an herbicide by simulating scenarios where the organism lives year-round in the most affected area (i.e., area of highest concentration), or that the organism consumes only food items that have been impacted by the herbicide. The tebuthiuron screening level ERA incorporates additional conservatism in the assumptions used in the herbicide concentration models such as GLEAMS (Appendix B; ENSR 2004c). Even with highly conservative assumptions in the ERA, however, concern may still exist over the potential risk to specific RTE species.

To help address this potential concern, the following section will discuss the ERA assumptions as they relate to the protection of RTE species. The goals of this discussion are as follows:

- Present the methods the ERA employs to account for risks to RTE species and the reasons for their selection.
- Define the factors that might motivate a site- and/or species-specific evaluation[3] of potential herbicide impacts to RTE species and provide perspective useful for such an evaluation.
- Present information that is relevant to assessing the uncertainty in the conclusions reached by the ERA with respect to RTE species.

The following sections describe information used in the ERA to provide protection to RTE species, including mammals, birds, plants, reptiles, amphibians and fish (e.g., salmonids) potentially occurring on BLM-managed lands. It includes a discussion of the quantitative and qualitative factors used to provide additional protection to RTE species and a discussion of potential secondary effects of herbicide use on RTE species.

Section 6.1 provides a review of the selection of LOCs and TRVs with respect to providing additional protection to RTE species. Section 6.2 provides a discussion of species-specific traits and how they relate to the RTE protection strategy in this ERA. Section 6.2 also includes a discussion of the selection of surrogate species (6.2.1), the RTE taxa

[3] Such an evaluation might include site-specific estimation of exposure point concentrations using one or more models, more focused consideration of potential risk to individual RTE species; and/or more detailed assessment of indirect effects to RTE species, such as those resulting from impacts to habitat.

of concern, and the surrogates used to represent them (6.2.2), and the biological factors that affect the exposure to and response of organisms to herbicides (6.2.3). This includes a discussion of how the ERA was defined to assure that consideration of these factors resulted in a conservative assessment. Mechanisms for extrapolating toxicity data from one taxon to another are briefly reviewed in Section 6.3. The potential for impacts, both direct and secondary, to salmonids is discussed in Section 6.4. Section 6.5 provides a summary of the section.

6.1 Use of LOCs and TRVs to Provide Protection to RTE Species

Potential direct impacts to receptors, including RTE species, are the measures of effect typically used in screening level ERAs. Direct impacts, such as those resulting from direct or indirect contact or ingestion, were assessed in the tebuthiuron ERA by comparing calculated RQs to receptor-specific LOCs. As described in the methodology document for this ERA (ENSR 2004c), RQs are calculated as the potential dose or EEC divided by the TRV selected for that pathway. An RQ greater than the LOC indicates the potential for risk to that receptor group via that exposure pathway. As described below, the selection of TRVs and the use of LOCs were pursued in a conservative fashion in order to provide a greater level of protection for RTE species.

The LOCs used in the ERA (Table 4-1) were developed by the USEPA for the assessment of pesticides (LOC information obtained from Michael Davy, USEPA OPP on 13 June 2002). In essence, the LOCs act as uncertainty factors often applied to TRVs. For example, using an LOC of 1.0 provides the same result as dividing the TRV by 10. The LOC for avian and mammalian RTE species is 0.1 for acute and chronic exposures. For fish and aquatic invertebrates, acute and chronic LOCs were 0.05 and 0.5, respectively. Therefore, up to a 20-fold uncertainty factor has been included in the TRVs for animal species. As noted below, such uncertainty factors provide a greater level of protection to RTE species to account for the factors listed in the introduction to this section.

For RTE plants, the exposure concentration, TRVs, and LOCs provided a direct assessment of potential impacts. For all exposure scenarios, the maximum modeled concentrations were used as the exposure concentrations. The TRVs used for RTE plants were selected based on highly sensitive endpoints, such as germination, rather than direct mortality of seedlings or larger plants. Conservatism has been built into the TRVs during their development (Section 3.1); the lowest suitable endpoint concentration available was used as the TRV for RTE plant species. Therefore, the RQ calculated for RTE plant exposure is intrinsically conservative. Given the conservative nature of the RQ, and consistent with USEPA policy, no additional levels of protection were required for the LOC (all plant LOCs are 1).

6.2 Use of Species Traits to Provide Protection to RTE Species

Over 500 RTE species currently listed under the Federal Endangered Species Act (ESA) have the potential to occur in the 17 states covered under this Programmatic ERA. These species include 287 plants, 80 fish, 30 birds, 47 mammals, 15 reptiles, 13 amphibians, 34 insects, 10 arachnids (spiders), and 22 aquatic invertebrates (12 mollusks and 10 crustaceans).[4] Some marine mammals are included in the list of RTE species, but given the limited possibility that these species would be exposed to herbicides applied to BLM-managed lands, no surrogates specific to the marine species are included in this ERA. However, the terrestrial mammalian surrogate species identified for use in the ERA include species that can be considered representative of these marine species as well. The complete list is presented in Appendix D.

Of the over 500 species potentially occurring in the 17 states, just over 300 species may occur on lands managed by the BLM. These species include 7 amphibians, 19 birds, 6 crustaceans, 65 fish, 30 mammals, 10 insects, 13 mollusks, 5 reptiles, and 151 plants.[4] Protection of these species is an integral goal of the BLM. These species are different from one another in regards to home range, foraging strategy, trophic level, metabolic rate, and other species-specific traits. Several methods were used in the ERA to take these differences into account during the quantification of potential

[4] The number of RTE species may have changed slightly since the writing of this document.

risk. Despite this precaution, these traits are reviewed in order to provide a basis for potential site- and species-specific risk assessment. Review of these factors provides a supplement to other sections of the ERA that discuss the uncertainty in the conclusions specific to RTE species.

6.2.1 Identification of Surrogate Species

Use of surrogate species in a screening ERA is necessary to address the broad range of species likely to be encountered on BLM-managed lands as well as to accommodate the fact that toxicity data may be restricted to a limited number of species. In this ERA, surrogates were selected to account for variation in the nature of potential herbicide exposure (e.g., direct contact, food chain) as well as to ensure that different taxa, and their behaviors, are considered. As described in Section 3.0 of the Methods document (ENSR 2004c), surrogate species were selected to represent a broad range of taxa in several trophic guilds that could potentially be impacted by herbicides on BLM-managed lands. Generally, the surrogate species that were used in the ERA are species commonly used as representative species in ERA. Many of these species are common laboratory species, or are described in the USEPA (1993a, b) Exposure Factors Handbook for Wildlife. Other species were included in the California Wildlife Biology, Exposure Factor, and Toxicity Database (CA OEHHA 2003),[5] or are those recommended by USEPA OPP for tests to support pesticide registration. Surrogate species were used to derive TRVs, and in exposure scenarios that involve organism size, weight, or diet, surrogate species were exposed to the herbicide in the models to represent potential impact to other species that may be present on BLM lands.

Toxicity data from surrogate species were used to generate TRVs because few, if any, data are available that demonstrate the toxicity of chemicals to RTE species. Most reliable toxicity tests are performed under controlled conditions in a laboratory, using standardized test species and protocols; RTE species are not used in laboratory toxicity testing. In addition, field-generated data, which are very limited in number but may include anecdotal information about RTE species, are not as reliable as laboratory data because uncontrolled factors may complicate the results of the tests (e.g., secondary stressors such as unmeasured toxicants, imperfect information on rate of exposure).

As described below, inter-species extrapolation of toxicity data often produces unknown bias in risk calculations. This ERA approached the evaluation of higher trophic level species by life history (e.g., large animals vs. small animals, herbivores vs. carnivores). Then surrogate species were used to evaluate all species of similar life history potentially found on BLM-managed lands, including RTE species. This procedure was not done for plants, invertebrates, and fish, as most exposure of these species to herbicides is via direct contact (e.g., foliar deposition, dermal deposition, and dermal/gill uptake) rather than ingestion of contaminated food items. Therefore, altering the life history of these species would not result in more or less exposure.

The following subsections describe the selection of surrogate species used in two separate contexts in the ERA.

6.2.1.1 Species Selected in Development of TRVs

As presented in Appendix A of the ERA, limited numbers of species are used for toxicity testing of chemicals, including herbicides. Species are typically selected because they tolerate laboratory conditions well. The species used in laboratory tests have relatively well-known response thresholds to a variety of chemicals. Growth rates, ingestion rates, and other species-specific parameters are known; therefore, test duration and endpoints of concern (e.g., mortality, germination) have been established in protocols for many of these laboratory species. Data generated during a toxicity test, therefore, can be compared to data from other tests and relative species sensitivity can be compared. Of course, in the case of RTE species, it would be unacceptable to subject individuals to toxicity tests.

The TRVs used in the ERA were selected after reviewing available ecotoxicological literature for tebuthiuron. Test quality was evaluated, and tests with multiple substances were not considered for the TRV. For most receptor groups, the lowest value available for an appropriate endpoint (e.g., mortality, germination) was selected as the TRV. Using

[5] On-line at http://www.oehha.org/cal_ecotox/default.htm

the most sensitive species provides a conservative level of protection for all species. The surrogate species used in the tebuthiuron TRVs are presented in Table 6-1.

6.2.1.2 Species Selected as Surrogates in the ERA

Plants, fish, insects, and other aquatic invertebrates were evaluated on a generic level. That is, the surrogate species evaluated to create the TRVs were selected to represent all potentially exposed species. For vertebrate terrestrial animals, in addition to these surrogate species, specific species were selected to represent the populations of similar species. The species used in the ERA are presented in Table 6-2.

The surrogate terrestrial vertebrate species selected for the ERA include species from several trophic levels that represent a variety of foraging strategies. Whenever possible, the species selected are found throughout the range of land included in the EIS; all species selected are found in at least a portion of the range. The surrogate species are common species whose life histories are well documented (USEPA 1993 a, b, CA OEHHA 2003). Because species-specific data, including BW and food ingestion rates, can vary for a single species throughout its range, data from studies conducted in western states or with western populations were selected preferentially. As necessary, site-specific data can be used to estimate potential risk to species known to occur locally.

6.2.2 Surrogates Specific to Taxa of Concern

Protection levels for different species and individuals vary. Some organisms are protected on a community level; that is, slight risk to individual species may be acceptable if the community of organisms (e.g., wildflowers, terrestrial insects) is protected. Generally, community level organisms include plants and invertebrates. Other organisms are protected on a population level; that is, slight risk to individuals of a species may be acceptable if the population, as a whole, is not endangered. However, RTE species are protected as individuals; that is, risk to any single organism is considered unacceptable. This higher level of protection motivates much of the conservative approach taken in this ERA. Surrogate species were grouped by general life strategy: sessile (i.e., plants), water dwelling (i.e., fish), and mobile terrestrial vertebrates (i.e., birds, mammals, and reptiles). The approach to account for RTE species was divided along the same lines.

Plants, fish, insects, and aquatic invertebrates were assessed using TRVs developed from surrogate species. All species from these taxa (identified in Appendix C) were represented by the surrogate species presented in Table 6-1. The evaluation of terrestrial vertebrates used surrogate species to develop TRVs and to estimate potential risk using simple food chain models. Tables 6-3 and 6-4 present the listed birds and mammals found on BLM-managed lands and their appropriate surrogate species.

Very few laboratory studies have been conducted using reptiles or amphibians. Therefore, data specific to the adverse effects of a chemical on species of these taxa are often unavailable. These animals, being cold-blooded, have very different rates of metabolism than mammals or birds (i.e., they require lower rates of food consumption). Nonetheless, mammals and birds were used as the surrogate species for reptiles and adult amphibians because of the lack of data for these taxa. Fish were used as surrogates for juvenile amphibians. For each trophic level of RTE reptile or adult amphibian, a comparable mammal or bird was selected to represent the potential risks. Table 6-5 presents the 7 listed reptiles found on BLM-managed lands and the surrogate species chosen to represent them in the ERA. Table 6-6 presents the listed amphibians found on BLM-managed lands and their surrogate species.

The sensitivity of reptiles and amphibians relative to other species is generally unknown. Some information about reptilian exposures to pesticides, including herbicides, is available. The following provides a brief summary of the data (as cited in Sparling et al. 2000), including data for pesticides not evaluated in this ERA:

- Mountain garter snakes (*Thamnophis elegans elegans*) were exposed to the herbicide thiobencarb in the field and in the laboratory. No effects were noted in the snakes fed contaminated prey or those caged and exposed directly to treated areas.

- No adverse effects to turtles were noted in a pond treated twice with the herbicide Kuron (2,4,5-T).

- Tortoises in Greece were exposed in the field to atrazine, paraquat, Kuron, and 2,4-D. No effects were noted on the tortoises exposed to atrazine or paraquat. In areas treated with Kuron and 2,4-D, no tortoises were noted following the treatment. The authors of the study concluded the result was a combination of direct toxicity (tortoises were noted with swollen eyes and nasal discharge) and loss of habitat (much of the vegetation killed during the treatment had provided important ground cover for the tortoises).

- Reptilian LD_{50} values from six organochlorine pesticides were compared to avian LD_{50} values. Of the six pesticides, five lizard LD_{50}s were higher, indicating lower sensitivity. Overlapping data were available for turtle exposure to one organochlorine pesticide; the turtle was less sensitive than the birds or lizards.

- In general, reptiles were found to be less sensitive than birds to cholinesterase inhibitors.

Unfortunately, these observations do not provide any sort of rigorous review of dose and response. On the other hand, there is little evidence that reptiles are more sensitive to pesticides than other, more commonly tested organisms.

As with reptiles, some toxicity data are available that describe the effects of herbicides on amphibians. The following provides a brief summary of the data (as cited in Sparling et al. 2000):

- Leopard frog *(Rana pipiens)* tadpoles exposed to up to 0.075 mg/L atrazine showed no adverse effects.

- In a field study, it was noted that frog eggs in a pond where atrazine was sprayed nearby suffered 100% mortality.

- Common frog (*Rana temporaria)* tadpoles showed behavioral and growth effects when exposed to 0.2 to 20 mg/L cyanatryn.

- Caged common frog and common toad (*Bufo bufo)* tadpoles showed no adverse effects when exposed to 1.0 mg/L diquat or 1.0 mg/L dichlobenil.

- All leopard frog eggs exposed to 2.0 to 10 mg/L diquat or 0.5 to 2.0 mg/L paraquat hatched normally, but showed adverse developmental effects. It was noted that commercial formulations of paraquat were more acutely toxic than technical grade paraquat. Tadpoles, however, showed significant mortality when fed paraquat-treated parrot feather watermilfoil (*Myriophyllum aquaticum*).

- 4-chloro-2-methylphenoaxyacetic acid (MCPA) is relatively non-toxic to the African clawed frog (*Xenopus laevis)* with an LC_{50} of 3,602 mg/L, and there is slight growth retardation at 2,000 mg/L.

- Approximately 86% of juvenile toads died when exposed to monosodium methanearsonate (ANSAR 259® HC) at 12.5% of the recommended application rate.

- Embryo hatch success, tadpole mortality, growth, paralysis, and avoidance behavior were studied in three species of ranid frogs (*Rana* sp.) exposed to hexazinone and triclopyr. No effects were noted in hexazinone exposure up to 100 mg/L. Two species showed 100% mortality at 2.4 mg/L triclopyr; no significant mortality was observed in the third species.

No conclusions can be drawn regarding the sensitivity of amphibians to exposure to tebuthiuron relative to the surrogate species selected for the ERA. Amphibians are particularly vulnerable to changes in their environment (chemical and physical) because they have skin with high permeability, making them at risk to dermal contact, and their complex life cycles make them vulnerable to developmental defects during the many stages of metamorphosis. Given the very low risks to animals in the modeled exposures, it is unlikely the concentrations of tebuthiuron predicted to occur as a result of regular herbicide usage would cause adverse effects to amphibians. Nonetheless, it should be noted that certain amphibians can be sensitive to pesticides, and site- and species-specific risk assessment should be carefully considered in the event that amphibian RTE species are present near a site of application.

Although the uncertainties associated with the potential risk to RTE mammals, birds, reptiles, and amphibians are valid, the vertebrate RQs generated in the ERA for tebuthiuron are generally very low (Section 4.3). With the exception of three receptor scenarios modeled for direct spray at the maximum application rate, none of the RQs exceed respective LOCs. Most vertebrate RQs, including fish exposure to accidental direct spray, were lower than respective LOCs by several orders of magnitude.

6.2.3 Biological Factors Affecting Impact from Herbicide Exposure

The potential for ecological receptors to be exposed to, and affected by, herbicide is dependent upon many factors. Many of these factors are independent of the biology or life history of the receptor (e.g., timing of herbicide use, distance to receptor). These factors were explored in the ERA by simulating scenarios that vary these factors (ENSR 2004c); these scenarios are discussed in Section 5.0 of this document. However, there are differences in life history among and between receptors that also influence the potential for exposure. Therefore, individual species have a different potential for exposure as well as response. In order to provide perspective on the assumptions made here, as well as the potential need to evaluate alternatives, receptor traits that may influence species-specific exposure and response were examined. These traits are presented and discussed in Table 6-7.

In addition to providing a review of the approach used in the ERA, the factors listed in Table 6-7 can be evaluated to assess whether a site- and species-specific ERA should be considered to address potential risks to a given RTE. They also provide perspective on the uncertainty associated with applying the conclusions of the ERA to a broad range of RTE species.

6.3 Review of Extrapolation Methods Used to Calculate Potential Exposure and Risk

Ecological risk assessment relies on extrapolation of observations from one system (e.g., species, toxicity endpoint) to another (see Table 6-7). While every effort has been made to anticipate bias in these extrapolations and to use them to provide an overestimate of risk, it is worth evaluating alternative approaches.

Toxicity Extrapolations in Terrestrial Systems (Fairbrother and Kaputska 1996) is an opinion paper that describes the difficulties associated with trying to quantitatively evaluate a particular species when toxicity data for that species, and/or for the endpoint of concern, are not available. The authors provide an overview of uncertainty factors and methods of data extrapolation used in TRV development for terrestrial organisms, and suggest an alternative approach to establishing inter-species TRVs. The following subsections summarize their findings for relevant methods of extrapolation.

6.3.1 Uncertainty Factors

Uncertainty factors are used often in both human health and ERA. The uncertainty factor most commonly used in ERAs is 10. This value has little empirical basis, but was developed and adopted by the risk assessment community because it seemed conservative and was "simple to use."[6] Six situations in which uncertainty factors may be applied in ecotoxicology were identified: (1) accounting for intraspecific heterogeneity, (2) supporting interspecific extrapolation, (3) converting acute to chronic endpoints and vice versa, (4) estimating LOAEL from NOAEL, (5) supplementing professional judgement, and (6) extrapolating laboratory data to field conditions. No extrapolation of toxicity data among classes (i.e., among birds, mammals, and reptiles) was discussed. The methods to extrapolate available laboratory toxicity data to suit the requirements of the TRVs in this ERA are discussed in Section 3. For this reason, extrapolation used to develop TRVs is not discussed in this section.

[6] Section 2, Fairbrother and Kaputska 1996. Page 7.

Empirical data for each of the situations discussed in the Fairbrother and Kaputska paper (as applicable) are presented in Tables 6-8 through 6-12. In each of these tables, the authors have presented the percentage of the available data that is included within a stated factor. For example, 90% of the observed LD_{50}s for bird species lie within a factor of ten (i.e., the highest LD_{50} within the central 90% of the population is 10-fold higher than the lowest value). This approach can be compared to the approach used in this ERA. For example, for aquatic invertebrates, an LOC of 0.05 was defined, which is analogous to application of an uncertainty factor 20 to the relevant TRV. In this case, the selected TRV is not the highest or the mid-point of the available values, but a value at the lower end of the available range. Thus, dividing the TRV by a factor of 20 is very likely to place it well below any observed TRV. With this perspective, the ranges (or uncertainty factors) provided by Fairbrother and Kaputska (1996) generally appear to support the approach used in the ERA (i.e., select low TRVs and consider comparison to an LOC < 1.0).

6.3.2 Allometric Scaling

Allometric scaling provides a formula based on BW that allows scaling of doses from one animal species to another. In this ERA, allometric scaling was used to extrapolate the terrestrial vertebrate TRVs from the laboratory species to the surrogate species used to estimate potential risk. The Environmental Sciences Division of the Oak Ridge National Laboratory (ORNL) (Opresko et al. 1994 and Sample et al. 1996) has used allometric scaling for many years to establish benchmarks for vertebrate wildlife. The USEPA has also used allometric scaling in development of wildlife water quality criteria in the Great Lakes Water Quality Initiative (USEPA 1995) and in the development of ecological soil screening levels (USEPA 2000).

The theory behind allometric scaling is that metabolic rate is proportional to body size. However, assumptions are made that toxicological processes are dependent on metabolic rate, and that toxins are equally bioavailable among species. Similar to other types of extrapolation, allometric scaling is sensitive to the species used in the toxicity test selected to develop the TRV. Given the limited amount of data, using the lowest value available for the most sensitive species is the best approach[7], although the potential remains for site-specific receptors to be more sensitive to the toxin. Further uncertainty is introduced to allometric scaling when the species-specific parameters (e.g., BW, ingestion rate) are selected. Interspecies variation of these parameters can be considerable, especially among geographic regions. Allometric scaling is not applicable between classes of organisms (e.g., bird to mammal). However, given these uncertainties, allometric scaling remains the most reliable easy-to-use means to establish TRVs for a variety terrestrial vertebrate species (Fairbrother and Kaputska 1996).

6.3.3 Recommendations

Fairbrother and Kaputska (1996) provided a critical evaluation of the existing, proposed, and potential means for intra-species toxicity value extrapolation. The paper they published describes the shortcomings of many methods of intra-specific extrapolation of toxicity data for terrestrial organisms. Using uncertainty factors or allometric scaling for extrapolation can often over- or under-predict the toxic effect to the receptor organism. Although using physiologically-based models may be a more scientifically correct way to predict toxicity, the logistics involved with applying them to an ERA on a large-scale make them impractical. In this ERA, extrapolation was performed using techniques most often employed by the scientific risk assessment community. These techniques included the use of uncertainty factors (i.e., potential use of LOC < 1.0) and allometric scaling.

6.4 Indirect Effects on Salmonids

In addition to the potential direct toxicity associated with herbicide exposure, organisms may be harmed from indirect effects, such as habitat degradation or loss of prey. Under Section 9 of the ESA of 1973, it is illegal to take an

[7] In the 1996 update to the ORNL terrestrial wildlife screening values document (Sample et al. 1996), studies by Mineau et al. (1996) using allometric scaling indicated that, for 37 pesticides studied, avian LD_{50}s varied from 1 to 1.55, with a mean of 1.148. The LD_{50} for birds is now recommended to be 1 across all species.

endangered species of fish or wildlife. "Take" is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." (16 USC 1532(19)). The National Marine Fisheries Service (NMFS; NOAA 1999) published a final rule clarifying the definition of "harm" as it relates to take of endangered species in the ESA. NOAA Fisheries defines "harm" as any act that injures or kills fish and wildlife. Acts may include "significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering." To comply with the ESA, potential secondary effects to salmonids were evaluated to ensure that use of tebuthiuron on BLM-managed lands would not cause harm to these endangered fish.

Indirect effects can generally be categorized as effects caused by either biological or physical disturbance. Biological disturbance includes impacts to the food chain; physical disturbance includes impacts to habitat[8] (Freeman and Boutin 1994).NOAA Fisheries (2002) has internal draft guidance for their Section 7 pesticide evaluations. The internal draft guidance describes the steps that should be taken in an ERA to ensure salmonids are addressed appropriately. The following subsections describe how, consistent with internal draft guidance from NOAA Fisheries, the tebuthiuron ERA dealt with the indirect effects assessment.

6.4.1 Biological Disturbance

Potential direct effects to salmonids were evaluated in the ERA. Sensitive endpoints were selected for the RTE species RQ calculations, and worst-case scenarios were assumed. With the exception of exposure by a direct spill, no tebuthiuron RQs for fish exceeded the respective RTE LOC (Section 4.3). Indirect effects caused by disturbance to the surrounding biological system were evaluated by looking at potential damage to the food chain.

The majority of the salmonid diet consists of aquatic invertebrates. Sustaining the aquatic invertebrate population is vital to minimizing biological damage from herbicide use. Consistent with ERA guidance (USEPA 1997, 1998), protection of non-RTE species, such as the aquatic invertebrates serving as prey to salmonids, is at the population or community level, not the individual level. Sustainability of the numbers (population) or types (community) of aquatic invertebrates and fish is the assessment endpoint. Therefore, unless acute risks are present, it is unlikely the herbicide will cause harm to the prey base of salmonids from direct damage to the aquatic invertebrates. As discussed in Section 4.3, with the exception of accidental spills and chronic exposure in a pond from runoff, no aquatic invertebrate, acute or chronic scenario RQs exceeded respective LOCs suggesting that direct impacts to the forage of salmonids are unlikely.

As primary producers and the food base of aquatic invertebrates, disturbance to aquatic vegetation may affect the aquatic invertebrate population, thereby affecting salmonids. As presented in Section 4.3, the potential for risk to aquatic vegetation may occur under a variety of exposure scenarios. The runoff scenario describes potential adverse effects to aquatic vegetation in a pond, but under most circumstances, not in a stream, the primary habitat of salmonids. The greatest potential for risk to aquatic vegetation would occur under accidental direct spray or spill of a terrestrial herbicide in to an aquatic system. RQs exceeded LOCs by up to three orders of magnitude under the spill and accidental spray scenarios. RQs in the runoff scenarios to a stream exceeded LOCs by up to a factor of two. This suggests that the potential for impacts to aquatic vegetation, and potential indirect effects on salmonids, from the use of the herbicide is likely to be restricted to only a few scenarios including accidental direct spraying.

The actual food items of many aquatic invertebrates, however, are not leafy aquatic vegetation, but detritus or benthic algae. Should aquatic vegetation be affected by an accidental herbicide exposure, the detritus in the stream may increase. Benthic algae are often the principal primary producers in streams. As such, disturbance of algal communities would cause an indirect effect (i.e., reduction in biomass at the base of the food chain) on all organisms living in the waterbody, including salmonids. Few data are available for the herbicide toxicity to benthic algae. Of the

[8] Physical damage to habitat may also be covered under an evaluation of critical habitat. Since all reaches of streams and rivers on BLM-administered lands may not be listed as critical habitat, a generalized approach to potential damage to any habitat was conducted. Any potential for risk due to physical damage to habitat should be addressed specifically for areas deemed critical habitat.

algae data used for tebuthiuron TRVs, the closest species to benthic algae is green algae, *Selenastrum capricornutum* . It is unknown if benthic algae would be more or less sensitive than *Selenastrum capricornutum*, the species used to derive the acute and chronic aquatic plant TRVs.

Based on an evaluation of the RQs calculated for this ERA, it is unlikely RTE fish, including salmonids, would be at risk from the indirect effects this herbicide may have on the aquatic food chain. Exceptions to this include potential acute effects to aquatic life from accidental spills, an extreme and unlikely scenario considered in this ERA to add conservatism to the risk estimates. Appropriate and careful use of tebuthiuron should preclude such an incident.

6.4.2 Physical Disturbance

The potential for indirect effects to salmonids as a result of physical disturbance is less easy to define than the potential for direct biological effects. Salmonids have distinct habitat requirements; any alteration to the coldwater streams in which they spawn and live until returning to the ocean as adults can be detrimental to the salmonid population. Out of the potential effects of herbicide application, it is likely that the killing of instream and riparian vegetation would cause the most important physical disturbances. The potential adverse effects could include, but would not necessarily be limited to: loss of primary producers (Section 6.4.1); loss of overhead cover, which may serve as refuge from predators or shade to provide cooling to the waterbodies; and increased sedimentation due to loss of riparian vegetation.

Adverse effects caused by herbicides can be cumulative, both in terms of toxicity stress from break-down products and other chemical stressors that may be present, and in terms of the use of herbicide on lands already stressed on a larger scale. Cumulative watershed effects (CWEs) often arise in conjunction with other land use practices, such as prescribed burning[9]. In forested areas, herbicides are generally used in areas that have been previously altered, such as cut or burned, during vegetative succession when invasive species may dominate. The de-vegetation of these previously stressed areas can delay the stabilization of the substrate, increasing the potential for erosion and resulting sedimentation in adjacent waterbodies.

Based on the results of the ERA, there is potential for risk to non-target terrestrial and aquatic plants in unlikely circumstances, such as incidents of spills or accidental direct spray (Sections 4.3.1 and 4.3.5), as well as in selected situations resulting from surface runoff at the maximum application rate, and from drift within 25-m of an application site. However, under the majority of exposure scenarios, no apparent risk to non-target plants is predicted. While it is unlikely that responsible use of tebuthiuron by BLM land managers will indirectly affect salmonids through the killing of in-stream or riparian vegetation, land managers should consider the proximity of salmonid habitat to potential application areas. It may be productive to develop a more site- and/or species-specific ERA in order to assure that the proposed herbicide application will not result in secondary impacts to salmonids, especially associated with loss of riparian cover.

In July 2004, the OPP evaluated the potential for tebuthiuron to impact Pacific anadromous salmonids (specifically Pacific salmon and steelhead) and their critical habitats in California and the Pacific Northwest. The OPP concluded that, based on the historic use of tebuthiuron (i.e., areas of application, nationwide use levels, application rates, and label limitations), tebuthiuron "will have no direct effect on endangered salmonids nor indirect effects from loss of food supply or loss of cover" (Stavola 2004).

6.5 Conclusions

The tebuthiuron ERA evaluated the potential risks to many species using many exposure scenarios. Some exposure scenarios are likely to occur, whereas others are unlikely to occur but were included to provide a level of conservatism to the ERA. Individual RTE species were not directly evaluated. Instead, surrogate species toxicity data were used to

[9] The following website provides a more detailed discussion of CWEs http://www.humbolt1.com/~heyenga/Herb.Drft.8_12_99.html.

indirectly evaluate RTE species exposure. Higher trophic level receptors were also evaluated based on their life history strategies; RTE species were represented by one of several avian or mammalian species commonly used in ERAs. To provide a layer of conservatism to the evaluation, lower LOCs and TRVs were used to assess the potential impacts to RTE species.

Uncertainty factors and allometric scaling were used to adjust the toxicity data on a species-specific basis when they were likely to improve applicability and/or conservatism. As discussed in Section 3.1, TRVs were developed using the best available data; uncertainty factors were applied to toxicity data consistent with recommendation of Chapman et al. (1998).

In a review of potential impacts of another terrestrial herbicide to threatened and endangered salmonids, USEPA OPP indicated that "for most pesticides applied to terrestrial environment, the effects in water, even lentic water, will be relatively transient" (Turner 2003). Only very persistent pesticides would be expected to have effects beyond the year of their application. The OPP report indicated that if a listed salmonid is not present during the year of application, there would likely be no concern (Turner 2003).

Potential secondary effects of tebuthiuron use should be of primary concern for the protection of RTE species. Habitat disturbance and disruptions in the food chain are often the cause of declines of species and populations. Herbicides may reduce riparian zones or harm primary producers in the waterbodies. For RTE species, habitat or food chain disruptions should be avoided to the extent practical. Some relationships among species are mutualistic, commensalistic, or otherwise symbiotic. For example, many species rely on a particular food source or habitat. Without that food or habitat species, the dependent species may be unduly stressed or extirpated. For RTE species, these obligatory habitats are often listed by USFWS as critical habitats. Critical habitats are afforded certain protection under the ESA. All listed critical habitat, as well as habitats that would likely support RTE species, should be avoided, as disturbance to the habitat may have an indirect adverse effect on RTE species.

The results of the ERA indicate that non-target terrestrial and aquatic plants may be at risk from tebuthiuron, especially when accidents occur, such as spills or accidental spraying, or sometimes when herbicides are applied at maximum application rates or too close to non-target receptors. In addition, RTE salmonids and other RTE species that depend on terrestrial and aquatic vegetation for habitat, food, etc. could be indirectly harmed by the application of tebuthiuron. However, certain application guidelines and restrictions (e.g., application rate, buffer distance, avoidance of designated critical habitat) for appropriate and responsible use of the herbicide on BLM-managed lands would reduce this risk (see Section 8).

TABLE 6-1
Surrogate Species Used to Derive Tebuthiuron TRVs

Species in Tebuthiuron Laboratory/Toxicity Studies		Surrogate for
Honeybee	*Apis mellifera*	Pollinating insects
Mouse	*Cavia sp.*	Mammals
Rat	*Rattus norvegicus* spp.	Mammals
Dog	*Canis familiaris*	Mammals
Rabbit	*Leporidae sp*	Mammals
Chicken	*Gallus gallus*	Birds
Bobwhite Quail	*Colinus virginianus*	Birds
Mallard	*Anas platyrhynchos*	Birds
Cabbage	*Brassica sp.*	Non-target terrestrial plants
Vegetative Crop	10 species, monocots and dicots	Non-target terrestrial plants
Water flea	*Ceriodaphnia dubia*	Aquatic invertebrates
Bluegill sunfish	*Lepomis macrochirus*	Fish
Snail	*Helisoma* and *Physa* spp.	Aquatic invertebrates
Fathead minnow	*Pimephales promelas*	Fish/Salmonids
Algae	*Selanastrum capricornutum*	Non-target aquatic plants

TABLE 6-2
Surrogate Species Used in Quantitative ERA Evaluation

Species		Trophic Level/Guild	Pathway Evaluated
American robin	*Turdus migratorius*	Avian invertivore/ vermivore/ insectivore	Ingestion
Canada goose	*Branta canadensis*	Avian granivore/ herbivore	Ingestion
Deer mouse	*Peromyscus maniculatus*	Mammalian frugivore/ herbivore	Direct contact and Ingestion
Mule deer	*Odocolieus hemionus*	Mammalian herbivore/ gramivore	Ingestion
Bald eagle (northern)	*Haliaeetus leucocephalus alascanus*	Avian carnivore/ piscivore	Ingestion
Coyote	*Canis latrans*	Mammalian carnivore	Ingestion

TABLE 6-3
RTE Birds and Selected Surrogates

RTE Avian Species Potentially Occurring on BLM Lands		RTE Trophic Guild	Surrogates
Marbled murrelet	*Brachyramphus marmoratus marmoratus*	Piscivore	Bald eagle
Western snowy plover	*Charadrius alexandrinus nivosus*	Insectivore/ Piscivore	American robin
Piping plover	*Charadrius melodus*	Insectivore	American robin
Mountain plover	*Charadrius montanus*	Insectivore	American robin
Southwestern willow flycatcher	*Empidonax traillii extimus*	Insectivore	American robin
Northern aplomado falcon	*Falco femoralis septentrionalis*	Carnivore	Bald eagle Coyote
Cactus ferruginous pygmy-owl	*Glaucidium brasilianum cactorum*	Carnivore	Bald eagle Coyote
Whooping crane	*Grus Americana*	Piscivore	Bald eagle
California condor	*Gymnogyps californianus*	Carnivore	Bald eagle Coyote
Bald eagle	*Haliaeetus leucocephalus*	Piscivore	Bald eagle
Brown pelican	*Pelecanus occidentalis*	Piscivore	Bald eagle
Inyo California towhee	*Pipilo crissalis eremophilus*	Omnivore [Granivore/ Insectivore]	Canada goose American robin
Coastal California gnatcatcher	*Polioptila californica californica*	Insectivore	American robin
Stellar's eider	*Polysticta stelleri*	Piscivore	Bald eagle
Yuma clapper rail	*Rallus longirostris yumanensis*	Carnivore	Bald eagle Coyote
Spectacled eider	*Somateria fischeri*	Omnivore [Insectivore/ Herbivore]	American robin Canada goose
Least tern	*Sterna antillarum*	Piscivore	Bald eagle
Northern spotted owl	*Strix occidentalis caurina*	Carnivore	Bald eagle Coyote
Mexican spotted owl	*Strix occidentalis lucida*	Carnivore	Bald eagle Coyote
Least Bell's vireo	*Vireo bellii pusillus*	Insectivore	American robin

TABLE 6-4
RTE Mammals and Selected Surrogates

RTE Mammalian Species Potentially Occurring on BLM Lands		RTE Trophic Guild	Surrogates
Sonoran pronghorn	*Antilocapra americana sonoriensis*	Herbivore	Mule deer
Pygmy rabbit	*Brachylagus idahoensis*	Herbivore	Mule deer
Gray wolf	*Canis lupus*	Carnivore	Coyote
Utah prairie dog	*Cynomys parvidens*	Herbivore	Deer mouse
Morro Bay kangaroo rat	*Dipodomys heermanni morroensis*	Omnivore [Herbivore/ Insectivore]	Deer mouse American robin
Giant kangaroo rat	*Dipodomys ingens*	Granivore/ Herbivore	Deer mouse
Fresno kangaroo rat	*Dipodomys nitratoides exilis*	Granivore/ Herbivore	Deer mouse
Tipton kangaroo rat	*Dipodomys nitratoides nitratoides*	Granivore/ Herbivore	Deer mouse
Stephens' kangaroo rat	*Dipodomys stephensi (incl. D. cascus)*	Granivore	Deer mouse
Southern sea otter	*Enhydra lutris nereis*	Carnivore/ Piscivore	Coyote Bald eagle
Steller sea lion	*Eumetopias jubatus*	Carnivore/ Piscivore	Coyote Bald eagle
Sinaloan jaguarundi	*Herpailurus (=Felis) yaguarundi tolteca*	Carnivore	Coyote
Ocelot	*Leopardus (=Felis) pardalis*	Carnivore	Coyote
Lesser long-nosed bat	*Leptonycteris curosoae yerbabuenae*	Frugivore/ Nectivore	Deer mouse
Mexican long-nosed bat	*Leptonycteris nivalis*	Herbivore	Deer mouse
Canada lynx	*Lynx canadensis*	Carnivore	Coyote
Amargosa vole	*Microtus californicus scirpensis*	Herbivore	Deer mouse
Hualapai Mexican vole	*Microtus mexicanus hualpaiensis*	Herbivore	Deer mouse
Black-footed ferret	*Mustela nigripes*	Carnivore	Coyote
Riparian (=San Joaquin Valley) woodrat	*Neotoma fuscipes riparia*	Herbivore	Deer mouse
Columbian white-tailed deer	*Odocolieus virginianus leucurus*	Herbivore	Mule deer
Bighorn sheep	*Ovis canadensis*	Herbivore	Mule deer
Bighorn sheep	*Ovis canadensis californiana*	Herbivore	Mule deer
Jaguar	*Panthera onca*	Carnivore	Coyote
Woodland caribou	*Rangifer tanandus caribou*	Herbivore	Mule deer
Northern Idaho ground squirrel	*Spermophilus brunneus brunneus*	Herbivore	Deer mouse
Grizzly bear	*Ursus arctos horribilis*	Omnivore [Herbivore/ Insectivore/ Piscivore]	American robin Mule deer Bald eagle
San Joaquin kit fox	*Vulpes macrotis mutica*	Carnivore	Coyote
Preble's meadow jumping mouse	*Zapus hudsonius preblei*	Omnivore [Herbivore/ Insectivore]	Deer mouse American robin

TABLE 6-5
RTE Reptiles and Selected Surrogates

RTE Reptilian Species Potentially Occurring on BLM Lands		RTE Trophic Guild	Surrogates
New Mexican ridge-nosed rattlesnake	*Crotalus willardi obscurus*	Carnivore/ Insectivore	Coyote/Bald eagle
			American robin
Blunt-nosed leopard lizard	*Gambelia silus*	Carnivore/ Insectivore	Coyote/Bald eagle
			American robin
Desert tortoise	*Gopherus agassizii*	Herbivore	Canada goose
Giant garter snake	*Thamnophis gigas*	Carnivore/ Insectivore/ Piscivore	Coyote
			American robin
			Bald eagle
Coachella Valley fringe-toed lizard	*Uma inornata*	Insectivore	American robin

Note: Five sea turtles are also listed species in the 17 states evaluated in this ERA. However, it is unlikely any exposure to herbicide would occur to marine species.

TABLE 6-6
RTE Amphibians and Selected Surrogates

RTE Amphibious Species Potentially Occurring on BLM Lands		RTE Trophic Guild	Surrogates
California tiger salamander	*Ambystoma californiense*	Invertivore[1]	Bluegill sunfish/Rainbow trout[3]
		Vermivore[2]	American robin[4]
Sonoran tiger salamander	*Ambystoma tigrinum stebbinsi*	Invertivore, Insectivore[1]	Bluegill sunfish/Rainbow trout[3]
		Carnivore, Ranivore[2]	American robin[4]
Desert slender salamander	*Batrachoseps aridus*	Invertivore	American robin[4,5]
Wyoming toad	*Bufo baxteri*	Insectivore	Bluegill sunfish/Rainbow trout[3]
			American robin[4]
Arroyo toad (=Arroyo southwestern toad)	*Bufo californicus*	Herbivore[1]	Bluegill sunfish/Rainbow trout[3]
		Invertivore[2]	American robin[4]
California red-legged frog	*Rana aurora draytonii*	Herbivore[1]	Bluegill sunfish/Rainbow trout[3]
		Invertivore[2]	American robin[4]
Chiricahua leopard frog	*Rana chiricahuensis*	Herbivore[1]	Bluegill sunfish/Rainbow trout[3]
		Invertivore[2]	American robin[4]

[1] Diet of juvenile (larval) stage.
[2] Diet of adult stage.
[3] Surrogate for juvenile stage.
[4] Surrogate for adult stage.
[5] *Bratrachoseps aridus* is a lungless salamander that has no aquatic larval stage, and is terrestrial as an adult.

TABLE 6-7
Species and Organism Traits That May Influence Herbicide Exposure and Response

Characteristic	Mode of Influence	ERA Solution
Body size	Larger organisms have a more surface area potentially exposed during a direct spray exposure scenario. However, larger organisms have a smaller surface area to volume ratio, leading to a lower per body weight dose of herbicide per application event.	To evaluate potential impacts from direct spray, small organisms were selected (i.e., honeybee and deer mouse).
Habitat preference	Not all of BLM lands are subject to nuisance vegetation control.	It was assumed that all organisms evaluated in the ERA were present in habitats subject to herbicide treatment.
Duration of potential exposure /home range	Some species are migratory or present during only a fraction of year, and larger species have home ranges that likely extend beyond application areas, thereby reducing exposure duration.	It was assumed that all organisms evaluated in the ERA were present within the zone of exposure full-time (i.e., home range = application area).
Trophic level	Many chemical concentrations increase in higher trophic levels.	Although the herbicides evaluated in the ERA have very low potential to bioaccumulate, BCFs were selected to estimate uptake to trophic level 3 fish (prey item for the piscivores), and several trophic levels (primary producers through top-level carnivore) were included in the ERA.
Food preference	Certain types of food or prey may be more likely to attract and retain herbicide.	It was assumed that all types of food were susceptible to high deposition and retention of herbicide.
Food ingestion rate	On a mass ingested per body weight basis, organisms with higher food ingestion rates (e.g., mammals versus reptiles) are more likely to ingest large quantities of food (therefore, herbicide).	Surrogate species were selected that consume large quantities of food, relative to body size. When ranges of ingestion rates were provided in the literature, the upper end of the values was selected for use in the ERA.
Foraging strategy	The way an organism finds and eats food can influence its potential exposure to herbicide. Organisms that consume insects or plants that are underground are less likely to be exposed via ingestion than those that consume exposed food items, such as grasses and fruits.	It was assumed all food items evaluated in the ERA were fully exposed to herbicide during spray or runoff events.
Metabolic and excretion rate	While organisms with high metabolic rates may ingest more food, they may also have the ability to excrete herbicides quickly, lowering the potential for chronic impact.	It was assumed that no herbicide was excreted readily by any organism in the ERA.
Rate of dermal uptake	Different organisms will assimilate herbicides across their skins at different rates. For example, thick scales and shells of reptiles and the fur of mammals are likely to present a barrier to uptake relative to bare skin.	It was assumed that uptake across the skin was unimpeded by scales, shells, fur, or feathers.
Sensitivity to herbicide	Species respond to chemicals differently; some species may be more sensitive to certain chemicals.	The literature was searched and the lowest values from appropriate toxicity studies were selected as TRVs. Choosing the sensitive species as surrogates for the TRV development provides protection to more species.
Mode of toxicity	Response sites to chemical exposure may not be the same among all species. For instance, the presence of aryl hydrocarbon (Ah) receptors in an organism increases its susceptibility to compounds that bind to proteins or other cellular receptors. However, not all species, even within a given taxonomic group (e.g., mammals) have Ah receptors.	Mode of toxicity was not specifically addressed in the ERA. Rather, by selecting the lowest TRV, it was assumed that all species evaluated in the ERA were also sensitive to the mode of toxicity.

TABLE 6-8
Summary of Findings: Interspecific Extrapolation Variability

Type of Data	Percentage of Data Variability Accounted for Within a Factor of:								
	2	4	10	15	20	50	100	250	300
Bird LD_{50}	--	--	90%	--	--	--	99%	100%	--
Mammal LD_{50}	--	58%	--	--	90%	--	96%	--	--
Bird and Mammal Chronic	--	--	--	--	--	94%	--	--	--
Plants	93%[a] 80%[b]	--	--	80%[c]	--	--	--	--	80%[d]

(a) Intra-genus extrapolation.
(b) Intra-family extrapolation.
(c) Intra-order extrapolation.
(d) Intra-class extrapolation.

TABLE 6-9
Summary of Findings: Intraspecific Extrapolation Variability

Type of Data	Percentage of Data Variability Accounted for Within Factor of 10	Citation from Fairbrother and Kaputska 1996
490 probit log-dose slopes	92%	Dourson and Starta 1983 as cited in Abt Assoc., Inc. 1995
Bird LC_{50}:LC_1	95%	Hill et al. 1975
Bobwhite quail LC_{50}:LC_1	71.5%	Shirazi et al. 1994

TABLE 6-10
Summary of Findings: Acute-to-chronic Extrapolation Variability

Type of Data	Percentage of Data Variability Accounted for Within Factor of 10	Citation from Fairbrother and Kaputska 1996
Bird and mammal dietary toxicity NOAELs (n=174)	90%	Abt Assoc., Inc. 1995

TABLE 6-11
Summary of Findings: LOAEL-to-NOAEL Extrapolation Variability

Type of Data	Percentage of Data Variability Accounted for Within Factor of:		Citation from Fairbrother and Kaputska 1996
	6	10	
Bird and mammal LOAELs and NOAELs	80%	97%	Abt Assoc., Inc. 1995

TABLE 6-12
Summary of Findings: Laboratory to Field Extrapolations

Type of Data	Response	Citation from Fairbrother and Kaputska 1996
Plant EC_{50} Values	3 of 20 EC_{50} lab study values were 2-fold higher than field data. 3 of 20 EC_{50} values from field data were 2-fold higher than lab study data.	Fletcher et al. 1990
Bobwhite quail	Shown to be more sensitive to cholinesterase-inhibitors when cold-stressed (i.e., more sensitive in the field).	Maguire and Williams 1987
Gray-tailed vole and deer mouse	Laboratory data over-predicted risk.	Edge et al. 1995

7.0 UNCERTAINTY IN THE ECOLOGICAL RISK ASSESSMENT

Every time an assumption is made, some level of uncertainty is introduced into the risk assessment. A thorough description of uncertainties is a key component that serves to identify possible weaknesses in the ERA analysis, and to elucidate what impact such weaknesses might have on the final risk conclusions. This uncertainty analysis lists the uncertainties, with a discussion of what bias—if any—the uncertainty may introduce into the risk conclusions. This bias is represented in qualitative terms that best describe whether the uncertainty might 1) underestimate risk, 2) overestimate risk, or 3) be neutral with regard to the risk estimates, or whether it cannot be determined without additional study.

Uncertainties in the ERA process are summarized in Table 7-1. Several of the uncertainties warrant further evaluation and are discussed below. In general, the assumptions made in this risk assessment have been designed to yield a conservative evaluation of the potential risks to the environment from herbicide application.

7.1 Toxicity Data Availability

The majority of the available toxicity data was obtained from studies conducted as part of the USEPA pesticide registration process. There are a number of uncertainties related to the use of this limited data set in the risk assessment. In general, it would often be preferable to base any ecological risk analysis on reliable field studies that clearly identify and quantify the amount of potential risk from particular exposure concentrations of the chemical of concern. However, in most risk assessments it is more common to extrapolate the results obtained in the laboratory to the receptors found in the field. It should be noted, however, that laboratory studies often actually overestimate risk relative to field studies (Fairbrother and Kapustka 1996).

Three tebuthiuron incident reports were available from the USEPAs Environmental Fate and Effects Division (EFED) (described in Section 2.3 and Table 2-2). These reports can be used to validate both exposure models, and/or hazards to ecological receptors. One incident report indicated that it was “highly probable” that the use of tebuthiuron resulted in the mortality of trees and algae in a nearby pond when it was applied on a right-of-way along power lines in Florida. This incident was classified as an accidental misuse of the herbicide. These observations support the predictions of risk to aquatic and terrestrial plants in the ERA due to off-site drift and surface runoff. Tebuthiuron was listed as the “probable” cause in the remaining two incidents. However, since the incident reports provide limited information regarding herbicide concentrations it is impossible to fully correlate the impacts predicted in the ERA with the incident reports.

Species for which toxicity data are available may not necessarily be the most sensitive species to a particular herbicide. These species have been selected as laboratory test organisms because they are generally sensitive to stressors, yet they can be maintained under laboratory conditions. However, the selected toxicity value for a receptor was based on a thorough review of the available data by qualified toxicologists and the selection of the most appropriate sensitive surrogate species. The surrogate species used in the registration testing are not an exact match to the wildlife receptors included in the ERA. For example, the only avian data available is for two primarily herbivorous birds: the mallard duck and the bobwhite quail. However, TRVs based on these receptors were also used to evaluate risk to insectivorous and piscivorous birds. Species with alternative feeding habits or species from different taxonomic groups may be more or less sensitive to the herbicide than those species tested in the laboratory. As discussed previously, plant toxicity data is generally only available for crop species, which may have different sensitivities than the rangeland plants occurring on BLM managed lands. Tebuthiuron is registered for woody plant (i.e., trees, shrubs, vines) and herbaceous broadleaf plant (i.e., clover) control, so the use of cabbage, a broadleaf species as a surrogate receptor is likely to be appropriately sensitive. Impacts to rangeland and non-cropland species may be overestimated by the used of toxicity data based on broadleaf species such as cabbage and other vegetables.

In general, the most sensitive available endpoint for the appropriate surrogate test species was used to derive TRVs. This approach is conservative since there may be a wide range of data and effects for different species. For example, several LC_{50}s were available for the aquatic invertebrates. These values ranged from 297 mg/L to > 400 mg/L for a *Daphnia magna*. Accordingly, 297 mg/L was selected as the aquatic invertebrate TRV. This selection criterion for the TRVs has the potential to overestimate risk within the ERA. In addition, in some cases (i.e., birds), no toxicity effects were observed at any of the tested doses, so these selected TRVs also have the potential to overestimate risk to these receptors.

There is also some uncertainty in the conversion of food concentration-based toxicity values (mg herbicide per kg food) to dose-based values (mg herbicide per kg BW) for birds and mammals. Converting the concentration-based endpoint to a dose-based endpoint is dependent upon certain assumptions, specifically the test animal ingestion rate and test animal BW. Default ingestion rates for different test species were used in the conversions unless test-specific values were measured and given. The ingestion rate was assumed to be constant throughout a test. However, it is possible that a test chemical may positively or negatively affect ingestion, thus resulting in an over- or underestimation of total dose.

For the purposes of pesticide registration, tests are conducted according to specific test protocols. For example, in the case of an avian oral LD_{50} study, test guidance follows the harmonized Office of Pollution Prevention and Toxic Substances (OPPTS) protocol 850.2100, Avian Acute Oral Toxicity Test or its Toxic Substances Control Act (TSCA) or FIFRA predecessor (e.g, 40 CFR 797.2175 and OPP 71-1). In this test the bird is given a single dose, by gavage, of the chemical and the test subject is observed for a minimum of 14 days. The LD_{50} derived from this test is the true dose (mg herbicide per kg BW). However, dietary studies were selected preferentially for this ERA and historical dietary studies followed 40 CFR 797.2050, OPP 71-2, or OECD 205, the procedures for which are harmonized in OPPTS 850.2200, Avian Dietary Toxicity Test. In this test, the test organism is presented with the dosed food for 5 days, with 3 days of additional observations after the chemical-laden food is removed. The endpoint for this assay is reported as an LC_{50} representing mg herbicide per kg food. For this ERA, the concentration-based value was converted to a dose-based value following the methodology presented in the Methods Document (ENSR 2004c)[10]. Then the dose-based value was multiplied by the number of days of exposure (generally 5) to result in an LD_{50} value representing the full herbicide exposure over the course of the test.

As indicated in Section 3.1, the toxicity data within the ERAs are presented in the units used in the reviewed studies. Attempts were not made to adjust toxicity data to the % a.i. since it was not consistently provided in all reviewed materials. In most cases the toxicity data applies to the a.i. itself; however, some data corresponds to a specific product containing the a.i. under consideration, and potentially other ingredients (e.g., other a.i. or inert ingredients). The assumption has been made that the toxicity observed in the tests is due to the a.i. under consideration. However, it is possible that the additional ingredients in the different formulations also had an effect. The OPP's Ecotoxicity Database (a source of data for the ERAs) does not adjust the toxicity data to the % a.i. and presents the data directly from the registration study in order to capture the potential effect caused by various inerts, additives, or other a.i. in the tested product. In many cases the tested material represents the highest purity produced and higher exposure to the a.i. would not be likely.

For tebuthiuron, the % a.i., listed in Appendix A when available from the reviewed study, ranged from 20% to 100%. The lowest % a.i. used in the actual TRV derivation was >97% in the studies used to derive some TRVs for aquatic invertebrates and fish. Adjusting these TRVs to 100% of the a.i. (by multiplying the TRV by the % a.i. in the study) would reduce these TRVs very slightly, resulting in slightly more elevated RQs. However, this would not result in any additional LOC exceedances. The remaining TRVs are based on studies with at least 97% a.i., so the RQ changes would be even more minimal.

[10] Dose-based endpoint $_{(mg/kg\ BW/day)}$ = [Concentration-based endpoint $_{(mg/kg\ food)}$ x Food Ingestion Rate $_{(kg\ food/day)}$]/BW $_{(kg)}$

7.2 Potential Indirect Effects on Salmonids

No actual field studies, or ecological incident reports related to the effects of tebuthiuron on salmonids were identified during the ERA. Therefore, any discussion of direct or indirect impacts to salmonids was limited to qualitative estimates of potential impacts on salmonid populations and communities. Salmonids were included in the database used to derive fish TRVs; however, toxicity data indicated that warm-water fish were more sensitive to tebuthiuron than were salmonids. A discussion of the potential indirect impacts to salmonids is presented in Section 4.3.6, and Section 6.6 provides a discussion of RTE salmonid species. These evaluations indicated that salmonids are not likely to be indirectly impacted by a reduction in food supply (i.e., fish and aquatic invertebrates). However, a reduction in vegetative cover may occur under limited conditions. Since the derivation of the fish TRV was based on a warm-water species, these results may overestimate the risk to salmonids from tebuthiuron concentrations in streams.

It is anticipated that these qualitative evaluations overestimate the potential risk to salmonids because of the conservative selection of TRVs for salmonid prey and vegetative cover, application of additional LOCs (with uncertainty/safety factors applied) to assess risk to RTE species, and the use of conservative stream characteristics in the exposure scenarios (i.e., low order stream, relatively small instantaneous volume, limited consideration of herbicide degradation or absorption in models).

7.3 Ecological Risks of Degradates, Inert Ingredients, Adjuvants, and Tank Mixtures

In a detailed herbicide risk assessment, it is preferable to estimate risks not just from the a.i. of an herbicide, but also from the cumulative risks of inert ingredients, adjuvants, surfactants, and degradates. Other pesticides may also factor into the risk estimates, as many herbicides can be tank mixed to expand the level of control and to accomplish multiple identified tasks. However, using currently available models (e.g., GLEAMS), it is only practical to calculate deterministic risk calculations (i.e., exposure modeling, effects assessment, and RQ calculations) for a single a.i.

In addition, information on inerts, adjuvants, and degradates is often limited by the availability of, and access to, reliable toxicity data for these constituents. The sections below present a qualitative evaluation of potential effects for risks from degradates, inert ingredients, adjuvants, and tank mixtures.

7.3.1 Degradates

The potential toxicity of degradates, also called herbicide transformation products (TPs), should be considered when selecting an herbicide; however, it is beyond the scope of this risk assessment to evaluate all of the possible degradates of the various herbicide formulations containing tebuthiuron. Degradates may be more or less mobile and more or less toxic in the environment than their source herbicides (Battaglin, et al. 2003). Differences in environmental behavior (e.g., mobility) and toxicity between parent herbicides and TPs makes prediction of potential TP impacts challenging. For example, a less toxic, but more mobile, bioaccumulative, or persistent TP may have the potential to have a greater adverse impact on the environment resulting from residual concentrations in the environment. A recent study indicated that 70% of TPs had either similar or reduced toxicity to fish, daphnids, and algae than the parent pesticide. However, 4.2% of the TPs were more than an order of magnitude more toxic than the parent pesticide, with a few instances with acute toxicity values below 1 mg/L (Sinclair and Boxall 2003). No evaluation of impacts to terrestrial species was conducted in this study. The lack of data on the toxicity of degradates of tebuthiuron represents a source of uncertainty in the risk assessment.

7.3.2 Inerts

Pesticide products contain both active and inert ingredients. The terms “active ingredient” and “inert ingredient” have been defined by Federal law—the FIFRA—since 1947. An a.i. is one that prevents, destroys, repels or mitigates the effects of a pest, or is a plant regulator, defoliant, desiccant, or nitrogen stabilizer. By law, the a.i. must be identified

by name on the label together with its percentage by weight. An inert ingredient is simply any ingredient in the product that is not intended to affect a target pest. For example, isopropyl alcohol may be an a.i. and antimicrobial pesticide in some products; however, in other products, it is used as a solvent and may be considered an inert ingredient. The law does not require inert ingredients to be identified by name and percentage on the label, but the total percentage of such ingredients must be declared.

In September 1997, the USEPA issued Pesticide Regulation Notice 97-6, which encouraged manufacturers, formulators, producers, and registrants of pesticide products to voluntarily substitute the term "other ingredients" as a heading for the inert ingredients in the ingredient statement. The USEPA made this change after learning the results of a consumer survey on the use of household pesticides. Many consumers are mislead by the term "inert ingredient," believing it to mean "harmless." Since neither the federal law nor the regulations define the term "inert" on the basis of toxicity, hazard or risk to humans, non-target species, or the environment, it should not be assumed that all inert ingredients are non-toxic. Whether referred to as "inerts" or "other ingredients," these components within an herbicide have the potential to be toxic.

BLM scientists received clearance from the USEPA to review CBI on inert compounds in the following herbicides under consideration in ERAs: bromacil, chlorsulfuron, diflufenzopyr, Overdrive® (a mix of dicamba and diflufenzopyr), diquat, diuron, fluridone, imazapic, sulfometuron methyl, and tebuthiuron. The information received listed the inert ingredients, their chemical abstract number, supplier, USEPA registration number, percentage of the formulation, and purpose in the formulation. This information is confidential, and is therefore not disclosed in this document. However, a review of available data for the herbicides is included in Appendix D.

The USEPA has a listing of regulated inert ingredients at http://www.epa.gov/opprd001/inerts/index.html. This listing categorizes inert ingredients into four lists. The listing of categories and the number of inert ingredients found among the ingredients listed for the herbicides are shown below:

- List 1 – Inert Ingredients of Toxicological Concern: None.
- List 2 – Potentially Toxic Inert Ingredients: None.
- List 3 – Inerts of Unknown Toxicity. 12.
- List 4 – Inerts of Minimal Toxicity. Over 50.

Nine inerts were not found on EPA's lists.

Toxicity information was also searched in the following sources:

- TOMES (a proprietary toxicological database including EPA's Integrated Risk Information System [IRIS], the Hazardous Substance Data Bank, and the Registry of Toxic Effects of Chemical Substances [RTECS]).
- EPA's ECOTOX database, which includes AQUIRE (a database containing scientific papers published on the toxic effects of chemicals to aquatic organisms).
- TOXLINE, a literature searching tool.
- Material Safety Data Sheets (MSDSs) from suppliers.
- Other sources, such as the Farm Chemicals Handbook.
- Other cited literature sources.

Relatively little toxicity information was found. A few acute studies on aquatic or terrestrial species were reported. No chronic data, no cumulative effects data and almost no indirect effects data (food chain species) were found for the inerts in the herbicides.

A number of the List 4 compounds (Inerts of Minimal Toxicity) are naturally-occurring earthen materials (e.g., clay materials or simple salts) that would produce no toxicity at applied concentrations. However, some of the inerts, particularly List 3 compounds and unlisted compounds, may have moderate to high potential toxicity to aquatic species based on MSDSs or published data.

As a tool to evaluate List 3 and unlisted inerts in the ERA, the exposure concentration of the inert compound was calculated and compared to toxicity information. As described in more detail in Appendix D, the GLEAMS model was set up to simulate the effects of a generalized inert compound in the previously described "base-case" watershed with a sand soil type. Toxicity information from the above sources was used in addition to the work of Muller (1980), Lewis (1991), Dorn et al. (1997), and Wong et al. (1997) concerning aquatic toxicity of surfactants. These sources generally suggested that acute toxicity to aquatic life for surfactants and anti-foam agents ranged from 1 to 10 mg/L, and that chronic toxicity ranged as low as 0.1 mg/L.

Appendix D presents the following general observation for tebuthiuron: inerts did not appear to be an issue. This indicates that inerts associated with the application of tebuthiuron are not predicted to occur at levels that would cause acute toxicity to aquatic life. However, due to the lack of specific inert toxicity data, it is not possible to state that the inerts in tebuthiuron will not result in adverse ecological impacts. It is assumed that toxic inerts would not represent a substantial percentage of the herbicide and that minimal impacts to the environment would result from these inert ingredients.

7.3.3 Adjuvants and Tank Mixtures

Evaluating the potential additional/cumulative risks from mixtures and adjuvants of pesticides is substantially more difficult than evaluating the inerts in the herbicide composition. While many herbicides are present in the natural environment along with other pesticides and toxic chemicals, the composition of such mixtures is highly site-specific, and thus nearly impossible to address at the level of the programmatic EIS.

Herbicide label information indicates whether a particular herbicide can be tank mixed with other pesticides. Adjuvants (e.g., surfactants, crop oil concentrates, fertilizers) may also be added to the spray mixture to improve the herbicide efficacy. Without product specific toxicity data, it is impossible to quantify the potential impacts of these mixtures. In addition, a quantitative analysis could only be conducted if reliable scientific evidence allowed a determination of whether the joint action of the mixture was additive, synergistic, or antagonistic. Such evidence is not likely to exist unless the mode of action is common among the chemicals and receptors.

7.3.3.1 Adjuvants

Adjuvants generally function to enhance or prolong the activity of an a.i. For terrestrial herbicides, adjuvants aid in the absorption of the a.i. into plant tissue. Adjuvant is a broad term and includes surfactants, selected oils, anti-foaming agents, buffering compounds, drift control agents, compatibility agents, stickers, and spreaders. Adjuvants are not under the same registration guidelines as pesticides and the USEPA does not register or approve the labeling of spray adjuvants Individual herbicide labels identify which types of adjuvants are approved for use with the particular herbicide.

Selection of adjuvants is under the control of BLM land managers, and it is recommended that land managers follow all label instructions and abide by any warnings. Selection of adjuvants with limited toxicity and low volumes is recommended to reduce the potential for the adjuvant to influence the toxicity of the herbicide. No adjuvants were identified on the reviewed labels for the Tebuthiuron formulations.

7.3.3.2 Tank Mixtures

Only the Spike 80DF label (Dow AgroSciences 1999) provided any indications for the possibility of tank mixing tebuthiuron with other registered products. However, no specific information was provided, and it is not within normal BLM practices to tank mix tebuthiuron products with other pesticides. Therefore, additional modeling of tank mixes was not performed for tebuthiuron.

In general it may be noted that selection of tank mixes, like adjuvants, is under the control of BLM land managers. To reduce uncertainties and potential negative impacts, it is required that land managers follow all label instructions and abide by any warnings. Labels for both tank mixed products should be thoroughly reviewed, and mixtures with the least potential for negative effects should be selected. This is especially relevant when a mixture is applied in a manner that may have increased potential for risk for an individual herbicide (e.g., runoff to ponds in sandy watersheds). Use of a tank mix under these conditions increases the level of uncertainty in the potential unintended risk to the environment.

7.4 Uncertainty Associated with Herbicide Exposure Concentration Models

The ERA relies on different models to predict the off-site impacts of herbicide use. These models have been developed and applied in order to develop a conservative estimate of herbicide loss from the application area to off-site locations.

As in any screening or higher-tier ERA, a discussion of potential uncertainties from fate and exposure modeling is necessary to identify potential overestimates or underestimates of risk. In particular, the uncertainty analysis focused on which environmental characteristics (e.g., soil type, annual precipitation) exert the biggest numeric impact on model outputs. The results of this uncertainty analysis have important implications not only for the uncertainty analysis itself, but also for the ability to apply risk calculations to different site characteristics from a risk management perspective.

7.4.1 AgDRIFT®

Off-target spray drift and resulting terrestrial deposition rates and water body concentrations (hypothetical pond or stream) were predicted using the computer model, AgDRIFT® Version 2.0.05 (SDTF 2002). As with any complex ERA model, a number of simplifying assumptions were made to ensure that the risk assessment results would be protective of most environmental settings encountered in the BLM land management program.

Predicted off-site spray drift and downwind deposition can be substantially altered by a number of variables intended to simulate the herbicide application process including, but not limited to, nozzle type used in the spray application of an herbicide mixture; ambient wind speed; release height (application boom height); and evaporation. Hypothetically, any variable in the model that is intended to represent some part of the physical process of spray drift and deposition can substantially alter predicted downwind drift and deposition patterns. Recognizing the lack of absolute knowledge about all of the scenarios likely to be encountered in the BLM land management program, these assumptions were developed to be conservative and likely result in overestimation of actual off-site spray drift and environmental impacts.

7.4.2 GLEAMS

The GLEAMS model was used to predict the loading of herbicide to nearby soils, ponds, and streams from overland runoff, erosion, and root-zone groundwater runoff. The GLEAMS model conservatively assumes that the soil, pond, and stream are directly adjacent to the application area. The use of buffer zones would reduce potential herbicide loading to the exposure areas.

7.4.2.1 Herbicide Loss Rates

The trends in herbicide loss rates (herbicide loss computed as a percent of the herbicide applied within the watershed) and water concentrations predicted by the GLEAMS model echo trends that have been documented in a wide range of streams located in the Midwestern United States. A recently published study (Lerch and Blanchard 2003) recognized that factors affecting herbicide transport to streams can be organized into four general categories:

- Intrinsic factors – soil, hydrologic properties, and geomorphologic characteristics of the watershed
- Anthropogenic factors – land use and herbicide management
- Climatic factors – particularly precipitation and temperature
- Herbicide factors – chemical and physical properties and formulation

These findings were based on the conclusions of several prior investigations, data collected as part of the U.S. Geological Survey's National Stream Quality Accounting Network (NASQAN) program, and the results of runoff and baseflow water samples collected in 20 streams in northern Missouri and southern Iowa. The investigation concluded that the median runoff loss rates for Atrazine, Cyanazine, Acetochlor, Alachlor, Metolachlor, and Metribuzin ranged from 0.33 to 3.9% of the mass applied—loss rates that were considerably higher than in other areas of the United States. Furthermore, the study indicated that the runoff potential was a critical factor affecting herbicide transport. Table 7-3 is a statistical summary of the GLEAMS predicted total loss rates and runoff loss rates for several herbicides. The median total loss rates range from 0.27 to 36%, and the median runoff loss rates range from 0 to 0.27%.

The results of the GLEAMS simulations indicate trends similar to those identified in the Lerch and Blanchard (2003) study. First, the GLEAMS simulations demonstrated that the most dominant factors controlling herbicide loss rates are soil type and precipitation; both are directly related to the amount of runoff from an area following an herbicide application. This finding was demonstrated in each of the GLEAMS simulations that considered the effect of highly variable annual precipitation rates and soil type on herbicide transport. In all cases, the GLEAMS model predicted that runoff loss rate was positively correlated with both precipitation rate and soil type.

Second, consistent with the conclusion reached by Lerch and Blanchard (i.e., that runoff potential is critical to herbicide transport) and the GLEAMS model results, estimating the groundwater discharge concentrations by using the predicted root-zone concentrations as a surrogate is extremely conservative. For example, while the median runoff loss rates range from 0 to 0.27%, confirming the Lerch and Blanchard study, the median total loss rates predicted using GLEAMS are substantially higher. This discrepancy may be due to the differences between the watershed characteristics in the field investigation and those used to describe the GLEAMS simulations. It is probably at least partially a result of the conservative nature of the baseflow predictions.

Based on the results and conclusions of prior investigations, the runoff loss rates predicted by the GLEAMS model are approximately equivalent to loss rates determined within the Mississippi River watershed and elsewhere in the United States, and the percolation loss rates are probably conservatively high. This finding confirms that our GLEAMS modeling approach either approximates or overestimates the rate of loadings observed in the field.

7.4.2.2 Root-zone Groundwater

In the application of GLEAMS, it was assumed that root-zone loading of herbicide would be transported directly to a nearby water body. This is a feasible scenario in several settings but is very conservative in situations in which the depth to the water table might be many feet. In particular, it is common in much of the arid and semi-arid western states for the water table to be well below the ground surface and for there to be little, if any, groundwater discharge to surface water features. Some ecological risk scenarios were dominated by the conservatively estimated loading of herbicide by groundwater discharge to surface waters. Again, while possible, this is likely to be an over-estimate of likely impacts in most settings on BLM lands.

7.4.3 CALPUFF

The USEPA's CALPUFF air pollutant dispersion model was used to predict impacts from the potential migration of the herbicide between 1.5 and 100 km from the application area by windblown soil (fugitive dust). Several assumptions were made that could overpredict or underpredict the deposition rates obtained from this model.

The use of flat terrain could underpredict deposition for mountainous areas. In these areas, hills and mountains would likely focus wind and deposition into certain areas, resulting in pockets of increased risk. The use of bare, undisturbed soil results in less uptake and transport than disturbed (i.e., tilled) soil. However, the BLM does not apply herbicides to agricultural areas, so this assumption may be appropriate for BLM-managed lands.

The modeling conservatively assumed that all of the herbicide would be present in the soil at the commencement of a windy event, and that no reduction due to vegetation interception/uptake, leaching, solar or chemical half-life would have occurred since the time of aerial application. Thus, the model likely overpredicts the deposition rates unless the herbicide is taken by the wind as soon as it is applied. It is more likely that a portion of the applied herbicide would be sorbed to plants or degraded over time.

Assuming a 1-mm penetration depth is also conservative and likely overestimates impacts. This penetration depth is less than the depth used in previous herbicide risk assessments (SERA 2001) and the depth assumed in the GLEAMS model (1 cm surface soil).

The surface roughness in the vicinity of the application site directly affects the deposition rates predicted by CALPUFF. The surface roughness length used in the CALPUFF model is a measure of the height of obstacles to wind flow and varies by land-use types. Forested areas and urban areas have the highest surface roughness lengths (0.5 m to 1.3 m) while grasslands have the lowest (0.001 m to 0.10 m).

Predicted deposition rates are likely to be highest near the application area and lowest at greater distances if the surface roughness in the area is relatively high (above 1 m, such as in forested areas). Therefore, overestimation of the surface roughness could overpredict deposition within about 50 km of the application area, and underpredict deposition beyond 50 km. Overestimation of the surface roughness could occur if, for example, prescribed burning was used to treat a typically forested area prior to planned herbicide treatment.

The surface roughness in the vicinity of the application site also affects the calculated friction velocity used to determine deposition velocities, which in turn are used by CALPUFF to calculate the deposition rate. The friction velocity increases with increasing wind speed and also with increased surface roughness. Higher friction velocities result in higher deposition velocities and likewise higher deposition rates, particularly within about 50 km of the emission source.

The CALPUFF modeling assumes that the data from the selected National Weather Service stations is representative of meteorological conditions in the vicinity of the application sites. Site-specific meteorological data (e.g, from an on-site meteorological tower) could provide slightly different wind patterns, possibly due to local terrain, which could impact the deposition rates as well as locations of maximum deposition.

7.5 Summary of Potential Sources of Uncertainty

The analysis presented in this section has identified several potential sources of uncertainty that may introduce bias into the risk conclusions. This bias has the potential to 1) underestimate risk, 2) overestimate risk, or 3) be neutral with regard to the risk estimates, or be undetermined without additional study. In general, few of the sources of uncertainty in this ERA are likely to underestimate risk to ecological receptors. Risk is more likely to be overestimated or the impacts of the uncertainty may be neutral or impossible to predict.

The following bullets summarize the potential impacts on the risk predictions based on the analysis presented above:

- Toxicity Data Availability – Although the species for which toxicity data are available may not necessarily be the most sensitive species to a particular herbicide, the TRV selection methodology has focused on identifying conservative toxicity values that are likely to be protective of most species; the use of various LOCs contributes an additional layer of protection for species that may be more sensitive than the tested species (i.e., RTE species).

- Potential Indirect Effects on Salmonids - Only a qualitative evaluation of indirect risk to salmonids was possible since no relevant studies or incident reports were identified; it is likely that this qualitative evaluation overestimates the potential risk to salmonids due to the numerous conservative assumptions related to TRVs and exposure scenarios, and the application of additional LOCs (with uncertainty/safety factors applied) to assess risk to RTE species.

- Ecological Risks of Degradates, Inerts, Adjuvants, and Tank Mixtures - Only limited information is available regarding the toxicological effects of degradates, inerts, adjuvants, and tank mixtures; in general, it is unlikely that highly toxic degradates or inerts are present in approved herbicides; selection of tank mixes and adjuvants is under the control of BLM land managers and to reduce uncertainties and potential risks products should be thoroughly reviewed and mixtures with the least potential for negative effects should be selected.

- Uncertainty Associated with Herbicide Exposure Concentration Models - Environmental characteristics (e.g., soil type, annual precipitation) will impact the three models used to predict the off-site impacts of herbicide use (i.e., AgDRIFT, GLEAMS, CALPUFF); in general, the assumptions used in the models were developed to be conservative and likely result in overestimation of actual off-site environmental impacts.

- General ERA Uncertainties – The general methodology used to conduct the ERA is more likely to overestimate risk than to underestimate risk due to the use of conservative assumptions (i.e., entire home range and diet is assumed to be impacted, aquatic waterbodies are relatively small, herbicide degradation over time is not applied in most scenarios).

TABLE 7-1
Potential Sources of Uncertainty in the ERA Process

Potential Source of Uncertainty	Direction of Effect	Justification
Physical-chemical properties of the active ingredient	Unknown	Available sources were reviewed for a variety of parameters. However, not all sources presented the same value for a parameter (e.g., water solubility) and some values were estimated.
Food chain assumed to represent those found on BLM lands	Unknown	BLM lands cover a wide variety of habitat types. A number of different exposure pathways have been included, but additional pathways may occur within management areas.
Receptors included in food chain model assumed to represent those found on BLM lands	Unknown	BLM lands cover a wide variety of habitat types. A number of different receptors have been included, but alternative receptors may occur within management areas.
Food chain model exposure parameter assumptions	Unknown	Some exposure parameters (e.g., body weight, food ingestion rates) were obtained from the literature and some were estimated. Efforts were made to select exposure parameters representative of a variety of species or feeding guilds.
Assumption that receptor species will spend 100% of time in impacted terrestrial or aquatic area (home range = application area)	Overestimate	These model exposure assumptions do not take into consideration the ecology of the wildlife receptor species. Organisms will spend varying amounts of time in different habitats, thus affecting their overall exposures. Species are not restricted to one location within the application area, may migrate freely off-site, may undergo seasonal migrations (as appropriate), and are likely to respond to habitat quality in determining foraging, resting, nesting, and nursery activities. A likely overly conservative assumption has been made that wildlife species obtain all their food items from the application area.
Waterbody characteristics	Overestimate	The pond and stream were designed with conservative assumptions resulting in relatively small volumes. Larger waterbodies are likely to exist within application areas.
Extrapolation from test species to representative wildlife species	Unknown	Species differ with respect to absorption, metabolism, distribution, and excretion of chemicals. The magnitude and direction of the difference may vary with species. It should be noted, though, that in most cases, laboratory studies actually overestimate risk relative to field studies (Fairbrother and Kapustka 1996).
Consumption of contaminated prey	Unknown	Toxicity to prey receptors may result in sickness or mortality. Fewer prey items would be available for predators. Predators may stop foraging in areas with reduced prey populations, discriminate against, or conversely, select contaminated prey.
No evaluation of inhalation exposure pathways	Underestimate	The inhalation exposure pathways are generally considered insignificant due to the low concentration of contaminants under natural atmospheric conditions. However, under certain conditions, these exposure pathways may occur.
Assumption of 100% drift for chronic ingestion scenarios	Overestimate	It is unlikely that 100% of the application rate would be deposited on a plant or animal used as food by another receptor. As indicated with the AgDRIFT® model, off-site drift is only a fraction of the applied amount.
Ecological exposure concentration	Overestimate	It is unlikely any receptor would be exposed continuously to the full predicted EEC.
Over-simplification of dietary composition in the food web models	Unknown	Assumptions were made that contaminated food items (e.g., vegetation, fish) were the primary food items for wildlife. In reality, other food items are likely consumed by these organisms.

TABLE 7-1 (Cont.)
Potential Sources of Uncertainty in the ERA Process

Potential Source of Uncertainty	Direction of Effect	Justification
Degradation or adsorption of herbicide	Overestimate	Risk estimates for direct spray and off-site drift scenarios generally do not consider degradation or adsorption. Concentrations will tend to decrease over time from degradation. Organic carbon in water or soil/sediment may bind to herbicide and reduce bioavailability.
Bioavailability of herbicides	Overestimate	Most risk estimates assume a high degree of bioavailability. Environmental factors (e.g., binding to organic carbon, weathering) may reduce bioavailablity.
Limited evaluation of dermal exposure pathways	Unknown	The dermal exposure pathway is generally considered insignificant due to natural barriers found in fur and feathers of most ecological receptors. However, under certain conditions (e.g., for amphibians), these exposure pathways may occur.
Amount of receptor's body exposed	Unknown	More or less than ½ of the honeybee or small mammal may be affected in the accidental direct spray scenarios.
Lack of toxicity information for amphibian and reptile species	Unknown	Information is not available on the toxicity of herbicides to reptile and amphibian species resulting from dietary or direct contact exposures.
Lack of toxicity information for RTE species	Unknown	Information is not available on the toxicity of herbicides to RTE species resulting from dietary or direct contact exposures. Uncertainty factors have been applied to attempt to assess risk to RTE receptors. See Section 7.2 for additional discussion of salmonids.
Safety factors applied to TRVs	Overestimate	Assumptions regarding the use of 3-fold uncertainty factors are based on precedent, rather than scientific data.
Use of lowest toxicity data to derive TRVs	Overestimate	The lowest data point observed in the laboratory may not be representative of the actual toxicity that might occur in the environment. Using the lowest reported toxicity data point as a benchmark concentration is a very conservative approach, especially when there is a wide range in reported toxicity values for the relevant species. See Section 7.1 for additional discussion.
Use of NOAELs	Overestimate	Use of NOAELs may over-estimate effects since this measurement endpoint does not reflect any observed impacts. LOAELs may be orders of magnitudes above observed literature-based NOAELs, yet NOAELs were generally selected for use in the ERA.
Use of chronic exposures to estimate effects of herbicides on receptors	Overestimate	Chronic toxicity screening values assume that ecological receptors experience continuous, chronic exposure. Exposure in the environment is unlikely to be continuous for many species that may be transitory and move in and out of areas of maximum herbicide concentration.
Use of measures of effect	Overestimate	Although an attempt was made to have measures of effect reflect assessment endpoints, limited available ecotoxicological literature resulted in the selection of certain measures of effect that may overestimate assessment endpoints.
Lack of toxicity information for mammals or birds	Unknown	TRVs for certain receptors were based on a limited number of studies conducted primarily for pesticide registration. Additional studies may indicate higher or lower toxicity values. See Section 7.1 for additional discussion.
Lack of seed germination toxicity information	Unknown	TRVs were based on a limited number of studies conducted primarily for pesticide registration. A wide range of germination data was not always available. Emergence or other endpoints were also used and may be more or less sensitive to the herbicide.

TABLE 7-1 (Cont.)
Potential Sources of Uncertainty in the ERA Process

Potential Source of Uncertainty	Direction of Effect	Justification
Species used for testing in the laboratory assumed to be equally sensitive to herbicide as those found within application areas.	Unknown	Laboratory toxicity tests are normally conducted with species that are highly sensitive to contaminants in the media of exposure. Guidance manuals from regulatory agencies contain lists of the organisms that they consider to be sensitive enough to be protective of naturally occurring organisms. However, reaction of all species to herbicides is not known, and species found within application areas may be more or less sensitive than those used in the laboratory toxicity testing. See Section 7.1 for additional discussion.
Risk evaluated for individual receptors only	Overestimate	Effects on individual organisms may occur with little population or community level effects. However, as the number of affected individuals increases, the likelihood of population-level effects increases.
Lack of predictive capability	Unknown	The RQ approach provides a conservative estimate of risk based on a "snapshot" of conditions; this approach has no predictive capability.
Unidentified stressors	Unknown	It is possible that physical stressors other than those measured may affect ecological communities.
Effect of decreased food item populations on predatory receptors	Unknown	Adverse population effects to food items may reduce the foraging population for predatory receptors, but may not necessarily adversely impact the population of predatory species.
Multiple conservative assumptions	Overestimate	Cumulative impact of multiple conservative assumptions predicts high risk to ecological receptors.
Predictions of off-site transport	Overestimate	Assumptions are implicit in each of the software models used in the ERA (AgDRIFT®, GLEAMS, and CALPUFF). These assumptions have been made in a conservative manner when possible. These uncertainties are discussed further in Section 7.4.
Impact of the other ingredients (e.g., inerts, adjuvants) in the application of the herbicide	Unknown	Only the active ingredient has been investigated in the ERA. Inerts, adjuvants, and tank mixtures may increase or decrease the impacts of the active ingredient. These uncertainties are discussed further in Section 7.3.

TABLE 7-2
Herbicide Loss Rates Predicted by the GLEAMS Model

Herbicide	Total Loss Rate			Runoff Loss Rate		
	Median	90th	Maximum	Median	90th	Maximum
Diflufenzopyr	0.27%	22%	54%	0.27%	6.0%	22%
Imazapic	4.5%	40%	79%	0.10%	4.1%	32%
Sulfometuron	0.49%	19%	37%	0.02%	1.6%	6.6%
Tebuthiuron	18%	56%	92%	0.23%	8.0%	23%
Diuron	3.7%	27%	40%	0.22%	5.0%	24%
Bromacil	36%	60%	66%	0.02%	1.7%	8.5%
Chlorsulfuron	1.9%	21%	68%	0.03%	3.9%	10%
Dicamba	26%	38%	42%	0.00%	0.0%	0.1%

8.0 SUMMARY

Based on the ERA conducted for tebuthiuron, there is the potential for risk to ecological receptors from exposure to herbicides under specific conditions on BLM-managed lands. Table 8-1 summarizes the relative magnitude of risk predicted for ecological receptors for each route of exposure. This was accomplished by comparing the RQs against the most conservative LOC, and ranking the results for each receptor-exposure route combination from 'no potential' to 'high potential' for risk. As expected due to the mode of action of terrestrial herbicides, the highest risk is predicted for non-target terrestrial and aquatic plant species, generally under accidental exposure scenarios (i.e., direct spray and accidental spills). Minimal risk was predicted for terrestrial animals, fish, and aquatic invertebrates.

The following bullets summarize the risk assessment findings for tebuthiuron under evaluated exposure scenarios:

- Direct Spray – Risks were predicted for pollinating insects resulting from direct spray and indirect contact with contaminated foliage. No risks were predicted for other terrestrial wildlife at the typical application rate. Risks were predicted for avian and mammalian herbivores resulting from ingestion of food items contaminated by direct spray at the maximum application rate. Risk to terrestrial and aquatic non-target plants is likely when plants or waterbodies are accidentally sprayed. No risks were predicted for fish; chronic risks were predicted for aquatic invertebrates in the pond and the stream.

- Off-Site Drift – Risk to non-target terrestrial plants (typical and RTE) may occur when herbicides are applied from the ground and buffer zones are 100 ft or less. No risks were predicted for fish, aquatic invertebrates, aquatic plants, or piscivorous birds.

- Surface Runoff– No risks to typical non-target terrestrial plants were predicted in any scenario. Risks to RTE terrestrial plant species were predicted in 4 scenarios at the typical application rate and 8 scenarios at the maximum application rate (in watersheds with clay and silt soils and more than 50 inches of precipitation per year). Acute risk to non-target aquatic plants in the pond was predicted in 9 scenarios (mostly in watersheds with sandy soils) at the typical application rate and most scenarios (37/42) at the maximum application rate. Chronic risks to aquatic plants in the pond were predicted in nearly the same set of scenarios (more risk to plants in watersheds with clay and loam soils at lower precipitation levels). Acute risks to aquatic plants were predicted in 10 scenarios in the stream at the maximum application rate (mostly in watersheds with sand and clay soils and 50 or more inches of precipitation annually. No acute risks were predicted at the typical rate, and no chronic risks to aquatic plants were predicted in the stream. No risks to aquatic invertebrates were predicted in the stream; chronic risks to aquatic invertebrates were predicted in the pond for most scenarios at the maximum application rate and for one scenario at the typical application rate (watershed with sandy soils and 10 inches of annual precipitation). No risks were predicted for fish or piscivorous birds in any modeled scenarios.

- Wind Erosion and Transport Off-Site – No risks were predicted for non-target terrestrial plants (only taxon modeled) under any of the evaluated conditions.

- Accidental Spill to Pond– Risk to fish, aquatic invertebrates, and non-target aquatic plants may occur when herbicides are spilled directly into the pond.

In addition, species that depend on non-target plant species for habitat, cover, and/or food may be indirectly impacted by a possible reduction in terrestrial or aquatic vegetation. For example, accidental direct spray, off-site drift, and surface runoff may negatively impact terrestrial and aquatic plants, reducing the cover available to RTE salmonids within the stream.

Based on the results of the ERA, it is possible that non-target terrestrial and aquatic plants and some RTE species could be adversely affected by application of tebuthiuron for the control of invasive plants. However, adherence to certain application guidelines (e.g., defined application rates, equipment, herbicide mixture, avoidance of critical

habitat, downwind distance to potentially sensitive habitat; see following section) would minimize the potential effects on non-target plants and associated indirect effects on species (including RTE salmonids) that depend on those plants for food, habitat, and cover.

8.1 Recommendations

The following recommendations are designed to reduce potential unintended impacts to the environment from the application of tebuthiuron:

- Although the BLM does not currently use adjuvants or tank mixes with tebuthiuron products, if this changes in the future, care must be taken when selecting adjuvants and tank mixtures since these have the potential to increase the level of toxicity above that predicted for the a.i. alone. This is especially important for application scenarios that already predict potential risk from the a.i. itself.

- Review, understand, and conform to "Environmental Hazards" section on herbicide label. This section warns of known pesticide risks to wildlife receptors or to the environment and provides practical ways to avoid harm to organisms or the environment.

- Avoid accidental direct spray and spill conditions to reduce the greatest potential impacts.

- Use the typical application rate rather than the maximum application rate, to reduce risk for off-site drift and surface runoff exposures to non-target RTE and aquatic plants.

- In watersheds with downgradient ponds or streams, limit the use of tebuthiuron to those watersheds that do not have predicted risks to aquatic plants resulting from surface runoff (e.g., at the typical application rate, most watersheds without sandy soils).

- If RTE terrestrial plants are present, do not apply tebuthiuron in watersheds with clay or silt soils and 50 or more inches of precipitation per year.

- Establish the following buffer zones to reduce off-site drift impacts to terrestrial plants:

    - Ground application by low boom (spray boom height set at 20 inches above the ground) – 100 ft from typical and RTE non-target terrestrial plants at the maximum application rate (buffer of < 25 ft at the typical application rate).
    - Ground application by high boom (spray boom height set at 50 inches above the ground) – 100 ft from typical non-target terrestrial plants at the maximum application rate; 100 ft from RTE terrestrial plants at the typical application rate; and more than 100 ft (no risk was predicted at 900 ft) from RTE terrestrial plants at the maximum application rate.

- Consider the proximity of potential application areas to salmonid habitat and the possible effects of herbicides on riparian vegetation. Maintain appropriate buffer zones around salmonid-bearing streams (see above buffer recommendations).

The results from this ERA assist the evaluation of proposed alternatives in the EIS and contribute to the development of a BA, specifically addressing the potential impacts to proposed and listed RTE species on western BLM treatment lands. Furthermore, this ERA will inform BLM field offices on the proper application of tebuthiuron to ensure that impacts to plants and animals and their habitat are minimized to the extent practical.

TABLE 8-1
Typical Risk Levels Resulting from Tebuthiuron Application

	Direct Spray/Spill		Off-Site Drift		Surface Runoff		Wind Erosion	
	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate	Typical Application Rate	Maximum Application Rate
Terrestrial Animals	0 [15: 16]	0 [9: 16]	NA	NA	NA	NA	NA	NA
Terrestrial Plants (Typical Species)	M [1: 1]	H [1: 1]	0 [6: 6]	0 [4: 6]	0 [42: 42]	0 [42: 42]	0 [9: 9]	0 [9: 9]
Terrestrial Plants (RTE Species)	M [1: 1]	H [1: 1]	0 [5: 6]	L [3: 6]	0 [38: 42]	0 [34: 42]	0 [9: 9]	0 [9: 9]
Fish In The Pond	0 [2: 2]	0 [2: 4]	0 [12: 12]	0 [12: 12]	0 [84: 84]	0 [84: 84]	NA	NA
Fish In The Stream	0 [2: 2]	0 [2: 2]	0 [12: 12]	0 [12: 12]	0 [84: 84]	0 [84: 84]	NA	NA
Aquatic Invertebrates In The Pond	L [1: 2]	L [2: 4]	0 [12: 12]	0 [12: 12]	0 [83: 84]	0 [53: 84]	NA	NA
Aquatic Invertebrates In The Stream	L [1: 2]	M [1: 2]	0 [12: 12]	0 [12: 12]	0 [84: 84]	0 [84: 84]	NA	NA
Aquatic Plants In The Pond	L [2: 2]	H [2: 4]	0 [12: 12]	0 [12: 12]	0 [65: 84]	L [55: 84]	NA	NA
Aquatic Plants In The Stream	M [1: 2]	H [1: 2]	0 [12: 12]	0 [12: 12]	0 [84: 84]	0 [74: 84]	NA	NA
Piscivorous Bird	NA	NA	0 [6: 6]	0 [6: 6]	0 [42: 42]	0 [42: 42]	NA	NA

Risk Levels:
0 = No Potential for Risk (majority of RQs < most conservative LOC).
L = Low Potential for Risk (majority of RQs 1-10 times the most conservative LOC).
M = Moderate Potential for Risk (majority of RQs 10-100 times the most conservative LOC).
H = High Potential for Risk (majority of RQs >100 times the most conservative LOC).
The reported Risk Level is based on the risk level of the majority of the RQs for each exposure scenario within each of the above receptor groups and exposure categories (i.e., direct spray/spill, off-site drift, surface runoff, wind erosion). As a result, risk may be higher than the reported risk category for some scenarios within each category. The reader should consult the risk tables in Section 4 to determine the specific scenarios that result in the displayed level of risk for a given receptor group.
Number in brackets represents Number of RQs in the Indicated Risk Level: Number of Scenarios Evaluated.
NA = Not applicable. No RQs calculated for this scenario.
In cases of a tie, the more conservative (higher) risk level was selected.

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APPENDIX A

Summary of Available and Relevant Toxicity Data from Ecological Risk Assessment Literature Review for Tebuthiuron

Appendix A

Summary of Available and Relevant Toxicity Data from Ecological Risk Assessment Literature Review for Tebuthiuron

Introduction

A literature review and ecological data evaluation was conducted on nine herbicides that are currently being used or are proposed for use by the Bureau of Land Management (BLM) for vegetation management on 261 million acres of public lands in the Western U.S., including Alaska. The information gathered from this evaluation will be included along with other collected data to derive toxicity reference values for use in the ecological risk assessment (ERA; ENSR 2005). The ERA was conducted in conjunction with the Vegetation Treatments Programmatic Ecological Impact Statement (PEIS) for the BLM. Scientific papers were gathered during this process to provide data on acute and chronic toxicity of selected herbicides to the non-target species. The review process included consideration of U.S. Fish and Wildlife Service (USFWS) draft literature search guidance. The nine herbicides that were investigated during this evaluation were as follows:

- Diflufenzopyr
- Diquat
- Fluridone
- Imazapic
- Sulfometuron-methyl
- Bromacil
- Chlorsulfuron
- Diuron
- Tebuthiuron

This review process was carried out in three tiers: Tier I – Literature search and preliminary review to select individual manuscripts; Tier II – Screening to determine whether the manuscript is acceptable; and Tier III – Thorough review to obtain data for possible toxicity reference value (TRV) use. This report provides information for bromacil; the other chemicals are discussed in separate reports.

Literature Search Methodology

The literature review process was initiated by conducting a keyword search pertaining to each of the nine chemicals in selected databases. The keyword search for all databases, except for one (Chemical Abstracts/Scifinder Scholar), included the herbicide name but not the commercial name (i.e., some commercial names are common words). The search parameters for Chemical Abstracts consisted of the herbicide name and chemical abstracts service (CAS) registry number. The open literature search was conducted at Colorado State University, Fort Collins, CO. The search period for bromacil was from 1970 (the start of the database) to 2003. The following 12 databases were searched:

- AGRICOLA
- ASFA (Aquatic Sciences and Fisheries Abstracts)
- Biological Sciences
- BIOSIS / Biological Abstracts
- Chemical Abstracts / Scifinder Scholar
- Environmental Science and Pollution Management
- MedLine
- Safety Science and Risk

- Toxline
- Water Resources Abstracts
- Web of Science / Science Citation Index
- Zoological Records

All of the documents obtained in the open literature searches were then evaluated by a Senior Toxicologist to select manuscripts pertaining to the specific objectives of this project (Tier I). Relevant studies were those that were judged, to the extent possible while searching literature databases (i.e., relying on title and abstract, when available), to provide useful data for conducting the ERA. Relevant studies contained the following information at a minimum:

- Acute (mortality vs. survival) or chronic (largely growth or reproduction, although other sublethal data—if available—were also considered potentially relevant) toxicity data for the active ingredient.
- Verifiable numeric endpoint values (e.g., LC_{50}, NOEC) that could be used in the risk characterization process.
- Toxicity data for clinical test species (e.g., mice, rats) and species used for screening non-human impacts (all other mammals, birds, invertebrates, algae, plants).
- Field or mesocosm studies were also included, but only if effects from exposure to the single herbicide in question could be identified and separated from other stressors.

Literature that was excluded as part of this initial literature gathering process included:

- analytical chemistry studies;
- methods papers without specific toxicity data;
- modeling studies that contained no empirically-derived data; and
- reviews or reports that were not primary toxicity data sources (except as a source for obtaining primary literature).

These search criteria enhanced the ability to screen scientific papers for the type of toxicity information needed in the ERA. Hard copies of all manuscripts that met these criteria were then obtained for further evaluation. Once articles were obtained, they were incorporated into a comprehensive management database (EndNote®). There were 243 documents identified from this process and obtained for further consideration. The bibliography list of articles obtained for tebuthiuron is included in this report (Appendix A.1).

Literature Review Methodology

A cursory review (Tier II) was performed on each manuscript after a hard copy was obtained. Exclusion and inclusion criteria to determine acceptability for further review were developed prior to the process in conjunction with the BLM. Manuscripts were excluded that dealt only with the following subjects:

- Human health effects
- Effects on microorganisms: (e.g., fungi, bacteria)
- Genotoxic effects (mutagenic, carcinogenic)
- Bioassays on cells of a whole organism (e.g., rat hepatocytes, rat liver S9)
- Effects on target plants (efficacy testing)
- Non-toxic effects (e.g., fate, transport, leaching, analytical methods)
- Mixtures including herbicides other than the nine being reviewed

In addition, manuscripts that solely included data on marine receptors were originally excluded; however, these

data were later included because marine ecosystems could be adjacent to application areas on BLM lands.

Inclusion criteria and rating (on a scale of 1 [weak] to 5 [strong]) of issues that were to be emphasized (requiring a subsequent review step) were as follows:

1. Effects on nontarget receptors related to ERA protocol
2. Chronic, sub-lethal, or reproductive effects that may have adverse effects on populations
3. Effects form inerts, degradates, and metabolites
4. Studies with mixtures that include bromacil and any of the 8 other herbicides (i.e., not containing other herbicides)
5. Indirect effects to food supply or cover

Additional criteria that were used in reviewing papers (reviewers answered 'Yes' or 'No') are listed below:

- Were the corroborating studies described in sufficient detail (i.e., weight of evidence)?
- Did the study have a proper exposure dose, mechanism, and duration?
- Did the test include proper sample size, statistical analysis, and especially statistical endpoints (e.g., NOAEL, EC_{50}) or dose response curves?
- Were proper controls used and were they acceptable?
- Were the data published in a peer-reviewed journal?

Each of the 243 identified papers was scored on the selection criteria listed above, including documentation of the number of test organisms, statistical analysis, proper use, and performance of controls, and the study was classified as either "adequate" on "not adequate".

In Tier III, papers that were found to be acceptable for use were evaluated more thoroughly based on criteria developed with the BLM, and the following information is included as a second review form page for each manuscript (Appendix A.2):

- Author(s).
- Date of publication.
- Title of publication.
- Name of publication.
- Herbicide(s) used in the study.
- Receptor category: 20 g mammal, honey bee, 70 kg herbivore, small bird, large bird, non-target plants (monocot and dicot), warmwater fish, coldwater fish, aquatic invertebrate, aquatic plant, aquatic macrophyte). The specific life history stage was also recorded when available.
- Exposure conditions specifying the formulation, concentration, or amount of active ingredient and medium.
- Effect: Acute or sublethal effect end points of product formulations and breakdown products, and/or their component chemicals, such as: larval and embryonic developmental effects, endocrine disruption, reproductive impairment, changes in behavioral traits such as predator avoidance, feeding/appetite, lethargy or excitement, homing ability, swimming speed, or attraction to or repulsion from the chemicals.
- Toxicity endpoints (e.g., NOAEL, EC_{50}, LC_{50}, or dose response curve).
- Degradates, inerts, if available.
- Ecological conditions of study (e.g., mescosm, static/flow-through, water quality parameters).
- Comments (e.g., mixture effects: additive, synergistic, or antagonistic effect end points of multiple products, other observations).

The Tier II and III reviews for tebuthiuron were conducted by only one senior toxicologist (this is consistent with the scope of work outlined for the review process). In some cases, a second (or third) review of data adequacy took place when a separate senior toxicologist compiled the Tier III reviews and entered the pertinent information into a master spreadsheet documenting review findings for possible use in TRV derivation. The documents used in this

TRV derivation are designated in **bold** in the bibliography (Appendix A.1), and the derivation of TRVs from all available sources is reported in the ERA (ENSR 2005).

Results

Nine papers were discovered in the review of the open literature for tebuthiuron, and of these, six were reviewed as part of Tier III and incorporated into the spreadsheet for TRV derivation for bromacil (Table 1; Appendix A.3).

TABLE 1

Summary of the Results of the Open Literature Review for Tebuthiuron

Total number of papers obtained for bromacil	9
Total number of papers accepted for Tier II review	6
Total number of papers used in TRV derivation	6

The data collected during this review resulted in toxicity information for algae, macrophytes (duckweed), aquatic invertebrates (cladoceran, snail, crab, oyster, chironomid), amphibians (frogs), and fish (trout, bluegill, goldfish, minnow). Data were available on the chronic toxicity of tebuthiuron to several species including snails (Caux et al. 1997), algae (Meyerhoff et al. 1985; Price et al. 1989; Caux et al. 1997), as well as for a long-term mesocosm study (Temple et al. 1991). There were no studies found that examined the toxic effects of degradation products of tebuthiuron or that examined the toxicity of mixtures of tebuthiuron and any of the other eight herbicides. There are several studies that examined indirect effects of tebuthiuron on food supply via changes in algal density (Meyerhoff et al. 1985; Adams et al. 1986; Price et al. 1989; Temple et al. 1991; Peterson et al. 1994; Caux et al. 1997 and macrophyte biomass (Peterson et al. 1994).

References

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Peterson, H.G., C. Boutin, P.A. Martin, K.E. Freemark, N.J. Ruecker, and M.J. Moody. 1994. Aquatic phyto-toxicity of 23 pesticides applied at expected environmental concentrations. Aquatic Toxicology 28:275-292.

Price, D.J., B.R. Murphy, and L.M. Smith. 1989. Effects of Tebuthiuron on characteristic green algae found in Playa Lakes. Journal of Environmental Quality 18:62-66.

Temple, A.J., B.R. Murphy, and E.F. Cheslak. 1991. Effects of tebuthiuron on aquatic productivity. Hydrobiologia 224(2):117-127.

APPENDIX A.1

BIBLIOGRAPHY LIST

Appendix A.1. Bibliography List

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Price, D.J., B.R. Murphy, and L.M. Smith. 1989. Effects of Tebuthiuron on characteristic green algae found in Playa Lakes. Journal of Environmental Quality 18:62-66.

Temple, A.J., B.R. Murphy, and E.F. Cheslak. 1991. Effects of tebuthiuron on aquatic productivity. Hydrobiologia 224(2):117-127.

APPENDIX A.2

TIER II AND III LITERATURE REVIEW FORMS

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	RZN 10/7/03
Title of Paper/Report:	Effect of acetone on the toxicity of four chemicals to Selenastrum Capricornutum
Author(s)	Adams, Goulding & Dobbs
Journal/Year/Vol:Pages	Bull Environ. Contam. Toxicol. 1986 36: 254-259

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	Yes
Genotoxic effects (mutagenic, carcinogenic)	NO
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	NO
Effects to target plants (efficacy testing)	↓
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	NO
Mixtures including non-BLM herbicides	NO
Marine receptors	NO

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	NO
Inerts, degradates, metabolite effects	NO
Mixtures of any of the five herbicides	NO (only w/ acetone)
Indirect effects (food supply, cover)	NO

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	- no measured conc
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes appears so
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	

Task 2: Data Evaluation

Reviewer/Date:	RJD 10/7/03 DAP,
Partial Title of Paper/Report:	Effect of acetone on the toxicity ...

Herbicides tested:	tebuthiuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	Warmwater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: green algae	
Test Species:	Selenastrum capricornutum		
Life Stage:	6 d		

Exposure Conditions	
Formulation:	NR
Concentration/amount of active ingredient:	NR
Medium (water, food, soil, etc.):	algal media
Test Concentrations (if appropriate):	0, 0.03 0.05, 0.07 0.10 0.3 mg/ml
Test System (e.g., flow-thru, mesocosm, etc.):	static 250ml Erlenmeyer flasks

n=3

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:	22°c	Organic Carbon (D or T):	
pH:		Ammonia:	
Other (rpm):	175	Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**(NOEC)/NOAEC**	**(LOEC)**	**Other ( )**
Mortality/Survival cell growth (6d)			0.03	0.05	mg/ml
Growth					
Reproduction					
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- stats Dunnett's - determined LOECs - 0.05 mg/ml LOEC ~~same~~ (w/o acetone) same for 3, 4 & 5 day as well - did not discuss measured concentrations (only for DDT)

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	10/7/03
Title of Paper/Report:	Ecotoxicological assessment of tebuthiuron, a substituted urea class herbicide.
Author(s)	Blaise & Harwood
Journal/Year/Vol:Pages	Revue des Sciences de l'Eau 1991: 50 121-134

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	No
Genotoxic effects (mutagenic, carcinogenic)	No
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	No
Effects to target plants (efficacy testing)	No
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	"
Mixtures including non-BLM herbicides	"
Marine receptors	"

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	1
Chronic effects (e.g., reproductive) that may affect populations	"
Inerts, degradates, metabolite effects	"
Mixtures of any of the five herbicides	No
Indirect effects (food supply, cover)	No

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	
Was the test of proper exposure dose, mechanism, & duration?	
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	
Were proper controls used and was control performance acceptable?	
Are the data presented in a peer-reviewed journal?	

Should evaluation of this paper continue in Task 2?	
Additional comments regarding acceptance/rejection:	data in abstract (English) but unable to evaluate data, journal written in French

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	RJN 10/7/03
Title of Paper/Report:	Canadian water quality guidelines for tebuthiuron
Author(s)	Cox et al
Journal/Year/Vol:Pages	Journal of Environmental Toxicology and Water Quality 61-75 12(1) 1997

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	~~Yes~~ Some

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	4
Chronic effects (e.g., reproductive) that may affect populations	4
Inerts, degradates, metabolite effects	NO
Mixtures of any of the five herbicides	NO
Indirect effects (food supply, cover)	NO

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NO - completion
Was the test of proper exposure dose, mechanism, & duration?	NA
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	|
Are the data presented in a peer-reviewed journal?	↓

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	this is a summary of WQ Guidelines - should be sufficiently evaluated for our needs

DAP comments on paper

- see pages 72 (Table IV)
  74 | V
  76 | VI for various tox data

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	KBN 10/13/03
Title of Paper/Report:	Chronic toxicity of tebuthiuron to an alga (Selenastrum capricornutum), a cladoceran (D. magna) and the fathead minnow (Pimephales promelas)
Author(s)	Meyerhoff et al
Journal/Year/Vol:Pages	Environ Toxicol Chem 1985 4:695-701

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	↓
Genotoxic effects (mutagenic, carcinogenic)	↓
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	↓
Effects to target plants (efficacy testing)	↓
Nontoxic effects (e.g., fate. transport, leaching, analytical methods)	↓
Mixtures including non-BLM herbicides	↓
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	3
Chronic effects (e.g., reproductive) that may affect populations	5
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	to high rank

Task 2: Data Evaluation

Reviewer/Date:	RJN 10/15/03
Partial Title of Paper/Report:	Chronic toxicity of tebuthiuron to an ...

Herbicides tested:	tebuthiuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	(Aquatic Invertebrate)	~~Warmwater Fish~~	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: Algae	
Test Species:	Selenastrum capricornutum	Daphnia magna	Pimephales promelas
Life Stage:	< 24 h for D.m.		
Duration:	14 d for S.c. , 21 d for D.m. , 33 d P.p.		

Exposure Conditions	
Formulation:	98% purity
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	
Test System (e.g., flow-thru, mesocosm, etc.):	static for S.c. Static renewal for D.m. flow-thru P.

S.c. n=3 n=10 for D.m. n=2 for P.p.

Test System Monitoring			
Dissolved Oxygen:	9.1 DM 8.5	Conductivity:	100 / 253 / 277
Temperature: °C	SC 25, 19.2 DM, 23.4 PP	Organic Carbon (D or T):	
pH:	7.8, 8.4, 8.1	Ammonia:	
Other (light):	Continuous-SC 16:8	Other (hardness):	~47.1 SC / 120 DM / 126 PP
Other ( ):	flow	Other (alk):	110 149 139

Water qual in Table 1 p 697

Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival S.c.	307 µg/L max sp. growth		1.5 mg/L	algistatic conc	
Growth D.M.			21.3 mg/L	44.2	# young/adult & length
Reproduction P.P.	total length		9.3 mg/L	18	
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- analytical for all studies, results reported as measured - Stats ok

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	RJS 10/14/03
Title of Paper/Report:	Metabolism of a new herbicide, tebuthiuron ... in mouse, rat, rabbit, dog, duck and fish
Author(s)	Morton & Hoffman
Journal/Year/Vol:Pages	J Toxicol & Environ Health 1976/1:757-768

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	NO
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	NA
Chronic effects (e.g., reproductive) that may affect populations	|
Inerts, degradates, metabolite effects	|
Mixtures of any of the five herbicides	|
Indirect effects (food supply, cover)	↓

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Not evaluated
Was the test of proper exposure dose, mechanism, & duration?	|
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	|
Were proper controls used and was control performance acceptable?	↓
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	NO
Additional comments regarding acceptance/rejection:	Metabolism data — no tox data

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	KBN 10/14/03
Title of Paper/Report:	Effects of tebuthiuron on characteristic green algae found in Playa lakes
Author(s)	Price et al
Journal/Year/Vol:Pages	J Environ Qual 1989 18:62-66

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	1 algae
Genotoxic effects (mutagenic, carcinogenic)	
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	
Effects to target plants (efficacy testing)	
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	
Mixtures including non-BLM herbicides	
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	2

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	~~yes~~ No only 1 trt
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes -
Were proper controls used and was control performance acceptable?	yes many have gotten into screen
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	- one conc. (0.18 µg/ml) - microcosm study low rank

Task 2: Data Evaluation

Reviewer/Date:	RJN 10/14/03
Partial Title of Paper/Report:	Effects of tebuthiuron on characteristic green ...

Herbicides tested:	tebuthiuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate	WarmWater Fish	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: algae	
Test Species: 11 sp.	Ankistrodesmus falcatus Bracteacoccus minor, Chlorella vulgaris, Euglena gracilis		
Life Stage:	Phacus pleuronectes Nocystis sp Staurastrum cristatum Golenkinia sp.		
Duration:	253 d Scenedesmus basilensis Scenedesmus quadricauda		

Exposure Conditions	
Formulation:	97.4% tech grade
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water Bold's Media
Test Concentrations (if appropriate):	0.18 mg/L TB
Test System (e.g., flow-thru, mesocosm, etc.):	400 ml beakers

n=3 each sampling day

Test System Monitoring			
Dissolved Oxygen:	~5-6	Conductivity:	
Temperature:	22.5 ± 1.7°C	Organic Carbon (D or T):	
pH:	~8.1	Ammonia:	
Other (photoperiod):	12h Light:dark	Other ( ):	
Other (hard):	~60 mg/L	Other ( ):	

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Biological and Statistical Endpoints					
Endpoint	**LC50/EC50**	**IC ( )**	**NOEC/NOAEC**	**LOEC**	**Other ( )**
Mortality/Survival				0.18	6 minor 3@ 1st trt
Growth			0.18		other 10 sp:
Reproduction			0.18		All 11 sp @ 2nd trt
Embryo/Larval Develop.					

Degradates/Inerts:	
Additional Comments and Observations:	- single conc. w/ 2 treatments (1) before active growth (Day 2) C max cell # (Day 211) - stats conducted - no analytical data used - nominal conc

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	LZN 10/12/03
Title of Paper/Report:	Effects of tebuthiuron on aquatic productivity
Author(s)	Temple, Murphy, Cheslak
Journal/Year/Vol:Pages	Hydrobiologia 1991/224: 117-127

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	↓
Genotoxic effects (mutagenic, carcinogenic)	↓
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	↓
Effects to target plants (efficacy testing)	↓
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	↓
Mixtures including non-BLM herbicides	↓
Marine receptors	↓

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	2
Chronic effects (e.g., reproductive) that may affect populations	2
Inerts, degradates, metabolite effects	NA
Mixtures of any of the five herbicides	↓
Indirect effects (food supply, cover)	1

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	yes
Was the test of proper exposure dose, mechanism, & duration?	yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	yes, but n=1 for most trtments
Were proper controls used and was control performance acceptable?	yes
Are the data presented in a peer-reviewed journal?	yes

Should evaluation of this paper continue in Task 2?	yes
Additional comments regarding acceptance/rejection:	Measured conc. / mesocosm study / fate info mod rank

Task 2: Data Evaluation

Reviewer/Date:	LJN 10/19/03
Partial Title of Paper/Report:	Effects of tebuthiuron on aquatic productivity

Herbicides tested:	tebuthiuron

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	Aquatic Invertebrate ✓	Warmwater Fish ✓	Coldwater Fish
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: phytoplankton aq. inverts, fathead	
Test Species:	Pimephales promelas		
Life Stage:			
Duration:	108 d		

Exposure Conditions	
Formulation:	97.5% technical
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	water – spike water sediment present
Test Concentrations (if appropriate):	0, 10 70 200, 500 1000 µg/L
Test System (e.g., flow-thru, mesocosm, etc.):	Mesocosm

n=1, except control & 200 n=3

Test System Monitoring			
Dissolved Oxygen:	5.9 – 7.6	Conductivity:	
Temperature:	21.5°C	Organic Carbon (D or T):	
pH:	~8.0	Ammonia:	
Other (hard):	~ 180–200 mg/L	Other ( ):	
Other (Alk):	~ 120–140 mg/L	Other ( ):	

Biological and Statistical Endpoints					
Endpoint	LC50/EC50	IC ( )	NOEC/NOAEC	LOEC	Other ( )
Mortality/Survival			≤ 200	200	Chironomid density
Growth			200	> 200	primary production
Reproduction			200	> 200	chironomid biomass
Embryo/Larval Develop.			200	> 200	fish biomass

Degradates/Inerts:	
Additional Comments and Observations:	– mesocosm exp. – 30 d colonization prior to dosing – fate study (H2O, sed)

endpts: 1° production, density & biomass of inverts, chironomids, fathead minnows

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-13-03
Title of Paper/Report:	Assessment of Effect levels of chemicals . . . .
Author(s)	M.M. Mumtaz . . . .
Journal/Year/Vol:Pages	Toxicol. Lett. / 1995 / 79: 131-143

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	/
Genotoxic effects (mutagenic, carcinogenic)	/
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	/
Effects to target plants (efficacy testing)	/
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	/
Mixtures including non-BLM herbicides	/
Marine receptors	/

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	3- Predicts chronic effects
Inerts, degradates, metabolite effects	/
Mixtures of any of the five herbicides	/
Indirect effects (food supply, cover)	/

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	NA
Was the test of proper exposure dose, mechanism, & duration?	/
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	/
Were proper controls used and was control performance acceptable?	/
Are the data presented in a peer-reviewed journal?	Yes - ?

Should evaluation of this paper continue in Task 2?	No
Additional comments regarding acceptance/rejection:	No new tox data - prediction of Chronic LOAEL only - Fluridone

BLM National Vegetation EIS

Literature Review Form

Reviewer/Date:	Pillard / 5-20-03
Title of Paper/Report:	Aquatic phyto-toxicity of 25 posticides applied at expected . . . .
Author(s)	H. G. Peterson et al.
Journal/Year/Vol:Pages	Aquat. Toxicol. / ~~ES~~ 1994 / 28: 275-292

Task 1: Application of Selection Criteria

A. Indicate if the paper meets these exclusion criteria

Issue (deals only with)	Indicate Yes or No
Human health effects	No
Effects to microorganisms	|
Genotoxic effects (mutagenic, carcinogenic)	|
Bioassays to cells of a whole organism (e.g., rate hepatocytes, rat liver S9)	|
Effects to target plants (efficacy testing)	|
Nontoxic effects (e.g., fate, transport, leaching, analytical methods)	|
Mixtures including non-BLM herbicides	|
Marine receptors	|

B. Issues to be emphasized

Issue	Rate Paper from 1 (Weak emphasis) to 5 (Strong)
Effects on nontarget receptors related to ERA protocol	
Chronic effects (e.g., reproductive) that may affect populations	3- Plant Growth
Inerts, degradates, metabolite effects	1
Mixtures of any of the five herbicides	1
Indirect effects (food supply, cover)	3 - Algae, duckweed

C. Other Criteria

Issue	Indicate Yes or No
Are corroborating studies described?	Yes
Was the test of proper exposure dose, mechanism, & duration?	Yes
Did the test include proper sample size, statistical analysis (especially NOAEL, or dose response curve)?	Yes
Were proper controls used and was control performance acceptable?	Not presented
Are the data presented in a peer-reviewed journal?	Yes

Should evaluation of this paper continue in Task 2?	Yes
Additional comments regarding acceptance/rejection:	-only test 1 conc - Est environ. conc.

Task 2: Data Evaluation

Reviewer/Date:	RSN 10/3/03
Partial Title of Paper/Report:	Aquatic phyto-toxicity of 23 pesticides applied at expected...
Herbicides tested:	~~Sulfometuron methyl~~ Metsulfuron-methyl (oust) tebuthiuron diquat

20 g Mammal	Honey Bee	70 kg Herbivore	Large Bird
Small Bird	~~Aquatic Invertebrate~~	Warmwater Fish	~~Coldwater Fish~~
Non-Target Plants	Aquatic Plant (Macrophyte)	Other: diatoms algae & Cyanobacteria	not included
Test Species:	diatoms: Cyclotella meneghiana Nitzschia sp. algae: Scenedesmus quadricauda Selenastrum capricornutum Lemna minor (duckweed)		
Life Stage:	L. minor (3 mature leaves / plant)		
Duration:	7-d (L. minor) 72h algae 6h incubation w/ pesticide 16h incubation w/ 14C		

Exposure Conditions	
Formulation:	technical / analytical grade
Concentration/amount of active ingredient:	
Medium (water, food, soil, etc.):	
Test Concentrations (if appropriate):	3 mg/L Oust / 0.733 mg/L diquat / 5.867 mg/L teb
Test System (e.g., flow-thru, mesocosm, etc.):	algae test tube 7ml / L. minor 12 ml M. cropht

Test System Monitoring			
Dissolved Oxygen:		Conductivity:	
Temperature:		Organic Carbon (D or T):	
pH:		Ammonia:	
Other (reps):	n=3 algae n=4 duckweed	Other ( ):	
Other ( ):		Other ( ):	

Biological and Statistical Endpoints					
Endpoint	~~LC50/EC50~~	IC ( )	NOEC/NOAEC	LOEC	~~Other~~ ( )
Mortality/Survival	Species	% Inhibition		% Inhibition (tebuthiuron)	
Growth	S. Capri	27 *	150	~~Gm~~ C.M.	98% *
Reproduction	L. minor	63 *	300	N.sp	99% *
Embryo/Larval Develop.	C. m.	99 *		S.q.	90 *
	N. sp	100 *		S.c.	100 *
	S.q.	53 *	+ diquat	L.m.	100 *
	S.c.	69 *			
	L.m.	100 *			

Degradates/Inerts:	
Additional Comments and Observations:	endpt was uptake of herbicides at est. environ. conc. - one conc (EEC) was tested - compared to control - endpts Algae: uptake of ^{14}C L. minor: increase in # leaves

APPENDIX A.3

SPREADSHEET OF TOXICITY DATA FOR TEBUTHIURON TRV

Formulation	% purity a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]		Toxicity Value (ai) [1]		Units	Chemical Analysis Done/ Reported?	Lab	Study Number	Data Source [2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Tebuthiuron	> 97	amphibian	frog	*Rana catesbeiana*	6 w	Static	Water	96 hr	96 hr	Survival	LC_{50}	>	306	NR		mg/L	Yes/Yes			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebutbiuron	**> 97**	**amphibian**	**frog**	***Rana catesbeiana***	**6 w**	**Static**	**Water**	**96 hr**	**96 hr**	**Survival**	**LC_{50}**	**<**	**398**	**NR**		**mg/L**	**Yes/Yes**			**Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]**			
Tebuthiuron	97.4	aquatic invertebrate	water flea	*Daphnia magna*		Acute	Water		21 d		LOEC		NR	<	44.2	mg ai/L			NAOTEB01	In USEPA 1994, 2003.			Yes
Tebuthiuron		aquatic invertebrate	water flea			Acute	Water		48 hr		LC_{50}		NR		225	mg ai/L				In DOE 2000.			
Tebuthiuron	97.4	aquatic invertebrate	water flea	*Daphnia magna*		Acute	Water		21 d		NOEL		NR	>	21.8	mg ai/L			NAOTEB01	In USEPA 1994, 2003.			Yes
Tebuthiuron, technical	97.5	aquatic invertebrate	chironomid		larvae	Mesocosm	Water	108 d	108 d	Chrionomid density	NOEC[5]	<	200	NR		ug/L	Yes/Yes			Temple et al. 1991. Hydrobiologia. 224: 117-127.			
Tebuthiuron, technical	97.5	aquatic invertebrate	chironomid		larvae	Mesocosm	Water	108 d	108 d	Chrionomid density	LOEC[5]		200	NR		ug/L	Yes/Yes			Temple et al. 1991. Hydrobiologia. 224: 117-127.			
Tebuthiuron, technical	97.5	aquatic invertebrate	chironomid		larvae	Mesocosm	Water	108 d	108 d	Chrionomid biomass	NOEC[5]		200	NR		ug/L	Yes/Yes			Temple et al. 1991. Hydrobiologia. 224: 117-127.			
Tebuthiuron, technical	97.5	aquatic invertebrate	chironomid		larvae	Mesocosm	Water	108 d	108 d	Chrionomid biomass	LOEC[5]	>	200	NR		ug/L	Yes/Yes			Temple et al. 1991. Hydrobiologia. 224: 117-127.			
Tebuthiuron	99.2	aquatic invertebrate	Water flea	*Daphnia magna*	< 10 hr	Static	Water	24 hr	48 hr	Survival	EC_{50}	>	400	NR		mg/L	No/No			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	**99.2**	**aquatic invertebrate**	**Water flea**	***Daphnia magna***	**< 10 hr**	**Static**	**Water**	**48 hr**	**48 hr**	**Survival**	**EC_{50}**		**297**	**NR**		**mg/L**	**No/No**	**Lilly Research Laboratories**	**MRID 00041694**	**Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3,4]**	**C.M. Natella**	**1987**	**Yes**
Tebutbiuron	**> 97**	**aquatic invertebrate**	**Snail**	***Helisoma sp.***	**egg**	**Static**	**Water**	**8 m**	**8 m**	**Biomass**	**NOEL**	**>**	**0.1**	**NR**		**mg/L**	**Yes/Yes**			**Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]**			
Tebuthiuron	**> 97**	**aquatic invertebrate**	**Snail**	***Physa sp.***	**egg**	**Static**	**Water**	**8 m**	**8 m**	**Biomass**	**NOEL**	**>**	**0.1**	**NR**		**mg/L**	**Yes/Yes**			**Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]**			
Tebuthiuron	> 97	aquatic invertebrate	Fiddler crab	*Uca pugilator*	unknown	Unknown	Water	96 hr	96 hr	Survival	LC_{50}	>	320	NR		mg/L	Unknown			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3,4]			
Tebuthiuron	> 97	aquatic invertebrate	Eastern oyster	*Crassostrea virginica*	embryo	Unknown	Water	48 hr	48 hr	Development	NOEL	>	180	NR		mg/L	Unknown	EG & G Corp (Diamond Shamrock)	MRID 00041684	Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3,4]			Yes
Tebuthiuron	> 97	aquatic invertebrate	Eastern oyster	*Crassostrea virginica*	embryo	Unknown	Water	48 hr	48 hr	Development	LOEL	<	320	NR		mg/L	Unknown	EG & G Corp (Diamond Shamrock)	MRID 00041684	Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			Yes
Tebuthiuron	98	aquatic invertebrate	Water flea	*Daphnia magna*	< 24 hr	Static	Water	21 d	21 d	Growth & Repro	NOEC		21.8	NR		mg/L	Yes/Yes		NAOTEB01	Meyerhoff et al. 1985. Environ. Toxicol. Chem. 4: 695-701.			
Tebuthiuron	98	aquatic invertebrate	Water flea	*Daphnia magna*	< 24 hr	Static	Water	21 d	21 d	Growth & Repro	LOEC		44.2	NR		mg/L	Yes/Yes			Meyerhoff et al. 1985. Environ. Toxicol. Chem. 4: 695-701.			
Tebuthiuron		aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	6 d	6 d	Growth	NOEC		0.03	NR		mg/L	No/No			Adams et al. 1986. Bull. Environ. Contam. Toxicol. 36: 254-259.			Yes
Tebuthiuron		aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	6 d	6 d	Growth	LOEC		0.05	NR		mg/L	No/No			Adams et al. 1986. Bull. Environ. Contam. Toxicol. 36: 254-259.			Yes
Tebuthiuron	99.08	aquatic plant	algae			Acute	Water		5 d		EC_{50}		NR		4.060	ai ppm				In USEPA 1994.			Yes
Tebuthiuron	99.08	aquatic plant	diatom			Acute	Water		5 d		EC_{50}		NR		0.050	ai ppm				In USEPA 1994.			Yes
Tebuthiuron	99.08	aquatic plant	diatom			Acute	Water		5 d		EC_{50}		NR		0.081	ai ppm				In USEPA 1994.			Yes
Tebuthiuron	98	aquatic plant	algae			Acute	Water		5 d		EC_{50}		NR		0.050	ai ppm				In USEPA 1994.			Yes
Tebuthiuron	**98**	**aquatic plant**	**Green algae**	***Selenastrum capricornutum***		**Static**	**Water**	14 d	**14** d		**EC_{50}**		**0.05**	**NR**		**mg/L**			**NAOTEB07**	**1983. In USEPA 2003.**	**M. Rostker**	**1984**	**Yes**
Tebuthiuron	98	aquatic plant	Green algae	*Selenastrum capricornutum*		Static	Water	14 d	14 d		NOEL		0.13	NR		mg/L			NAOTEB07	1983. In USEPA 2003.	M. Rostker	1984	Yes

Formulation	% purity a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]	Toxicity Value (ai) [1]	Units	Chemical Analysis Done/ Reported?	Lab	Study Number	Data Source[2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Tebuthiuron, technical	99.08	aquatic plant	Marine diatom	*Skeletonema costatum*	culture	7 d alga growth	Water		7 d	growth and reproduc	EC_{25}	NR	0.036	mg ai/L		Lilly Research Laboratories	MRID 41080402	1989. In USEPA 1990, 2003.	Prapimpan Kosalwat	1/10/1990	Yes
Tebuthiuron, technical	99.08	aquatic plant	Marine diatom	*Skeletonema costatum*	culture	7 d alga growth	Water		7 d	growth and reproduc	EC_{50}	NR	0.067	mg ai/L		Lilly Research Laboratories	MRID 41080402	1989. In USEPA 1990, 1992.	Prapimpan Kosalwat	1/10/1990	Yes
Tebuthiuron, technical	99.08	aquatic plant	Marine diatom	*Skeletonema costatum*	culture	7 d alga growth	Water		7 d	growth and reproduc	NOEC	NR	0.036	mg ai/L		Lilly Research Laboratories	MRID 41080402	1989. In USEPA 1990, 2003.	Prapimpan Kosalwat	1/10/1990	Yes
Tebuthiuron, technical	99.08	aquatic plant	Freshwater diatom	*Navicula pelliculosa*	culture	7 d alga growth	Water		7 d	growth and reproduc	EC_{25}	NR	0.111	mg ai/L		Lilly Research Laboratories	MRID 41080403	1989. In USEPA 1990, 2003.	Debra S. Segal	1/8/1990	Yes
Tebuthiuron, technical	99.08	aquatic plant	Freshwater diatom	*Navicula pelliculosa*	culture	7 d alga growth	Water		7 d	growth and reproduc	EC_{50}	NR	0.193	mg ai/L		Lilly Research Laboratories	MRID 41080403	1989. In USEPA 1990, 2003.	Debra S. Segal	1/8/1990	Yes
Tebuthiuron, technical	99.08	aquatic plant	Freshwater diatom	*Navicula pelliculosa*	culture	7 d alga growth	Water		7 d	growth and reproduc	NOEC	NR	0.056	mg ai/L		Lilly Research Laboratories	MRID 41080403	1989. In USEPA 1990, 2003.	Debra S. Segal	1/8/1990	Yes
Tebuthiuron, technical	99.08	aquatic plant	Duckweed	*Lemna gibba*	culture	14 d growth	Water		14 d	growth and reproduc	EC_{25}	NR	0.066	mg ai/L		Lilly Research Laboratories	MRID 41080404	1989. In USEPA 1990, 2003.	Prapimpan Kosalwat	1/10/1990	Yes
Tebuthiuron, technical	99.08	aquatic plant	Duckweed	*Lemna gibba*	culture	14 d growth	Water		14 d	growth and reproduc	EC_{50}	NR	0.135	mg ai/L		Lilly Research Laboratories	MRID 41080404	1989. In USEPA 1990, 2003.	Prapimpan Kosalwat	1/10/1990	Yes
Tebuthiuron, technical	99.08	aquatic plant	Duckweed	*Lemna gibba*	culture	14 d growth	Water		14 d	growth and reproduc	NOEC	NR	0.066	mg ai/L		Lilly Research Laboratories	MRID 41080404	1989. In USEPA 1990, 2003.	Prapimpan Kosalwat	1/10/1990	Yes
Tebuthiuron, technical	97.4	aquatic plant	algae	*Bracteacoccus minor*	cells[7]	Static	Water	189 d[8]	210 d	Growth	LOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Ankistrodesmus falcatus*	cells[7]	Static	Water	189 d[8]	210 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	Green algae	*Chlorella vulgaris*	cells[7]	Static	Water	189 d[8]	210 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	Green algae	*Euglena gracilis*	cells[7]	Static	Water	189 d[8]	210 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Gloeocystis ampla*	cells[7]	Static	Water	189 d[8]	210 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Golenkinia sp.*	cells[7]	Static	Water	189 d[8]	210 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Oocystis sp.*	cells[7]	Static	Water	189 d[8]	210 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Phacus pleuronectes*	cells[7]	Static	Water	189 d[8]	210 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	Green algae	*Scenedesmus basilensis*	cells[7]	Static	Water	189 d[8]	210 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	Green algae	*Scenedesmus quadricauda*	cells[7]	Static	Water	189 d[8]	210 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Staurastrum cristatum*	cells[7]	Static	Water	189 d[8]	210 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Bracteacoccus minor*	cells	Static	Water	42 d	253 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Ankistrodesmus falcatus*	cells	Static	Water	42 d	253 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	Green algae	*Chlorella vulgaris*	cells	Static	Water	42 d	253 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	Green algae	*Euglena gracilis*	cells	Static	Water	42 d	253 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Gloeocystis ampla*	cells	Static	Water	42 d	253 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Golenkinia sp.*	cells	Static	Water	42 d	253 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Oocystis sp.*	cells	Static	Water	42 d	253 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Phacus pleuronectes*	cells	Static	Water	42 d	253 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	Green algae	*Scenedesmus basilensis*	cells	Static	Water	42 d	253 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	Green algae	*Scenedesmus quadricauda*	cells	Static	Water	42 d	253 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			
Tebuthiuron, technical	97.4	aquatic plant	algae	*Staurastrum cristatum*	cells	Static	Water	42 d	253 d	Growth	NOEC	0.18	NR	ug/ml	No/No			Price et al. 1989. J. Environ. Qual. 18: 62-66.			

Formulation	% purity a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]	Toxicity Value (ai) [1]	Units	Chemical Analysis Done/ Reported?	Lab	Study Number	Data Source [2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Tebuthiuron, technical	97.5	aquatic plant	phytoplankton		various	Mesocosm	Water	108 d	108 d	Primary production	NOEC [5]	200	NR	ug/L	Yes/Yes			Temple et al. 1991. Hydrobiologia 224: 117-127.			
Tebuthiuron, technical	97.5	aquatic plant	phytoplankton		various	Mesocosm	Water	108 d	108 d	Primary production	LOEC [5]	> 200	NR	ug/L	Yes/Yes			Temple et al. 1991. Hydrobiologia 224: 117-127.			
technical or analytical		aquatic plant	diatom	*Cyclotella meneghiana*	cells	Static	Water	22 hr	22 hr	^{14}C uptake	98% inhibition at EEC	NR	NR		No/No			Peterson et al. 1994. Aquatic Toxicology 28: 275-292.			
technical or analytical		aquatic plant	diatom	*Nitzschia spp*	cells	Static	Water	22 hr	22 hr	^{14}C uptake	99% inhibition at EEC	NR	NR		No/No			Peterson et al. 1994. Aquatic Toxicology 28: 275-292.			
technical or analytical		aquatic plant	Green algae	*Scenedesmus quadricauda*	cells	Static	Water	22 hr	22 hr	^{14}C uptake	90% inhibition at EEC	NR	NR		No/No			Peterson et al. 1994. Aquatic Toxicology 28: 275-292.			
technical or analytical		aquatic plant	Green algae	*Selenastrum capricornutum*	cells	Static	Water	22 hr	22 hr	^{14}C uptake	100% inhibition at EEC	NR	NR		No/No			Peterson et al. 1994. Aquatic Toxicology 28: 275-292.			
technical or analytical		aquatic plant	Duckweed	*Lemna minor*	plant	Static	Water	7 d	7 d	Frond growth	100% inhibition at EEC	NR	NR		No/No			Peterson et al. 1994. Aquatic Toxicology 28: 275-292.			
Tebuthiuron		aquatic plant	Green algae	*Selenastrum capricornutum*	1000 cells/ml	Static	Water	1-6 d	1-6 d	Growth	NOEL	0.01-0.05	NR	mg/L	No/No			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	> 97	aquatic plant	Green algae	*Selenastrum capricornutum*	unknown	Static	Water	96 hr	96 hr	Growth	EC_{50}	0.08	NR	mg/L	No/No			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	99	aquatic plant	Green algae	*Selenastrum capricornutum*	unknown	Static	Water	96 hr	96 hr	Growth	EC_{50}	0.102	NR	mg/L	No/No			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	**98**	**aquatic plant**	**Green algae**	***Selenastrum capricornutum***	**1000 cells/ml**	**Static**	**Water**	**14 d**	**14 d**	**Population density**	**NOEL**	**0.013**	**NR**	**mg/L**	**Yes/Yes**			**Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]**			
Tebuthiuron	98	aquatic plant	Green algae	*Selenastrum capricornutum*	1000 cells/ml	Static	Water	14 d	14 d	Population density	LOEL	0.016	NR	mg/L	Yes/Yes			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	98	aquatic plant	Green algae	*Selenastrum capricornutum*	1000 cells/ml	Static	Water	14 d	14 d	Growth	LOEL	0.079	NR	mg/L	Yes/Yes			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	98	aquatic plant	Green algae	*Selenastrum capricornutum*	1000 cells/ml	Static	Water	14 d	14 d	Biomass	LOEL	0.168	NR	mg/L	Yes/Yes			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	99	aquatic plant	Freshwater diatom	*Navicula pelliculosa*	1000 cells/ml	Static	Water	7 d	7 d	Growth	NOEL	0.056	NR	mg/L	Yes/Yes			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	99	aquatic plant	Freshwater diatom	*Navicula pelliculosa*	1000 cells/ml	Static	Water	7 d	7 d	Growth	LOEL	0.11	NR	mg/L	Yes/Yes			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	99	aquatic plant	Freshwater diatom	*Navicula pelliculosa*	1000 cells/ml	Static	Water	7 d	7 d	Growth	EC_{50}	0.213	NR	mg/L	Yes/Yes			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	99	aquatic plant	Duckweed	*Lemna gibba*	3 frond/ plant	Static-renewal	Water	14 d	14 d	Growth	NOEL	0.091	NR	mg/L	Unknown			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	99	aquatic plant	Duckweed	*Lemna gibba*	3 frond/ plant	Static-renewal	Water	14 d	14 d	Growth	LOEL	0.19	NR	mg/L	Unknown			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	99	aquatic plant	Duckweed	*Lemna gibba*	3 frond/ plant	Static-renewal	Water	14 d	14 d	Growth	EC_{50}	0.235	NR	mg/L	Unknown			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	99	aquatic plant	marine diatom	*Skeletonema costatum*	10,000 cells/ml	Static	Water	7 d	7 d	Growth	NOEL	0.038	NR	mg/L	Yes/Yes			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	99	aquatic plant	marine diatom	*Skeletonema costatum*	10,000 cells/ml	Static	Water	7 d	7 d	Growth	LOEL	0.076	NR	mg/L	Yes/Yes			Caux et al. 1997. Environ. Toxicol. Water Qual. 12: 61-95. [3]			
Tebuthiuron	98	aquatic plant	Green algae	*Selenastrum capricornutum*	9 d old culture	Static	Water	14 d	14 d	Growth [6]	EC_{50}	NR	0.307	mg ai/L	Yes/Yes			Meyerhoff et al. 1985. Environ. Toxicol. Chem. 4: 695-701.			
Tebuthiuron	98	aquatic plant	Green algae	*Selenastrum capricornutum*	9 d old culture	Static	Water	14 d	14 d	Growth [6]	EC_{50}	NR	0.033	mg ai/L	Yes/Yes			Meyerhoff et al. 1985. Environ. Toxicol. Chem. 4: 695-701.			
Tebuthiuron	98	aquatic plant	Green algae	*Selenastrum capricornutum*	9 d old culture	Static	Water	14 d	14 d	Growth [6]	LOEL	NR	0.079	mg ai/L	Yes/Yes			Meyerhoff et al. 1985. Environ. Toxicol. Chem. 4: 695-701.			
Tebuthiuron	98	aquatic plant	Green algae	*Selenastrum capricornutum*	9 d old culture	Static	Water	14 d	14 d	Growth	Algistatic conc.	NR	1.5	mg ai/L	Yes/Yes			Meyerhoff et al. 1985. Environ. Toxicol. Chem. 4: 695-701.			
Tebuthiuron	98	bird	Mallard duck	*Anas platyrhynchos*	9 mos	Acute	Oral		14 d	mortality	LD_{50}	NR	2000	mg ai/kg		Lilly Research Laboratories	MRID 00041692	1986. In USEPA 1993, 2003.	C.M. Natella	1986	Yes
Tebuthiuron		**bird**	**Hen (species?)**				**Diet**		**30 d**		**NOEL**	**NR**	**1000**	**mg ai/kg/d**				**In PIP 1993.**			**Yes**

Formulation	% purity a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]	Toxicity Value (ai) [1]	Units	Chemical Analysis Done/ Reported?	Lab	Study Number	Data Source [2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Tebuthiuron	98	bird	Chicken	*White Rock Cross*	Adult	Acute	Oral				LD_{50}	NR	500	mg ai/kg		EG & G Corp (Diamond Shamrock)	MRID 00020661	1972. In USEPA 1994, 2003.	C.M. Natella	1986	Yes
Tebuthiuron		bird	Bobwhite quail	*Colinus virginianus*		Subacute	Diet				LC_{50}	NR	5000	ai ppm				In USEPA 1994.			Yes
Tebuthiuron		bird	Mallard duck	*Anas platyrhynchos*		Subacute	Diet			mortality	LC_{50}	NR	5000	ai ppm				In USEPA 1994.			Yes
Tebuthiuron	98	bird	Mallard duck	*Anas platyrhynchos*	7 day	Acute	Oral		8 d	mortality	LD_{50}	2500	NR	mg/kg		Lilly Research Laboratories	MRID 00041680	1976. In USEPA 2003.	C.M. Natella	1986	Yes
Tebuthiuron	98	bird	Bobwhite quail	*Colinus virginianus*	7 day	Acute	Diet		8 d		LC_{50}	2500	NR	ppm		Lilly Research Laboratories	MRID 00041681	1976. In USEPA 2003.	C.M. Natella	1986	Yes
Tebuthiuron	98	bird	Mallard duck	*Anas platyrhynchos*	12 m	Acute	Oral		14 d	mortality	LD_{50}	500	NR	mg/kg		Lilly Research Laboratories	MRID 00020661	1972. In USEPA 2003.	C.M. Natella	1986	Yes
Tebuthiuron	98	bird	Bobwhite quail	*Colinus virginianus*	> or = 4 m	Acute	Oral		14 d		LD_{50}	500	NR	mg/kg		Lilly Research Laboratories	MRID 00020661	1972. In USEPA 2003.	C.M. Natella	1986	Yes
Tebuthiuron	96.4	bird	Mallard duck	*Anas platyrhynchos*	early life	Chronic	Reproductive		22 w	mortality	LOEL	100	NR	ppm		Lilly Research Laboratories	MRID 00093690	1972. In USEPA 2003.	C.M. Natella	1987	Yes
Tebuthiuron	96.4	bird	Mallard duck	*Anas platyrhynchos*	early life	Chronic	Reproductive		22 w		NOEL	NR	100	ai ppm		Lilly Research Laboratories	MRID 00093690	1972. In USEPA 1994, 2003.	C.M. Natella	1987	Yes
Tebuthiuron	96.4	bird	Bobwhite quail	*Colinus virginianus*	early life	Chronic	Reproductive		22 w		LOEL	NR	100	ai ppm		Wildlife International	MRID 00104243	1978. In USEPA 1994, 2003.	C.M. Natella	1987	Yes
Tebuthiuron	96.4	bird	Bobwhite quail	*Colinus virginianus*	early life	Chronic	Reproductive		22 w		NOEL	100	NR	ppm		Wildlife International	MRID 00104243	1978. In USEPA 2003.	C.M. Natella	1987	Yes
Tebuthiuron, technical	**99.1**	**bird**	**Bobwhite quail**	***Colinus virginianus***	**11 d**	**8 d acute w growth**	**Diet**		**8 d**		**LC_{50}**	**NR**	**5113**	**ai ppm**		**Lilly Research Laboratories**	**MRID 40601001**	**1988. In USEPA 1991a, 1994, 2003.**	**Tracy L. Perry**	**1/10/1990**	**Yes**
Tebuthiuron, technical	**99.1**	**bird**	**Mallard duck**	***Anas platyrhynchos***	**4 d**	**8 d acute w growth**	**Diet**		**8 d**	**mortality**	**LC_{50}**	**NR**	**5093**	**ai ppm**		**Lilly Research Laboratories**	**MRID 40601002**	**1988. In USEPA 1991a, 1994, 2003.**	**Tracy L. Perry**	**5/29/1991**	**Yes**
pellet	20	fish	Fathead minnow	*Pimephales promelas*	unknown	Static	Water	7 d	7 d	Survival	LOEL	70	NR	mg/L	Yes/Yes			Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
powder	80	fish	Fathead minnow	*Pimephales promelas*	unknown	Static	Water	7 d	7 d	Survival	NOEL	90	NR	mg/L	Yes/Yes			Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
powder	80	fish	Fathead minnow	*Pimephales promelas*	unknown	Static	Water	7 d	7 d	Survival	LOEL	110	NR	mg/L	Yes/Yes			Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
Tebuthiuron	98	fish	Rainbow trout	*Oncorhynchus mykiss*		Acute	Water		96 hr		LC_{50}	143	NR	mg/L		EG & G Corp (Diamond Shamrock)	MRID 00020661	1972. In USEPA 2003.	C.M. Natella	1986	Yes
Tebuthiuron		fish	trout			Acute	Water		96 hr		LC_{50}	NR	87	mg ai/L				In DOE 2000.			
Tebuthiuron	98	fish	Bluegill sunfish	*Lepomis macrochirus*		Acute	Water		96 hr		LC_{50}	NR	106	mg ai/L		EG & G Corp (Diamond Shamrock)	MRID 00020661	1972. In USEPA 1994, 2003.	C.M. Natella	1986	Yes
Tebuthiuron		fish	Bluegill sunfish	*Lepomis macrochirus*		Acute	Water		96 hr		LC_{50}	NR	87	mg ai/L				In DOE 2000.			
Tebuthiuron	98	fish	Fathead minnow	*Pimephales promelas*	Juv	Acute	Water		96 hr		LC_{50}	180	NR	mg/L		Lilly Research Laboratories	MRID 00041685	1976. In USEPA 2003.	C.M. Natella	1987	Yes
Tebuthiuron	80	fish	Fathead minnow	*Pimephales promelas*	Juv	Acute	Water		96 hr		LC_{50}	180	NR	mg/L		Lilly Research Laboratories	41685	1976. In USEPA 2003.	C.M. Natella	1987	Yes
Tebuthiuron	20	fish	Fathead minnow	*Pimephales promelas*	Juv	Acute	Water		96 hr		LC_{50}	180	NR	mg/L		Lilly Research Laboratories	41685	1976. In USEPA 2003.	C.M. Natella	1987	Yes
Tebuthiuron, technical	97	fish	Goldfish	*Carassius auratus*	5 cm	Static	Water	96 hr	96 hr	Survival	LC_{50}*	> 160	NR	mg/L	No/No	Lilly Research Laboratories	MRID 00020661	Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]	C.M. Natella		Yes
Tebuthiuron, technical	97	fish	Fathead minnow	*Pimephales promelas*	adult	Static	Water	96 hr	96 hr	Survival	LC_{50}	> 160	NR	mg/L	No/No			Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
Tebuthiuron, technical	97	fish	Fathead minnow	*Pimephales promelas*	unknown	Static	Water	7 d	7 d	Survival	LOEL	< 70	NR	mg/L	Yes/Yes			Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
Tebuthiuron, technical	97.5	fish	Fathead minnow	*Pimephales promelas*	1.6 cm	Mesocosm	Water	108 d	108 d	Fish biomass	NOEC[5]	0.2	NR	mg/L	Yes/Yes			Temple et al. 1991. Hydrobiologia 224: 117-127.			Yes
Tebuthiuron, technical	97.5	fish	Fathead minnow	*Pimephales promelas*	1.6 cm	Mesocosm	Water	108 d	108 d	Fish biomass	LOEC[5]	> 0.2	NR	mg/L	Yes/Yes			Temple et al. 1991. Hydrobiologia 224: 117-127.			Yes

Formulation	% purity a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]		Toxicity Value (ai) [1]		Units	Chemical Analysis Done/ Reported?	Lab	Study Number	Data Source[2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Tebuthiuron	**> 97**	**fish**	**Rainbow trout**	***Oncorhynchus mykiss***	**10 g**	**Static**	**Water**	**96 hr**	**96 hr**	**Survival**	**LC_{50}**		**115**		**NR**	**mg/L**	**No/No**			**Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]**			**Yes**
Tebuthiuron	~ 100	fish	Rainbow trout	*Oncorhynchus mykiss*	1.5 g	Static	Water	24 hr	96 hr	Survival	LC_{50}	>	160		NR	mg/L	No/No			Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
Tebuthiuron	~ 100	fish	Rainbow trout	*Oncorhynchus mykiss*	1.5 g	Static	Water	96 hr	96 hr	Survival	LC_{50}		144		NR	mg/L	No/No			Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
Tebuthiuron	97.5	fish	Rainbow trout	*Oncorhynchus mykiss*	9 w	Static	Water	24 hr	5 d	Survival	LC_{50}		193		NR	mg/L	No/No			Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
Tebuthiuron	97.5	fish	Rainbow trout	*Oncorhynchus mykiss*	9 w	Static	Water	5 d	5 d	Survival	LC_{50}		126		NR	mg/L	No/No			Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
Tebuthiuron	**98**	**fish**	**Rainbow trout**	***Oncorhynchus mykiss***	**larvae**	**Flow through**	**Water**	**45 d**	**45 d**	**Survival**	**NOEL**		**26**		**NR**	**mg/L**	**Unknown**	**Lilly Research Laboratories**	**MRID 00090083**	**Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]**			**Yes**
Tebuthiuron	98	fish	Rainbow trout	*Oncorhynchus mykiss*	larvae	Flow through	Water	45 d	45 d	Survival	LOEL		52		NR	mg/L	Unknown	Lilly Research Laboratories	MRID 00090083	Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
Tebuthiuron	**98**	**fish**	**Rainbow trout**	***Oncorhynchus mykiss***	**larvae**	**Flow through**	**Water**	**45 d**	**45 d**	**Growth**	**NOEL**		**26**		**NR**	**mg/L**	**Unknown**	**Lilly Research Laboratories**	**MRID 00090083**	**Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]**			**Yes**
Tebuthiuron	98	fish	Rainbow trout	*Oncorhynchus mykiss*	larvae	Flow through	Water	45 d	45 d	Growth	LOEL		52		NR	mg/L	Unknown	Lilly Research Laboratories	MRID 00090083	Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
Tebuthiuron	~ 100	fish	Bluegill sunfish	*Lepomis macrochirus*	36 mm	Static	Water	24 hr	96 hr	Survival	LC_{50}	>	160	N	NR	mg/L	Yes/Yes			Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
Tebuthiuron	**~ 100**	**fish**	**Bluegill sunfish**	***Lepomis macrochirus***	**36 mm**	**Static**	**Water**	**96 hr**	**96 hr**	**Survival**	**LC_{50}**		**112**		**NR**	**mg/L**	**Yes/Yes**			**Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]**			**Yes**
Tebuthiuron	~ 100	fish	Bluegill sunfish	*Lepomis macrochirus*	36 mm	Static	Water	96 hr	96 hr	Survival	NOEL		50		NR	mg/L	Yes/Yes			Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
Tebuthiuron	97.5	fish	Bluegill sunfish	*Lepomis macrochirus*	young	Unknown	Water	10 d	10 d	Survival	LOEL	</=	120	</=	NR	mg/L	Yes/Yes			Caux et al.1997. Environ. Toxicol. Water Qual. 12: 61-95.[3]			Yes
Tebuthiuron	**98**	**fish**	**Fathead minnow**	***Pimephales promelas***	**< 24 hr**	**Flow through**	**Water**	**33 d**	**33 d**	**Length**	**NOEC**		**NR**		**9.3**	**mg ai/L**	**Yes/Yes**	**Lilly Research Laboratories**	**MRID 00090084**	**Meyerhoff et al. 1985. Environ. Toxicol. Chem. 4: 695-701.**			**Yes**
Tebuthiuron	98	fish	Fathead minnow	*Pimephales promelas*	< 24 hr	Flow through	Water	33 d	33 d	Length	LOEC		NR		18	mg ai/L	Yes/Yes	Lilly Research Laboratories	MRID 00090084	Meyerhoff et al. 1985. Environ. Toxicol. Chem. 4: 695-701.			Yes
Tebuthiuron		**insect**	**Honeybee**	***Apis mellifera***	**worker**	**Acute dermal contact**	**Dermal**		**48 hr**		**LD_{50}**		**NR**		**30**	**ug ai/bee**				**In DOE 2000.**			**Yes**
Tebuthiuron, technical	99.1	insect	Honeybee	*Apis mellifera*	1-7 d	Acute dermal contact	Dermal		48 hr		LD_{50}		NR	>	100	ug ai/bee	Yes/Yes	Wildlife International	MRID 40840401	1988. In USEPA 1989a, 2003.	Allen W. Vaughan	3/31/1989	Yes
Tebuthiuron		mammal	rat			Acute	Oral				LD_{50}		NR		644	mg ai/kg				In DOE 2000.			No[9]
Tebuthiuron		mammal	rabbit			Acute	Dermal				LD_{50}		NR		200	mg ai/kg/d				In DOE 2000.			No[9]
Tebuthiuron		mammal	rat			Carcinogenicity	Diet		2 y		NOEC		NR		1600	ai ppm				In DOE 2000.			No[9]
Tebuthiuron		mammal	rat			Developmental	Diet				NOEC		NR		1800	ai ppm				In DOE 2000.			No[9]
Tebuthiuron		mammal	rabbit			Developmental	Diet				NOEC		NR		825	ai ppm				In DOE 2000.			No[9]
Tebuthiuron		mammal	rat			Reproductive	Diet?				NOEC		NR		20	mg ai/kg/d				In DOE 2000.			No[9]
Tebuthiuron		mammal	rabbit			Acute	Dermal				LD_{50}		NR	>	5000	mg ai/kg				In USEPA 1994.			Yes
Tebuthiuron		mammal	rabbit			Subchronic	Dermal		21 d		NOEL		NR	<	1000	mg ai/kg/d				In USEPA 1994.			Yes
Tebuthiuron		mammal	rat			Reproductive	Diet		2-generation		LOEL		NR		200	ai ppm				In USEPA 1994.			Yes
Tebuthiuron		mammal	rat			Reproductive	Diet		2-generation		NOEL		NR		100	ai ppm				In USEPA 1994.			Yes
Tebuthiuron		mammal	dog			Acute	Oral				LD_{50}		NR	>	500	mg ai/kg				In USEPA 1994.			Yes
Tebuthiuron		mammal	dog			Subchronic	Oral		90 d		LOEL		NR		1000	ai ppm				In USEPA 1994.			Yes
Tebuthiuron		**mammal**	**dog**			**Subchronic**	**Oral**		**90 d**		**NOEL**		**NR**		**500 (12.5)**	**ppm (mg ai/kg/d)**				**In USEPA 1994.**			**Yes**
Tebuthiuron		mammal	rabbit			Developmental	Diet				NOEL		NR	>	825	ai ppm				In Information Ventures, Inc. 1995.			Yes
Tebuthiuron		mammal	rat			Reproductive	Water				NOEL		NR	>	20	mg ai/kg/d				In Information Ventures, Inc. 1995.			Yes
Tebuthiuron		**mammal**	**mouse**			**Acute**	**Oral**				**LD_{50}**		**NR**		**58**	**mg ai/kg**				**In PIP 1993.**			**Yes**
Tebuthiuron		mammal	rabbit			Acute	Oral				LD_{50}		NR		286	mg ai/kg				In PIP 1993.			Yes
Tebuthiuron		mammal	rat			Chronic	Diet		2 y		NOEL		NR		80	mg ai/kg				In PIP 1993.			Yes
Tebuthiuron		mammal	mouse			Chronic	Diet		Life		NOEL		NR		200	mg ai/kg				In PIP 1993.			Yes

Formulation	% purity a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]		Toxicity Value (ai) [1]	Units	Chemical Analysis Done/ Reported?	Lab	Study Number	Data Source[2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Tebuthiuron		mammal	rat			Reproductive	Diet		3-generations pregnancy		NOEL	NR		56	mg ai/kg				In PIP 1993.			Yes
Tebuthiuron		mammal	rabbit			Reproductive	Water		Pregnancy		NOEL	NR		25	mg ai/kg				In PIP 1993.			Yes
Tebuthiuron		mammal	rat			Reproductive	Water		Pregnancy		NOEL	NR		180	mg ai/kg				In PIP 1993.			Yes
Tebuthiuron		mammal	rat			Teratogenic	Diet				NOEL	NR		800	mg ai/kg BW				In PIP 1993.			Yes
Tebuthiuron		mammal	rat			Teratogenic	Diet				NOEL	NR		90	mg ai/kg				In PIP 1993.			Yes
Tebuthiuron		mammal	rabbit			Teratogenic	Water		Gestation d 6-18		NOEL	NR	<	25	mg ai/kg/d				In PIP 1993, USEPA 1994.			Yes
Tebuthiuron	97	mammal	mouse			Carcinogenicity	Diet		2 y		NOEL	NR		240	mg ai/kg				In PIP 1993, DPR 2003.			Yes
Tebuthiuron		mammal	rat			Subchronic	Diet		90 d		NOEL	NR		50	mg ai/kg/d				In USEPA 1994.			Yes
Tebuthiuron		mammal	rat			Subchronic	Diet		90 d		LOEL	NR		125	mg ai/kg/d				In USEPA 1994.			Yes
Tebuthiuron		mammal	rat			Systemic	Diet		2 y		NOEL	NR		40	mg ai/kg				In PIP 1993.			Yes
Tebuthiuron		mammal	rat		Male	Acute	Oral				LD_{50}	NR		477	mg ai/kg				In USEPA 1994.			Yes
Tebuthiuron		mammal	mouse		Male	Acute	Oral				LD_{50}	NR		528	mg ai/kg				In USEPA 1994.			Yes
Tebuthiuron		mammal	mouse		Female	Acute	Oral				LD_{50}	NR		620	mg ai/kg				In USEPA 1994.			Yes
Tebuthiuron		mammal	rabbit			Acute	Oral				LD_{50}	NR		286	mg ai/kg				In USEPA 1994.			Yes
Tebuthiuron		mammal	rabbit			Subchronic	Dermal		6 hr/day 21 d		LOEL	NR		1000	mg ai/kg/d				In USEPA 1994.			Yes
Tebuthiuron		mammal	mouse			Carcinogenicity	Diet		2 y		NOEL	NR		228	mg ai/kg/d				In USEPA 1994.			Yes
Tebuthiuron		mammal	rat			Developmental	Diet		6-15 gestation d	Maternal toxicity	LOEL	NR		45	mg ai/kg/d				In USEPA 1994.			Yes
Tebuthiuron		mammal	rat			Developmental	Diet			Developmental toxicity	NOEL	NR		45	mg ai/kg/d				In USEPA 1994.			Yes
Tebuthiuron		**mammal**	**rat**			**Reproductive**	**Diet**		**2-generation**	**systemic toxicity**	**NOEL**	**NR**		**100 (7)**	**ppm (mg ai/kg/d)**			**MRID 00090108**	**In USEPA 1994.**			**Yes**
Tebuthiuron		mammal	rat			Reproductive	Diet		2-generation		LOEL	NR		200 (14)	**ppm (mg ai/kg/d)**			MRID 00090108	In USEPA 1994.			Yes
Tebuthiuron		mammal	rat			Reproductive	Diet		2-generation		NOEL	NR		28	mg ai/kg/d				In USEPA 1994.			Yes
Tebuthiuron		mammal	rat			Reproductive	Diet		3-generation		LOEL	NR		28	mg ai/kg/d				In USEPA 1994.			Yes
Tebuthiuron		mammal	dog			Chronic	Oral		1 y	systemic toxicity	NOEL	NR		25	mg ai/kg/d				In DPR 2003.			Yes
Tebuthiuron		mammal	dog			Chronic	Oral		1 y		LOEL	NR		50	mg ai/kg/d				In DPR 2003.			Yes
Tebuthiuron		mammal	cat			Acute	Oral				LOEL	NR	<	200	mg ai/kg				In USEPA 1994.			Yes
Tebuthiuron		mammal	dog			Subchronic	Diet		90 d		LOEL	NR		25	mg ai/kg/d				In USEPA 1994.			Yes
Tebuthiuron		mammal	dog			Subchronic	Diet		90 d		NOEL	NR		12.5	mg ai/kg/d				In USEPA 1994.			Yes
Tebuthiuron		mammal	mouse			Carcinogenicity	Diet		2 y		NOEC	NR		1600	ai ppm				In DOE 2000.			No
Tebuthiuron		mammal	rat		Female	Acute	Oral				LD_{50}	NR		387	mg ai/kg				In USEPA 1994.			Yes
Tebuthiuron	**99.6**	**terrestrial plant**	**crop plants**	***10 species***	**seedlings**	**Germination**			**5 d**		**NOEL**	**NR**	**>**	**6**	**lb ai/acre**		**Lilly Research Laboratories**	**MRID 41066902**	**In USEPA 1994, 2003.**	**R. Petrie**	**1989**	**Yes**
Tebuthiuron	99.6	terrestrial plant	Radish	*Rhaphanus sativus*	seedlings	Emergence /vigor			7-21 d	Emergence/ vigor	EC_{25}	NR		0.05	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b, 1994, 2003.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron	99.6	terrestrial plant	Cucumber		seedlings	Emergence /vigor			7-21 d	Emergence/ vigor	EC_{25}	NR		0.06	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b, 1994, 2003.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron	99.6	terrestrial plant	Wheat	*Triticum aestivum*	seedlings	Emergence /vigor			7-21 d		EC_{25}	NR		0.07	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b, 1994, 2003.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Radish	*Rhaphanus sativus*	seed	Plant emergence	Soil			Emergence	EC_{25}	NR		0.13	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	**99.6**	**terrestrial plant**	**Cabbage**	***Brassica oleracea***	**seed**	**Plant emergence**	**Soil**			**Emergence**	**EC_{25}**	**NR**		**0.03**	**lb ai/acre**		**Lilly Research Laboratories**	**MRID 41066901**	**In USEPA 1989b, 1994, 2003.**	**Richard C. Petrie**	**10/23/1989**	**Yes**
Tebuthiuron, technical	99.6	terrestrial plant	Cucumber		seed	Plant emergence	Soil			Emergence	EC_{25}	NR		0.13	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Wheat	*Triticum aestivum*	seed	Plant emergence	Soil			Emergence	EC_{25}	NR		0.1	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Radish	*Rhaphanus sativus*	seed	Plant emergence	Soil			Emergence	EC_{50}	NR		0.23	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cabbage	*Brassica oleracea*	seed	Plant emergence	Soil			Emergence	EC_{50}	NR		0.07	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cotton		seed	Plant emergence	Soil			Emergence	EC_{50}	NR	>	0.64	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cucumber		seed	Plant emergence	Soil			Emergence	EC_{50}	NR		0.24	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes

Formulation	% purity a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]		Toxicity Value (ai) [1]	Units	Chemical Analysis Done/ Reported?	Lab	Study Number	Data Source [2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Tebuthiuron, technical	99.6	terrestrial plant	Sunflower		seed	Plant emergence	Soil			Emergence	EC_{50}	NR	>	0.64	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Soybean		seed	Plant emergence	Soil			Emergence	EC_{50}	NR	>	0.64	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Wheat	*Triticum aestivum*	seed	Plant emergence	Soil			Emergence	EC_{50}	NR		0.16	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Corn		seed	Plant emergence	Soil			Emergence	EC_{50}	NR	>	1.28	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Sorghum		seed	Plant emergence	Soil			Emergence	EC_{50}	NR	>	1.28	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Rice		seed	Plant emergence	Soil			Emergence	EC_{50}	NR	>	1.28	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Radish	*Rhaphanus sativus*		Plant height	Soil			Height	EC_{25}	NR		0.06	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cabbage	*Brassica oleracea*		Plant height	Soil			Height	EC_{25}	NR		0.05	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	cotton			Plant height	Soil			Height	EC_{25}	NR		0.27	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cucumber			Plant height	Soil			Height	EC_{25}	NR		0.08	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	sunflower			Plant height	Soil			Height	EC_{25}	NR		0.3	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	soybean			Plant height	Soil			Height	EC_{25}	NR		0.74	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Wheat	*Triticum aestivum*		Plant height	Soil			Height	EC_{25}	NR		0.09	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	corn			Plant height	Soil			Height	EC_{25}	NR		0.39	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	sorghum			Plant height	Soil			Height	EC_{25}	NR		0.89	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	rice			Plant height	Soil			Height	EC_{25}	NR		0.83	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Radish	*Rhaphanus sativus*		Plant height	Soil			Height	EC_{50}	NR		0.14	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cabbage	*Brassica oleracea*		Plant height	Soil			Height	EC_{50}	NR		0.1	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	cotton			Plant height	Soil			Height	EC_{50}	NR		0.91	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cucumber			Plant height	Soil			Height	EC_{50}	NR		0.2	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	sunflower			Plant height	Soil			Height	EC_{50}	NR		1.03	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	soybean			Plant height	Soil			Height	EC_{50}	NR		1.7	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Wheat	*Triticum aestivum*		Plant height	Soil			Height	EC_{50}	NR		0.15	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	corn			Plant height	Soil			Height	EC_{50}	NR		1.3	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	sorghum			Plant height	Soil			Height	EC_{50}	NR		1.84	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	rice			Plant height	Soil			Height	EC_{50}	NR		1.85	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Radish	Rhaphanus sativus		Fresh Weight	Soil			Weight	EC_{25}	NR		0.05	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cabbage	*Brassica oleracea*		Fresh Weight	Soil			Weight	EC_{25}	NR		0.03	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	cotton			Fresh Weight	Soil			Weight	EC_{25}	NR		0.43	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cucumber			Fresh Weight	Soil			Weight	EC_{25}	NR		0.06	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	sunflower			Fresh Weight	Soil			Weight	EC_{25}	NR		0.36	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes

Formulation	% purity a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]	Toxicity Value (ai) [1]	Units	Chemical Analysis Done/ Reported?	Lab	Study Number	Data Source [2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Tebuthiuron, technical	99.6	terrestrial plant	Wheat	*Triticum aestivum*		Fresh Weight	Soil			Weight	EC_{25}	NR	0.07	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	corn			Fresh Weight	Soil			Weight	EC_{25}	NR	1.02	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	sorghum			Fresh Weight	Soil			Weight	EC_{25}	NR	1.12	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	rice			Fresh Weight	Soil			Weight	EC_{25}	NR	0.74	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Radish	Rhaphanus sativus		Fresh Weight	Soil			Weight	EC_{50}	NR	0.09	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cabbage	*Brassica oleracea*		Fresh Weight	Soil			Weight	EC_{50}	NR	0.06	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	cotton			Fresh Weight	Soil			Weight	EC_{50}	NR	4.82	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cucumber			Fresh Weight	Soil			Weight	EC_{50}	NR	0.13	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	sunflower			Fresh Weight	Soil			Weight	EC_{50}	NR	1.19	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	soybean			Fresh Weight	Soil			Weight	EC_{50}	NR	> 0.64	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Wheat	*Triticum aestivum*		Fresh Weight	Soil			Weight	EC_{50}	NR	0.11	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	corn			Fresh Weight	Soil			Weight	EC_{50}	NR	1.85	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	sorghum			Fresh Weight	Soil			Weight	EC_{50}	NR	1.42	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	rice			Fresh Weight	Soil			Weight	EC_{50}	NR	1.26	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Radish	Rhaphanus sativus		Vegetative Vigor	Soil			Vigor	EC_{25}	NR	0.09	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cabbage	*Brassica oleracea*		Vegetative Vigor	Soil			Vigor	EC_{25}	NR	0.07	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	cotton			Vegetative Vigor	Soil			Vigor	EC_{25}	NR	0.31	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cucumber			Vegetative Vigor	Soil			Vigor	EC_{25}	NR	0.11	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	sunflower			Vegetative Vigor	Soil			Vigor	EC_{25}	NR	0.25	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	soybean			Vegetative Vigor	Soil			Vigor	EC_{25}	NR	0.31	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Wheat	*Triticum aestivum*		Vegetative Vigor	Soil			Vigor	EC_{25}	NR	0.09	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	corn			Vegetative Vigor	Soil			Vigor	EC_{25}	NR	0.65	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	sorghum			Vegetative Vigor	Soil			Vigor	EC_{25}	NR	1	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	rice			Vegetative Vigor	Soil			Vigor	EC_{25}	NR	0.53	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Radish	Rhaphanus sativus		Vegetative Vigor	Soil			Vigor	EC_{50}	NR	0.15	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cabbage	*Brassica oleracea*		Vegetative Vigor	Soil			Vigor	EC_{50}	NR	0.1	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	cotton			Vegetative Vigor	Soil			Vigor	EC_{50}	NR	0.58	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Cucumber			Vegetative Vigor	Soil			Vigor	EC_{50}	NR	0.18	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	sunflower			Vegetative Vigor	Soil			Vigor	EC_{50}	NR	0.57	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	soybean			Vegetative Vigor	Soil			Vigor	EC_{50}	NR	0.9	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	Wheat	*Triticum aestivum*		Vegetative Vigor	Soil			Vigor	EC_{50}	NR	0.12	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes

Formulation	% purity a.i.	General Taxonomic Group	Common Name	Scientific Name	Age	Test Type	Means of Exposure	Exposure Duration	Test Duration	Biological Endpoint	Statistical Endpoint	Toxicity Value (tested product) [1]	Toxicity Value (ai) [1]	Units	Chemical Analysis Done/ Reported?	Lab	Study Number	Data Source [2]	EPA Reviewer	Date Reviewed	Used for TRV derivation
Tebuthiuron, technical	99.6	terrestrial plant	corn			Vegetative Vigor	Soil			Vigor	EC_{50}	NR	1.39	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	sorghum			Vegetative Vigor	Soil			Vigor	EC_{50}	NR	1.43	lb ai/acre		Lilly Research Laboratories		In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes
Tebuthiuron, technical	99.6	terrestrial plant	rice			Vegetative Vigor	Soil			Vigor	EC_{50}	NR	1.22	lb ai/acre		Lilly Research Laboratories	MRID 41066901	In USEPA 1989b.	Richard C. Petrie	10/23/1989	Yes

Boldface indicates study selected for derivation of toxicity reference value (TRV) used in risk assessment.

[1]Toxicity values relate the dose of a compound with a potentially adverse effect. Values are reported as they were presented in the reviewed source.

[2]See the bibliography of this ERA document, Appendix A of the associated Literature Review document, and source footnote for complete citations.

[3]Review and evaluation of scientific literature for use in derivation of Canadian water quality guidelines.

[4]As cited in USEPA 2003.

[5]Nominal concentration.

[6]Maximum specific growth rate.

[7]Before active growth at 333 cells/ml.

[8]Treatment at 21 d.

[9]Pesticide Fact Sheet states that EPA is requiring additional studies; reliability of the data is uncertain.

Abbreviations

m - male

f - female

a.i. - active ingredient

NR - Not reported.

MRID - Master Record Identification Number

Endpoints

EC_{25} - 25% effect concentration

EC_{50} - 50% effect concentration

LC_{50} - median lethal concentration, 50% mortality

LD_{50} - median lethal dose, 50% mortality

LOEC - lowest-observable-effect concentration

LOEL - lowest-observable-effect level

MATC - maximum acceptable toxicant concentration

NOEC - no-observable-effect concentration

NOEL - no-observable-effect level

Durations

hr - hours

d - days

w - weeks

m - months

y - years

APPENDIX B

Ecological Risk Assessment Worksheet - Tebuthiuron

DERIVATION OF EECS

Section 3.0 of the Methods Document (ENSR 2005) presents the details of the exposure scenarios considered in the risk assessments. The following sub-sections describe the scenarios that were evaluated for bromacil. Note that in many cases, units were converted during the calculations (e.g., lb/acre converted to mg/cm^2). These conversions were not included in the equations presented below.

Direct Spray

Plant and wildlife species may be unintentionally impacted during normal application of a terrestrial herbicide as a result of a direct spray of the receptor or the waterbody inhabited by the receptor, indirect contact with dislodgeable foliar residue after herbicide application, or consumption of prey items sprayed during application. These exposures may occur within the application area (consumption of prey items) or outside of the application area (waterbodies accidentally sprayed during application of terrestrial herbicide). Generally, impacts outside of the intended application area are accidental exposures and are not typical of BLM application practices. The following direct spray scenarios were evaluated:

Direct Spray of Terrestrial Wildlife

Small mammal or Insect 100% Dermal Absorption

Surface Areas (A): $cm^2 = 12.3 \times BW^{0.65}$

Where: BW = body weight in grams

Amount deposited on ½ receptor (Amnt): $0.5 \times A \times R$

Where: A = Surface area in cm^2

R = Application rate in lb a.i./acre

Small mammal 1st order

Proportion absorbed over period T (Prop): $1-\exp(-k\ T)$

Where: k = First order dermal absorption rate ($hour^{-1}$)

T = Time (24 hours)

Absorbed Dose: $Amnt \times Prop \div BW$

Ingestion of Food Items Contaminated by Direct Spray

All herbivorous receptors ingestion acute

Concentration on food (C): $R \times rr$

Where: R = Application rate (lb a.i./acre)

rr = Residue rate as determined from Kenaga nomagram (mg/kg per lb/acre)

Dose estimates (D): $C \times A \div BW$

Where: C = Concentration on food (mg/kg food)

A = Wet weight food ingestion rate (kg/day)

BW = Body Weight

All herbivorous receptors ingestion chronic

Initial concentration on food (C0): $R \times rr \times Drift$

Where: R = Application rate (lb a.i./acre)

rr = Residue rate as determined from Kenaga nomagram (mg/kg per lb/acre)

Drift = 1

Concentration on food at time T: $C0 \times \exp(-k \times T)$

Where: C0 = Concentration on food at time zero (mg/kg food)

k = Decay Coefficient: $\ln(2) \div t50$ ($days^{-1}$)

T = Time (90 days)

Time-weighted Average Concentration on vegetation (CTWA): $C0 \times (1-\exp(-k \times T)) \div (k \times T)$

Dose estimates (D): $CTWA \times A \times Prop \div BW$

Where: CTWA = Time Weighted Concentration on food (mg/kg food)

A = Wet weight food ingestion rate (kg/day)

Prop = Proportion of food impacted by direct spray (100%)

BW = Body Weight

Large carnivorous mammal ingestion acute

Amount deposited on small mammal prey (Amnt_mouse): 0.5 × SurfaceArea × R
Where: R = Application rate (lb a.i./acre)
Dose estimates: Drift × Prop × Amnt_mouse ÷ BW_mouse × A ÷BW
Where: Drift = 1
Prop = Proportion of food impacted by direct spray (100%)
A = Wet weight food ingestion rate (kg/day)
BW = Body Weight of carnivore
BW_mouse = Body weight of food (small mammal; mouse)

Large carnivorous mammal ingestion chronic
Initial concentration on mammal (C0): 0.5 × SurfaceArea × R ÷ BW_smallmammal
Where: R = Application rate (lb a.i./acre)
SurfaceArea = Surface area of food (small mammal; mouse)
BW_smallmammal = Body weight of food (small mammal; mouse)
Concentration absorbed in small mammal at time T (C90): C0 × exp(-k × T)
Where: C0 = Concentration on food at time zero (mg/kg food)
k = Decay Coefficient: ln(2)/t50 ($days^{-1}$)
T = Time (90 days)
Dose estimates: C90 × FIR_coyote × Prop ÷ BW
Where: C90 = Concentration of herbicide in food at 90 days
FIR = Wet weight food ingestion rate (mg/kg-day)
Prop = Proportion of food impacted by direct spray (100%)
BW = Body Weight

Accidental Direct Spray Over Pond
Mass in Pond (Mp): Ap × R
Where: Ap = Area of pond
R = Application rate (lb a.i./acre)
Concentration in Pond: Mp ÷ (Vp)
Where: Vp = Volume of pond

Accidental Direct Spray Over Stream
Mass in Stream Reach (Ms): As × R
Where: Ap = Area of stream affected by spray
R = Application rate (lb a.i./acre)
Concentration in Pond: Ms ÷ (Vs)
Where: Vs = Volume of stream reach affected by spray

Off-Site Drift and Surface and Ground Water Runoff

During normal application of herbicides, it is possible for a portion of the herbicide to drift outside of the treatment area and deposit onto non-target receptors. Precipitation may also result in the transport of herbicides bound to soils from the application area via surface runoff and root-zone groundwater flow. To simulate these off-site herbicide transport mechanisms, AgDRIFT® software was used to evaluate a number of possible drift scenarios and GLEAMS software was used to evaluate transport to off-site soils or waterbodies via surface runoff or root-zone ground water flow. These models provide concentrations in media. Details of the model and calculations used to obtain soil and water concentrations are presented in the Methods document (ENSR 2005). The surface water concentrations were used in the ERAs to estimate fish concentrations and consumption of these fish by an avian piscivore. The following presents those calculations:

Consumption of Fish From Contaminated Pond
Concentration in fish = Cw × BCF × FCM TL2 × FCM TL3
Where: Cw = Concentration in water (obtained from model) mg/L
BCF = Bioconcentration factor (L/kg fish)
FCM TL2 = Trophic Level 2 food chain multiplier (unitless)
FCM TL3 = Trophic Level 3 food chain multiplier (unitless)

Dose estimates (D): C × A × Prop ÷ BW

Where: C = Concentration in fish (mg/kg food)
A = Wet weight food ingestion rate (kg/day)
Prop = Proportion of food impacted (100%)
BW = Body Weight

Accidental Spill to Pond

To represent worst-case potential impacts to ponds, a spill scenario was considered. A truck or helicopter spilling an entire load of herbicide mixed for the maximum application rate into a 1/4 acre, 1 meter deep pond.

Truck or Helicopter Spill into Pond

Concentrations in water (Cw): Cm × Vspill ÷ Vp

Where: Cm = Herbicide concentration in the truck or helicopter mixture (mg a.i./L)
Vspill = Volume of the spill (L)
Vp = Volume of the pond (L)

LIST OF TABLES

General note: Exposure parameters and equations in the following tables are described in more detail in the *Vegetation Treatments Programmatic EIS Ecological Risk Assessment Methodology* (ENSR 2005) and Section 4 of the ecological risk assessment for this herbicide.

TABLE B-1

Direct Spray of Terrestrial Receptors and Exposure from Indirect Contact with Foliage

Parameter		Pollinating Insect	Small Mammal	Units
Duration of exposure (T)		24	24	hours
Body weight (BW)		0.000093	0.02	kg
Surface areas (A): $cm^2 = 12.3 \times BW(g)^{0.65}$ [1]		2.63	86.21	cm^2
Application rates (R)	Typical	0.5	0.5	lb/acre
	Maximum	4	4	lb/acre
Amount deposited on ½ receptor (Amnt):	Typical	0.0074	0.2416	mg
$0.5 \times A \times R \times cf$ [2]	Maximum	0.059	1.9326	mg
Dose Estimate Assuming 100% Dermal Adsorption[3]				
Absorbed Dose: Amnt × Prop / BW	Typical	7.92E+01	1.21E+01	mg/kg bw
	Maximum	6.34E+02	9.66E+01	mg/kg bw
Dose Estimate Assuming First Order Dermal Adsorption[4]				
First-order dermal absorption coefficient (k)	Central Estimate		0.0231	$hour^{-1}$
Proportion absorbed over period T (Prop):	Typical		0.0981	unitless
$1-exp(-k \times T)$ [5]	Maximum		0.0981	unitless
Absorbed dose: Amnt × Prop / BW	Typical		1.18E+00	mg/kg bw
	Maximum		9.47E+00	mg/kg bw

RISK QUOTIENTS[6] - Direct Spray	Toxicity Reference Value (mg/kg bw)[7]	Typical Application	Maximum Application
Small mammal - 100% absorption	64	6.51E-04	5.21E-03
Pollinating insect - 100% absorption	323	2.45E-01	1.96E+00
Small mammal - 1st order dermal adsorption	64	6.38E-05	5.10E-04

RISK QUOTIENTS - Indirect Contact[8]	Toxicity Reference Value (mg/kg bw)[7]	Typical Application	Maximum Application
Small mammal - 100% absorption	64	6.51E-05	5.21E-04
Pollinating insect - 100% absorption	323	2.45E-02	1.96E-01
Small mammal - 1st order dermal adsorption	64	6.38E-06	5.10E-05

[1] Surface area calculation for mammals from Stahl (1967; presented in USEPA 1993). No surface area calculation identified for insects. Mammalian equation used as a surrogate.
[2] A conversion factor (cf) of 0.011208493 was used to convert the application rate (R) from lb/acre to mg/cm^2.
[3] 100% dermal absorption - all of the herbicide falling on the receptor was assumed to penetrate the skin within 24 hours.
[4] 1st order dermal absorption - absorption occurs over 24 hours, taking into consideration the potential for some herbicide to not be absorbed.
[5] $exp(-k \times T) = e^{(-k \times T)}$, where e is a constant = 2.7828.
[6] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[7] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.
[8] Exposure from indirect contact assumed to be 1/10 of direct spray exposure (Harris and Solomon 1992).

TABLE B-2

Potential Risks to Small Herbivorous/Omnivorous Mammal (Deer Mouse) From Consumption of Contaminated Fruit (Acute Exposure Scenario)

Parameters/Assumptions		Value	Units
Body weight (BW)		0.02	kg
Food ingestion rate (dry weight [dw]) [1]		0.003364	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) [2]		0.01463	kg ww/day
Application rates (R)	Typical	0.5	lb/acre
	Maximum	0.4	lb/acre
Residue rate – berries (rr) [3]	Typical	5.4	mg/kg per lb/acre
	Maximum	40.7	mg/kg per lb/acre
Concentration on berries (C): R × rr	Typical	2.7	mg/kg fruit
	Maximum	162.8	mg/kg fruit
Dose estimates (D): C × ir / BW	Typical	1.97E+00	mg/kg bw
	Maximum	1.19E+02	mg/kg bw

RISK QUOTIENTS[4] - Ingestion	**Toxicity Reference Value (mg/kg bw)[5]**	**Typical Application**	**Maximum Application**
Small mammalian herbivore/omnivore (acute exposure)	64	3.09E-02	1.86E+00

[1] Calculated using algorithm developed by Nagy (1987) for rodents; where food ingestion rate (g dw/day) = 0.621× (BW g)^0.564; converted into kg dw/day.
[2] Assumes fruit is 77% water (USEPA 1993; Table 4-2 - value for fruit pulp and skin).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
[4] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[5] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-3

Potential Risks to Small Herbivorous/Omnivorous Mammal (Deer Mouse) From Consumption of Contaminated Fruit (Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	days
Body weight (BW)		0.02	kg
Food ingestion rate (dry weight [dw]) [1]		0.003364	kg dw/day
Food ingestion rate (wet weight [ww]) (ir) [2]		0.01463	kg ww/day
Half life on vegetation (t_{50})	Herbicide specific	30	days
Application rates (R)	Typical	0.5	lb/acre
	Maximum	4	lb/acre
Residue rate - berries (rr) [3]	Typical	5.4	mg/kg per lb/acre
	Maximum	40.7	mg/kg per lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay coefficient (k): ln(2) / t_{50} [4]	Typical	0.0231	$days^{-1}$
	Maximum	0.0231	$days^{-1}$
Initial concentration on berries (C_0): R × rr × Drift	Typical	2.7	mg/kg fruit
	Maximum	162.8	mg/kg fruit
Concentration on berries at time T: $C_0 \times \exp(-k \times T)$ [5]	Typical	0.3375	mg/kg fruit
	Maximum	20.35	mg/kg fruit
Time-weighted average concentration on vegetation (CTWA): $C_0 \times (1-\exp(-k \times T)) / (k \times T)$ [5]	Typical	1.1361	mg/kg fruit
	Maximum	68.5040	mg/kg fruit
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): (CTWA × ir × PC) / BW	Typical	8.31E-01	mg/kg bw/day
	Maximum	5.01E+01	mg/kg bw/day

RISK QUOTIENTS[6] – Ingestion	Toxicity Reference Value (mg/kg bw/day)[7]	Typical Application	Maximum Application
Small mammalian herbivore/omnivore (chronic exposure)	14	5.93E-02	3.58E+00

[1] Calculated using algorithm developed by Nagy (1987) for rodents; where food ingestion rate (g dw/day) = 0.621×(BW g)^0.564; converted into kg dw/day.
[2] Assumes fruit is 77% water (USEPA 1993; Table 4-2 - value for fruit pulp and skin).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
[4] ln = Natural log function.
[5] exp(-k×T) = e^(-k×T), where e is a constant = 2.7828.
[6] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[7] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-4

Potential Risks to Large Herbivorous Mammal (Mule Deer) From Consumption of Contaminated Vegetation (Acute Exposure Scenario)

Parameters/Assumptions		Value	Units
Body weight (BW)		70	kg
Food ingestion rate (dry weight [dw]) [1]		1.9212	kg dw/day
Food ingestion rate (wet weight [ww])(ir) [2]		6.4038	kg ww/day
Duration of exposure (D)		1	day
Application rates (R)	Typical	0.5	lb/acre
	Maximum	4	lb/acre
Residue rate - grass (rr) [3]	Typical	36	mg/kg per lb/acre
	Maximum	197	mg/kg per lb/acre
Concentration on grass (C): R × rr	Typical	18	mg/kg grass
	Maximum	788	mg/kg grass
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates: (Drift × PC × C × ir) / BW	Typical	1.65E+00	mg/kg bw/day
	Maximum	7.21E+01	mg/kg bw/day

RISK QUOTIENTS[4] – Ingestion	**Toxicity Reference Value (mg/kg bw/day)[5]**	**Typical Application**	**Maximum Application**
Large mammalian herbivore/gramivore (acute exposure)	326	5.05E-03	2.21E-01

[1] Calculated using algorithm developed by Nagy (1987) for herbivores; where food ingestion rate (g dw/day) = 0.577×(BW g)^0.727; converted into kg dw/day.
[2] Assumes grass is 70% water (USEPA 1993; Table 4-2 - lowest value for young grasses).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
[4] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[5] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-5

Potential Risks to Large Herbivorous Mammal (Mule Deer) From Consumption of Contaminated Vegetation (Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	day
Body weight (BW)		70	kg
Food ingestion rate (dry weight [dw]) [1]		1.9212	kg dw/day
Food ingestion rate (wet weight [ww])(ir) [2]		6.4038	kg ww/day
Half life on vegetation (t_{50})	Herbicide specific	30	days
Application rates (R)	Typical	0.5	lb/acre
	Maximum	4	lb/acre
Residue rate - grass (rr) [3]	Typical	36	mg/kg per lb/acre
	Maximum	197	mg/kg per lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay coefficient (k): ln(2) / t_{50} [4]	Typical	0.0231	$days^{-1}$
	Maximum	0.0231	$days^{-1}$
Initial concentration on grass (C_0): R × rr × Drift	Typical	18	mg/kg grass
	Maximum	788	mg/kg grass
Concentration on grass at time T: $C_0 \times \exp(-k \times T)$ [5]	Typical	2.25	mg/kg grass
	Maximum	98.5	mg/kg grass
Time-weighted average concentration on vegetation (CTWA): $C_0 \times (1-\exp(-k \times T)) / (k \times T)$ [5]	Typical	7.5741	mg/kg vegetation
	Maximum	331.5794	mg/kg vegetation
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): (CTWA × ir × PC) / BW	Typical	6.93E-01	mg/kg bw/day
	Maximum	3.03E+01	mg/kg bw/day

RISK QUOTIENTS[6] – Ingestion	Toxicity Reference Value (mg/kg bw/day)[7]	Typical Application	Maximum Application
Large mammalian herbivore/gramivore (chronic exposure)	8	8.66E-02	3.79E+00

[1] Calculated using algorithm developed by Nagy (1987) for herbivores; where food ingestion rate (g dw/day) = 0.577×(BW g)^0.727; converted into kg dw/day.
[2] Assumes grass is 70% water (USEPA 1993; Table 4-2 - lowest value for young grasses).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
[4] ln = Natural log function.
[5] exp(-k×T) = e^(-k×T), where e is a constant = 2.7828.
[6] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[7] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-6

Potential Risks to Carnivorous Mammal (Coyote) From Consumption of Contaminated Small Mammals (Acute Exposure Scenario)

Parameters/Assumptions		Value	Units
Body weight (BW)		12	Kg
Body weight small mammal (BW_mouse)		0.02	Kg
Surface area small mammal (A)		86.21	cm^2
Food ingestion rate (dry weight [dw]) [1]		0.5297	kg dw/day
Food ingestion rate (wet weight [ww])(ir) [2]		1.6554	kg ww/day
Duration of exposure (D)		1	Day
Application rates (R)	Typical	0.5	lb/acre
	Maximum	4	lb/acre
Amount deposited on small mammal prey (Amnt_mouse): 0.5 × A × R [3]	Typical	0.2416	Mg
	Maximum	1.9326	Mg
Drift (Drift)	Typical	1	Unitless
	Maximum	1	Unitless
Proportion of diet contaminated (PC)	Typical	1	Unitless
	Maximum	1	Unitless
Dose estimates (D): ([(Drift × PC × Amnt_mouse) / BW_mouse] × ir) / BW	Typical	1.67E+00	mg/kg bw
	Maximum	1.33E+01	mg/kg bw

RISK QUOTIENTS[4] - Ingestion	Toxicity Reference Value (mg/kg bw)[5]	Typical Application	Maximum Application
Large carnivorous mammal (acute exposure)	507	3.29E-03	2.63E-02

[1] Calculated using algorithm developed by Nagy (1987); where food ingestion rate (g dw/day) = 0.0687×(BW g)^0.822; converted into kg dw/day.
[2] Assumes mammals are 68% water (USEPA 1993).
[3] Surface area (A) and body weight of mouse receptor presented in Table B-1. Surface area calculation for mammals from Stahl (1967; presented in USEPA 1993).
[4] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[5] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-7

Potential Risks to Carnivorous Mammal (Coyote) From Consumption of Contaminated Small Mammals (Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	Day
Body weight (BW)		12	Kg
Body weight small mammal (BW_mouse)		0.02	Kg
Surface area small mammal (A)		86.21	cm^2
Food ingestion rate (dry weight [dw]) [1]		0.5297	kg dw/day
Food ingestion rate (wet weight [ww])(ir) [2]		1.6554	kg ww/day
Application rates (R)	Typical	0.5	lb/acre
	Maximum	4	lb/acre
Drift (Drift)	Typical	1	Unitless
	Maximum	1	Unitless
Decay coefficient (k): ln(2) / t_{50} [3]	Typical	0.0231	$days^{-1}$
	Maximum	0.0231	$days^{-1}$
Initial concentration on mammal (C_0): (0.5 × A × R) / BW_mouse	Typical	12.0786	mg /kg mammal
	Maximum	96.6284	mg /kg mammal
Concentration absorbed in small mammal at time T (C_{90}): C_0 × exp(-k×T) [4]	Typical	1.1843	mg/kg mammal
	Maximum	9.4748	mg/kg mammal
Proportion of diet contaminated (PC)	Typical	1	Unitless
	Maximum	1	Unitless
Dose estimates: (C_{90} × ir × PC) / BW	Typical	1.63E-01	mg/kg bw/day
	Maximum	1.31E+00	mg/kg bw/day

RISK QUOTIENTS - Ingestion[5]	Toxicity Reference Value (mg/kg bw/day)[6]	Typical Application	Maximum Application
Large mammalian carnivore (chronic exposure)	13	1.26E-02	1.01E-01

[1] Calculated using algorithm developed by Nagy (1987); where food ingestion rate (g dw/day) = 0.0687×(BW g)^0.822; converted into kg dw/day.
[2] Assumes mammals are 68% water (USEPA 1993).
[3] ln = Natural log function.
[4] exp(-k×T) = e^(-k×T), where e is a constant = 2.7828.
[5] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[6] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-8

Potential Risks to Insectivorous Bird (American Robin) From Consumption of Contaminated Insects (Acute Exposure Scenario)

Parameters/Assumptions		Value	Units
Body weight (BW)		0.08	Kg
Food ingestion rate (dry weight [dw]) [1]		0.0112	kg dw/day
Food ingestion rate (wet weight [ww])(ir) [2]		0.0363	kg ww/day
Duration of exposure (D)		1	Day
Application rates (R)	Typical	0.5	lb/acre
	Maximum	4	lb/acre
Residue rate - insects (rr) [3]	Typical	45	mg/kg per lb/acre
	Maximum	350	mg/kg per lb/acre
Concentration on insects (C): R × rr	Typical	22.5	mg/kg insect
	Maximum	1400	mg/kg insect
Drift (Drift)	Typical	1	Unitless
	Maximum	1	Unitless
Proportion of diet contaminated (PC)	Typical	1	Unitless
	Maximum	1	Unitless
Dose estimates: (Drift × PC × C × ir) / BW	Typical	1.02E+01	mg/kg bw
	Maximum	6.35E+02	mg/kg bw

RISK QUOTIENTS[4] – Ingestion	**Toxicity Reference Value (mg/kg bw)[5]**	**Typical Application**	**Maximum Application**
Small insectivorous bird (acute exposure)	15440	6.61E-04	4.11E-02

[1] Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^0.651.
[2] Assumes insects are 69% water (USEPA 1993; Table 4-1 - value for grasshoppers and crickets).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994).
[4] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[5] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-9

Potential Risks to Insectivorous Bird (American Robin) From Consumption of Contaminated Insects (Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	day
Body weight (BW)		0.08	kg
Food ingestion rate (dry weight [dw]) [1]		0.0112	kg dw/day
Food ingestion rate (wet weight [ww])(ir) [2]		0.0363	kg ww/day
Half life on insect (t_{50})	Herbicide specific	30	days
Application rates (R)	Typical	0.5	lb/acre
	Maximum	4	lb/acre
Residue rate - insects (rr) [3]	Typical	45	mg/kg per lb/acre
	Maximum	350	mg/kg per lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay coefficient (k): ln(2) / t_{50} [4]	Typical	0.0231	$days^{-1}$
	Maximum	0.0231	$days^{-1}$
Initial concentration on insects (C_0): R × rr × Drift	Typical	22.5	mg/kg insect
	Maximum	1400	mg/kg insect
Concentration on insects at time T	Typical	2.8125	mg/kg insect
(C_{90}): C_0 × exp(-k×T) [5]	Maximum	175	mg/kg insect
Time-weighted average concentration on insects	Typical	9.4677	mg/kg insect
(CTWA): C_0 × (1-exp(-k×T)) / (k×T) [5]	Maximum	589.1005	mg/kg insect
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): (CTWA × ir × PC) / BW	Typical	4.29E+00	mg/kg bw/day
	Maximum	2.67E+02	mg/kg bw/day

RISK QUOTIENTS[6] – Ingestion	Toxicity Reference Value (mg/kg bw/day)[7]	Typical Application	Maximum Application
Small insectivorous bird (chronic exposure)	1,029	4.17E-03	2.60E-01

[1] Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^0.651.
[2] Assumes insects are 69% water (USEPA 1993; Table 4-1 - value for grasshoppers and crickets).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994).
[4] ln = Natural log function.
[5] exp(-k×T) = e^(-k×T), where e is a constant = 2.7828.
[6] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[7] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-10

Potential Risks to Herbivorous Bird (Canada goose) From Consumption of Contaminated Vegetation (Acute Exposure Scenario)

Parameters/Assumptions		Value	Units
Body weight (BW)		3.72	kg
Food ingestion rate (dry weight [dw]) [1]		0.1368	kg dw/day
Food ingestion rate (wet weight [ww])(ir) [2]		0.9125	kg ww/day
Duration of exposure (D)		1	day
Application rates (R)	Typical	0.5	lb/acre
	Maximum	4	lb/acre
Residue rate - vegetation (rr) [3]	Typical	35	mg/kg per lb/acre
	Maximum	296	mg/kg per lb/acre
Concentration on vegetation (C): R × rr	Typical	17.5	mg/kg veg
	Maximum	1184	mg/kg veg
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates: (Drift × PC × C × ir) / BW	Typical	4.29E+00	mg/kg bw
	Maximum	2.90E+02	mg/kg bw

RISK QUOTIENTS[4] - Ingestion	**Toxicity Reference Value (mg/kg bw)[5]**	**Typical Application**	**Maximum Application**
Large herbivorous bird - acute exposure	2,545	1.69E-03	1.14E-01

[1]Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^0.651.
[2]Assumes vegetation is 85% water (USEPA 1993; Table 4-2 - value for dicotyledons).
[3]Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
[4]Risk Quotient = Estimated Dose/Toxicity Reference Value.
[5]Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-11

Potential Risks to Herbivorous Bird (Canada goose) From Consumption of Contaminated Vegetation – (Chronic Exposure Scenario)

Parameters/Assumptions		Value	Units
Duration of exposure (T)		90	day
Body weight (BW)		3.72	kg
Food ingestion rate (dry weight [dw]) [1]		0.1369	Kg dw/day
Food ingestion rate (wet weight [ww])(ir) [2]		0.9126	Kg ww/day
Half life on vegetation (t_{50})	Herbicide specific	30	days
Application rates (R)	Typical	0.5	lb/acre
	Maximum	4	lb/acre
Residue rate - vegetation (rr) [3]	Typical	35	mg/kg per lb/acre
	Maximum	296	mg/kg per lb/acre
Drift (Drift)	Typical	1	unitless
	Maximum	1	unitless
Decay coefficient (k): ln(2) / t_{50} [4]	Typical	0.0231	$days^{-1}$
	Maximum	0.0231	$days^{-1}$
Initial concentration on vegetation (C_0): R × rr × Drift	Typical	17.5	Mg/kg veg
	Maximum	1184	Mg/kg veg
Concentration on vegetation at time T	Typical	2.1875	Mg/kg veg
(C_{90}) : C_0 × exp(-k×T) [5]	Maximum	148	Mg/kg veg
Time-weighted Average Concentration on vegetation	Typical	7.3638	Mg/kg veg
(CTWA): C_0 × (1-exp(-k×T))/(k×T) [5]	Maximum	498.2107	Mg/kg veg
Proportion of diet contaminated (PC)	Typical	1	unitless
	Maximum	1	unitless
Dose estimates (D): (CTWA × ir × PC) / BW	Typical	1.81E+00	mg/kg bw/day
	Maximum	1.22E+02	mg/kg bw/day

RISK QUOTIENTS[6] - Ingestion	Toxicity Reference Value (mg/kg bw/day)[7]	Typical Application	Maximum Application
Large herbivorous bird (chronic exposure)	1,000	1.81E-03	1.22E-01

[1] Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^0.651.
[2] Assumes vegetation is 85% water (USEPA 1993; Table 4-2 - value for dicotyledons).
[3] Residue rates were obtained from the Kenaga nomogram as updated (Fletcher et al. 1994) and are vegetation-specific.
[4] ln = Natural log function.
[5] exp(-k×T) = e^(-k×T), where e is a constant = 2.7828.
[6] Risk Quotient = Estimated Dose/Toxicity Reference Value.
[7] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.

TABLE B-12

Potential Risks to Aquatic Species from Accidental Spray Drift to Pond

OFF-SITE DRIFT - modeled in AgDrift TYPICAL APPLICATION RATE									
				Risk Quotients[1] - Acute			Risk Quotients[1] - Chronic		
Mode of Application	Application Height or Type	Distance from Receptor (ft)	Pond Concentration (mg/L)	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Ground	Low Boom	25	3.41E-04	3.04E-06	1.15E-06	6.82E-03	3.67E-05	3.41E-03	2.62E-02
Ground	Low Boom	100	1.87E-04	1.67E-06	6.30E-07	3.74E-03	2.01E-05	1.87E-03	1.44E-02
Ground	Low Boom	900	3.61E-05	3.22E-07	1.22E-07	7.22E-04	3.88E-06	3.61E-04	2.78E-03
Ground	High Boom	25	5.47E-04	4.88E-06	1.84E-06	1.09E-02	5.88E-05	5.47E-03	4.21E-02
Ground	High Boom	100	2.88E-04	2.57E-06	9.70E-07	5.76E-03	3.10E-05	2.88E-03	2.22E-02
Ground	High Boom	900	4.58E-05	4.09E-07	1.54E-07	9.16E-04	4.92E-06	4.58E-04	3.52E-03
OFF-SITE DRIFT - modeled in AgDrift MAXIMUM APPLICATION RATE									
				Risk Quotients[1] - Acute			Risk Quotients[1] - Chronic		
Mode of Application	Application Height or Type	Distance from Receptor (ft)	Pond Concentration (mg/L)	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Ground	Low Boom	25	1.58E-03	1.41E-05	5.32E-06	3.16E-02	1.70E-04	1.58E-02	1.22E-01
Ground	Low Boom	100	7.85E-04	7.01E-06	2.64E-06	1.57E-02	8.44E-05	7.85E-03	6.04E-02
Ground	Low Boom	900	1.31E-04	1.17E-06	4.41E-07	2.62E-03	1.41E-05	1.31E-03	1.01E-02
Ground	High Boom	25	3.00E-03	2.68E-05	1.01E-05	6.00E-02	3.23E-04	3.00E-02	2.31E-01
Ground	High Boom	100	1.40E-03	1.25E-05	4.71E-06	2.80E-02	1.51E-04	1.40E-02	1.08E-01
Ground	High Boom	900	1.75E-04	1.56E-06	5.89E-07	3.50E-03	1.88E-05	1.75E-03	1.35E-02

[1]Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-13

Potential Risks to Aquatic Species from Accidental Spray Drift to Stream

OFF-SITE DRIFT - modeled in AgDrift TYPICAL APPLICATION RATE									
				Risk Quotients[1] - Acute			Risk Quotients[1] - Chronic		
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Stream Concentration (mg/L)	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Ground	Low Boom	25	6.13E-04	5.48E-06	2.06E-06	1.23E-02	6.59E-05	6.13E-03	4.72E-02
Ground	Low Boom	100	1.80E-04	1.60E-06	6.05E-07	3.59E-03	1.93E-05	1.80E-03	1.38E-02
Ground	Low Boom	900	1.86E-05	1.66E-07	6.26E-08	3.72E-04	2.00E-06	1.86E-04	1.43E-03
Ground	High Boom	25	1.03E-03	9.17E-06	3.46E-06	2.05E-02	1.10E-04	1.03E-02	7.90E-02
Ground	High Boom	100	2.91E-04	2.60E-06	9.79E-07	5.82E-03	3.13E-05	2.91E-03	2.24E-02
Ground	High Boom	900	2.46E-05	2.20E-07	8.28E-08	4.92E-04	2.64E-06	2.46E-04	1.89E-03
OFF-SITE DRIFT - modeled in AgDrift MAXIMUM APPLICATION RATE									
				Risk Quotients[1] - Acute			Risk Quotients[1] - Chronic		
Mode of Application	Application Height or Type	Distance From Receptor (ft)	Stream Concentration (mg/L)	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Ground	Low Boom	25	4.91E-03	4.38E-05	1.65E-05	9.81E-02	5.28E-04	4.91E-02	3.77E-01
Ground	Low Boom	100	1.44E-03	1.28E-05	4.84E-06	2.87E-02	1.55E-04	1.44E-02	1.11E-01
Ground	Low Boom	900	1.49E-04	1.33E-06	5.01E-07	2.98E-03	1.60E-05	1.49E-03	1.14E-02
Ground	High Boom	25	8.22E-03	7.34E-05	2.77E-05	1.64E-01	8.84E-04	8.22E-02	6.32E-01
Ground	High Boom	100	2.33E-03	2.08E-05	7.84E-06	4.65E-02	2.50E-04	2.33E-02	1.79E-01
Ground	High Boom	900	1.97E-04	1.76E-06	6.62E-07	3.93E-03	2.12E-05	1.97E-03	1.51E-02

[1]Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-14

Potential Risks to Non-target Terrestrial Plants from Direct Spray and Spray Drift

DIRECT SPRAY	Terrestrial Concentration (lb/acre)[1]	Typical Species RQ[2]	Rare, Threatened, and Endangered Species RQ[2]
Typical application rate	0.5	1.67E+01	5.00E+01
Maximum application rate	4	1.33E+02	4.00E+02

OFF-SITE DRIFT - modeled in AgDrift TYPICAL APPLICATION RATE					
Mode of Application	**Application Height or Type**	**Distance from Receptor (ft)**	**Soil Concentration (lb/acre) [1]**	**Typical Species RQ[2]**	**Rare, Threatened, and Endangered Species RQ[2]**
Ground	Low Boom	25	6.30E-03	2.10E-01	6.30E-01
Ground	Low Boom	100	2.20E-03	7.33E-02	2.20E-01
Ground	Low Boom	900	3.00E-04	1.00E-02	3.00E-02
Ground	High Boom	25	1.04E-02	3.47E-01	1.04E+00
Ground	High Boom	100	3.50E-03	1.17E-01	3.50E-01
Ground	High Boom	900	4.00E-04	1.33E-02	4.00E-02
OFF-SITE DRIFT - modeled in AgDrift MAXIMUM APPLICATION RATE					
Mode of Application	**Application Height or Type**	**Distance from Receptor (ft)**	**Soil Concentration (lb/acre) [1]**	**Typical Species RQ[2]**	**Rare, Threatened, and Endangered Species RQ[2]**
Ground	Low Boom	25	3.33E-02	1.11E+00	3.33E+00
Ground	Low Boom	100	9.60E-03	3.20E-01	9.60E-01
Ground	Low Boom	900	1.20E-03	4.00E-02	1.20E-01
Ground	High Boom	25	6.59E-02	2.20E+00	6.59E+00
Ground	High Boom	100	1.77E-02	5.90E-01	1.77E+00
Ground	High Boom	900	1.70E-03	5.67E-02	1.70E-01

[1] a.i. = active ingredient.
[2] RQ = Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-15

Potential Risk to Predatory Bird from Consumption of Contaminated Fish from Pond (Pond Impacted by Spray Drift Modeled in AgDrift)

Parameters/ Assumptions	Value	Units
Body weight (BW)	5.15	kg
Food ingestion rate (dry weight [dw]) [1]	0.1018	kg dw/day
Food ingestion rate (wet weight [ww])(ir) [2]	0.4072	kg ww/day
Bioconcentration factor (BCF)	2.63	L/kg fish
Proportion of diet contaminated (PC)	1	unitless
Toxicity reference value (TRV) [3]	1,000	mg/kg-bw/day

TYPICAL APPLICATION RATE

Mode of Application	Application Height or Type	Distance From Receptor (ft)	Pond Concentration[4] (C_{pond} mg/L)	Concentration in fish (C_{Fish}): C_{pond} × BCF	Dose estimate (D): (C_{Fish} × ir × PC) / BW	Risk Quotient[5]
Ground	Low Boom	25	3.41E-04	8.97E-04	7.09E-05	7.09E-08
Ground	Low Boom	100	1.87E-04	4.92E-04	3.89E-05	3.89E-08
Ground	Low Boom	900	3.61E-05	9.49E-05	7.51E-06	7.51E-09
Ground	High Boom	25	5.47E-04	1.44E-03	1.14E-04	1.14E-07
Ground	High Boom	100	2.88E-04	7.57E-04	5.99E-05	5.99E-08
Ground	High Boom	900	4.58E-05	1.20E-04	9.52E-06	9.52E-09

MAXIMUM APPLICATION RATE

Mode of Application	Application Height or Type	Distance From Receptor (ft)	Pond Concentration[4] (C_{pond} mg/L)	Concentration in fish (C_{Fish}): C_{pond} × BCF	Dose estimate (D): (C_{Fish} × ir × PC) / BW	Risk Quotient[5]
Ground	Low Boom	25	1.58E-03	4.16E-03	3.29E-04	3.29E-07
Ground	Low Boom	100	7.85E-04	2.06E-03	1.63E-04	1.63E-07
Ground	Low Boom	900	1.31E-04	3.45E-04	2.72E-05	2.72E-08
Ground	High Boom	25	3.00E-03	7.89E-03	6.24E-04	6.24E-07
Ground	High Boom	100	1.40E-03	3.68E-03	2.91E-04	2.91E-07
Ground	High Boom	900	1.75E-04	4.60E-04	3.64E-05	3.64E-08

[1] Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^0.651.
[2] Assumes fish are 75% water (USEPA 1993; Table 4-1 - value for bony fishes).
[3] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.
[4] Pond concentrations in spray drift scenarios were calculated by the AgDRIFT. See associated report methodology document for further details.
[5] Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-16

Potential Risks to Aquatic Species from Surface Runoff to Pond

SURFACE RUNOFF - Modeled in GLEAMS - TYPICAL APPLICATION RATE

GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE[2] Soil Erodibility Factor (ton/ac per EI)	Vegetation Type	Soil Type	Pond Concentrations (mg/L)		Risk Quotients[1] - Acute			Risk Quotients[1] - Chronic		
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
G_BASE_SAND_005_POND_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_005_POND_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_005_POND_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010_POND_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Sand	1.41E-01	1.28E-01	1.26E-03	4.76E-04	2.83E+00	1.37E-02	1.28E+00	9.82E+00
G_BASE_CLAY_010_POND_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Clay	2.01E-03	3.54E-04	1.80E-05	6.78E-06	4.03E-02	3.81E-05	3.54E-03	2.73E-02
G_BASE_LOAM_010_POND_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Loam	2.35E-04	2.06E-04	2.10E-06	7.92E-07	4.71E-03	2.22E-05	2.06E-03	1.59E-02
G_BASE_SAND_025_POND_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Sand	1.76E-02	4.08E-03	1.57E-04	5.93E-05	3.52E-01	4.39E-04	4.08E-02	3.14E-01
G_BASE_CLAY_025_POND_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Clay	3.73E-02	1.70E-02	3.33E-04	1.26E-04	7.46E-01	1.83E-03	1.70E-01	1.31E+00
G_BASE_LOAM_025_POND_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Loam	3.68E-02	3.41E-02	3.29E-04	1.24E-04	7.36E-01	3.67E-03	3.41E-01	2.62E+00
G_BASE_SAND_050_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Sand	1.02E-01	2.16E-02	9.10E-04	3.43E-04	2.04E+00	2.33E-03	2.16E-01	3.14E-01
G_BASE_CLAY_050_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.28E-01	1.73E-02	1.15E-03	4.32E-04	2.57E+00	1.86E-03	1.73E-01	1.33E+00
G_BASE_LOAM_050_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.71E-02	1.10E-02	1.53E-04	5.76E-05	3.42E-01	1.18E-03	1.10E-01	8.46E-01
G_BASE_SAND_100_POND_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Sand	9.91E-02	4.08E-02	8.84E-04	3.34E-04	1.98E+00	4.38E-03	4.08E-01	3.14E+00
G_BASE_CLAY_100_POND_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Clay	6.64E-02	9.52E-03	5.92E-04	2.23E-04	1.33E+00	1.02E-03	9.52E-02	7.32E-01
G_BASE_LOAM_100_POND_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.37E-02	1.66E-03	1.22E-04	4.60E-05	2.73E-01	1.78E-04	1.66E-02	1.27E-01
G_BASE_SAND_150_POND_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Sand	9.03E-02	3.08E-02	8.06E-04	3.04E-04	1.81E+00	3.31E-03	3.08E-01	2.37E+00
G_BASE_CLAY_150_POND_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Clay	2.90E-02	7.25E-03	2.59E-04	9.77E-05	5.80E-01	7.79E-04	7.25E-02	5.57E-01

TABLE B-16 (Cont.)

Potential Risks to Aquatic Species from Surface Runoff to Pond

SURFACE RUNOFF - Modeled in GLEAMS - TYPICAL APPLICATION RATE															
								Pond Concentrations (mg/L)		Risk Quotients[1] - Acute			Risk Quotients[1] - Chronic		
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE[2] Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
G_BASE_LOAM _150_POND_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Loam	2.66E-02	4.36E-03	2.38E-04	8.97E-05	5.33E-01	4.69E-04	4.36E-02	3.35E-01
G_BASE_SAND_ 200_POND_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Sand	8.17E-02	1.95E-02	7.29E-04	2.75E-04	1.63E+00	2.10E-03	1.95E-01	1.50E+00
G_BASE_CLAY_ 200_POND_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Clay	3.09E-02	6.17E-03	2.76E-04	1.04E-04	6.18E-01	6.63E-04	6.17E-02	4.74E-01
G_BASE_LOAM _200_POND_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Loam	2.93E-02	6.57E-03	2.61E-04	9.85E-05	5.85E-01	7.06E-04	6.57E-02	5.05E-01
G_BASE_SAND_ 250_POND_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Sand	8.11E-02	1.20E-02	7.24E-04	2.73E-04	1.62E+00	1.29E-03	1.20E-01	9.26E-01
G_BASE_CLAY_ 250_POND_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Clay	4.11E-02	5.50E-03	3.67E-04	1.38E-04	8.21E-01	5.91E-04	5.50E-02	4.23E-01
G_BASE_LOAM _250_POND_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.96E-02	7.92E-03	2.64E-04	9.96E-05	5.92E-01	8.52E-04	7.92E-02	6.09E-01
G_ARV1_050_PO ND_TYP	50	1	0.05	0.015	0.401	Weeds (78)	Loam	1.20E-02	1.05E-02	1.07E-04	4.05E-05	2.41E-01	1.13E-03	1.05E-01	8.08E-01
G_ARV2_050_PO ND_TYP	50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.84E-02	1.12E-02	1.64E-04	6.19E-05	3.68E-01	1.21E-03	1.12E-01	8.65E-01
G_ARV3_050_PO ND_TYP	50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	2.08E-02	1.13E-02	1.85E-04	6.99E-05	4.15E-01	1.21E-03	1.13E-01	8.68E-01
G_ERV1_050_PO ND_TYP	50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.71E-02	1.10E-02	1.53E-04	5.76E-05	3.42E-01	1.18E-03	1.10E-01	8.45E-01
G_ERV2_050_PO ND_TYP	50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.71E-02	1.10E-02	1.53E-04	5.76E-05	3.42E-01	1.18E-03	1.10E-01	8.46E-01
G_ERV3_050_PO ND_TYP	50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.71E-02	1.10E-02	1.53E-04	5.76E-05	3.42E-01	1.18E-03	1.10E-01	8.46E-01
G_RGV1_050_PO ND_TYP	50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.71E-02	1.10E-02	1.53E-04	5.76E-05	3.42E-01	1.18E-03	1.10E-01	8.46E-01
G_RGV2_050_PO ND_TYP	50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.71E-02	1.10E-02	1.53E-04	5.76E-05	3.42E-01	1.18E-03	1.10E-01	8.45E-01
G_RGV3_050_PO ND_TYP	50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.71E-02	1.10E-02	1.53E-04	5.76E-05	3.42E-01	1.18E-03	1.10E-01	8.45E-01
G_SLV1_050_PO ND_TYP	50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.71E-02	1.10E-02	1.53E-04	5.76E-05	3.42E-01	1.18E-03	1.10E-01	8.45E-01

TABLE B-16 (Cont.)

Potential Risks to Aquatic Species from Surface Runoff to Pond

GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE[2] Soil Erodibility Factor (ton/ac per EI)	Vegetation Type	Soil Type	Pond Concentrations (mg/L)		Risk Quotients[1] - Acute			Risk Quotients[1] - Chronic		
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
SURFACE RUNOFF - Modeled in GLEAMS - TYPICAL APPLICATION RATE															
G_SLV2_050_POND_TYP	50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.71E-02	1.10E-02	1.53E-04	5.76E-05	3.42E-01	1.18E-03	1.10E-01	8.45E-01
G_SLV3_050_POND_TYP	50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.71E-02	1.10E-02	1.53E-04	5.76E-05	3.42E-01	1.18E-03	1.10E-01	8.46E-01
G_STV1_050_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	4.23E-02	1.82E-02	3.78E-04	1.42E-04	8.46E-01	1.96E-03	1.82E-01	1.40E+00
G_STV2_050_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt	3.76E-02	1.61E-02	3.35E-04	1.26E-04	7.51E-01	1.73E-03	1.61E-01	1.24E+00
G_STV3_050_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	7.38E-02	1.70E-02	6.59E-04	2.48E-04	1.48E+00	1.83E-03	1.70E-01	1.31E+00
G_VGV1_050_POND_TYP	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.71E-02	1.10E-02	1.53E-04	5.76E-05	3.42E-01	1.18E-03	1.10E-01	8.46E-01
G_VGV2_050_POND_TYP	50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.71E-02	1.10E-02	1.53E-04	5.76E-05	3.42E-01	1.18E-03	1.10E-01	8.46E-01
G_VGV3_050_POND_TYP	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	1.12E-02	6.20E-03	9.98E-05	3.76E-05	2.24E-01	6.66E-04	6.20E-02	4.77E-01
MAXIMUM APPLICATION RATE															
G_BASE_SAND_005_POND_MAX	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_005_POND_MAX	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_005_POND_MAX	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010_POND_MAX	10	10	0.05	0.015	0.401	Weeds (78)	Sand	1.13E+00	1.02E+00	1.01E-02	3.81E-03	2.26E+01	1.10E-01	1.02E+01	7.86E+01
G_BASE_CLAY_010_POND_MAX	10	10	0.05	0.015	0.401	Weeds (78)	Clay	1.61E-02	2.83E-03	1.44E-04	5.42E-05	3.22E-01	3.05E-04	2.83E-02	2.18E-01
G_BASE_LOAM_010_POND_MAX	10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.88E-03	1.65E-03	1.68E-05	6.34E-06	3.76E-02	1.77E-04	1.65E-02	1.27E-01
G_BASE_SAND_025_POND_MAX	25	10	0.05	0.015	0.401	Weeds (78)	Sand	1.41E-01	3.26E-02	1.26E-03	4.74E-04	2.82E+00	3.51E-03	3.26E-01	2.51E+00
G_BASE_CLAY_025_POND_MAX	25	10	0.05	0.015	0.401	Weeds (78)	Clay	2.98E-01	1.36E-01	2.66E-03	1.00E-03	5.97E+00	1.47E-02	1.36E+00	1.05E+01

TABLE B-16 (Cont.)

Potential Risks to Aquatic Species from Surface Runoff to Pond

SURFACE RUNOFF - Modeled in GLEAMS - MAXIMUM APPLICATION RATE															
								Pond Concentrations (mg/L)		Risk Quotients[1] - Acute			Risk Quotients[1] - Chronic		
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE[2] Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
G_BASE_LOAM_025_POND_MAX	25	10	0.05	0.015	0.401	Weeds (78)	Loam	2.94E-01	2.73E-01	2.63E-03	9.91E-04	5.89E+00	2.93E-02	2.73E+00	2.10E+01
G_BASE_SAND_050_POND_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Sand	8.16E-01	1.73E-01	7.28E-03	2.75E-03	1.63E+01	1.86E-02	1.73E+00	1.33E+01
G_BASE_CLAY_050_POND_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.03E+00	1.39E-01	9.17E-03	3.46E-03	2.05E+01	1.49E-02	1.39E+00	1.07E+01
G_BASE_LOAM_050_POND_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.37E-01	8.80E-02	1.22E-03	4.61E-04	2.74E+00	9.46E-03	8.80E-01	6.77E+00
G_BASE_SAND_100_POND_MAX	100	10	0.05	0.015	0.401	Weeds (78)	Sand	7.92E-01	3.26E-01	7.08E-03	2.67E-03	1.58E+01	3.51E-02	3.26E+00	2.51E+01
G_BASE_CLAY_100_POND_MAX	100	10	0.05	0.015	0.401	Weeds (78)	Clay	5.31E-01	7.61E-02	4.74E-03	1.79E-03	1.06E+01	8.18E-03	7.61E-01	5.86E+00
G_BASE_LOAM_100_POND_MAX	100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.09E-01	1.33E-02	9.75E-04	3.68E-04	2.18E+00	1.42E-03	1.33E-01	1.02E+00
G_BASE_SAND_150_POND_MAX	150	10	0.05	0.015	0.401	Weeds (78)	Sand	7.22E-01	2.47E-01	6.45E-03	2.43E-03	1.44E+01	2.65E-02	2.47E+00	1.90E+01
G_BASE_CLAY_150_POND_MAX	150	10	0.05	0.015	0.401	Weeds (78)	Clay	2.32E-01	5.80E-02	2.07E-03	7.82E-04	4.64E+00	6.23E-03	5.80E-01	4.46E+00
G_BASE_LOAM_150_POND_MAX	150	10	0.05	0.015	0.401	Weeds (78)	Loam	2.13E-01	3.49E-02	1.90E-03	7.18E-04	4.26E+00	3.75E-03	3.49E-01	2.68E+00
G_BASE_SAND_200_POND_MAX	200	10	0.05	0.015	0.401	Weeds (78)	Sand	6.54E-01	1.56E-01	5.84E-03	2.20E-03	1.31E+01	1.68E-02	1.56E+00	1.20E+01
G_BASE_CLAY_200_POND_MAX	200	10	0.05	0.015	0.401	Weeds (78)	Clay	2.47E-01	4.93E-02	2.21E-03	8.32E-04	4.94E+00	5.30E-03	4.93E-01	3.79E+00
G_BASE_LOAM_200_POND_MAX	200	10	0.05	0.015	0.401	Weeds (78)	Loam	2.34E-01	5.26E-02	2.09E-03	7.88E-04	4.68E+00	5.65E-03	5.26E-01	4.04E+00
G_BASE_SAND_250_POND_MAX	250	10	0.05	0.015	0.401	Weeds (78)	Sand	6.48E-01	9.63E-02	5.79E-03	2.18E-03	1.30E+01	1.04E-02	9.63E-01	7.41E+00
G_BASE_CLAY_250_POND_MAX	250	10	0.05	0.015	0.401	Weeds (78)	Clay	3.28E-01	4.40E-02	2.93E-03	1.11E-03	6.57E+00	4.73E-03	4.40E-01	3.38E+00
G_BASE_LOAM_250_POND_MAX	250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.37E-01	6.34E-02	2.11E-03	7.97E-04	4.74E+00	6.81E-03	6.34E-01	4.87E+00
G_ARV1_050_POND_MAX	50	1	0.05	0.015	0.401	Weeds (78)	Loam	9.62E-02	8.40E-02	8.59E-04	3.24E-04	1.92E+00	9.03E-03	8.40E-01	6.46E+00

TABLE B-16 (Cont.)

Potential Risks to Aquatic Species From Surface Runoff to Pond

SURFACE RUNOFF - Modeled in GLEAMS - MAXIMUM APPLICATION RATE

GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE[2] Soil Erodibility Factor (ton/ac per EI)	Vegetation Type	Soil Type	Pond Concentrations (mg/L)		Risk Quotients[1] – Acute			Risk Quotients[1] - Chronic		
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants	Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
G_ARV2_050_POND_MAX	50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.47E-01	8.99E-02	1.31E-03	4.95E-04	2.94E+00	9.67E-03	8.99E-01	6.92E+00
G_ARV3_050_POND_MAX	50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	1.66E-01	9.03E-02	1.48E-03	5.59E-04	3.32E+00	9.71E-03	9.03E-01	6.95E+00
G_ERV1_050_POND_MAX	50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.37E-01	8.79E-02	1.22E-03	4.61E-04	2.74E+00	9.45E-03	8.79E-01	6.76E+00
G_ERV2_050_POND_MAX	50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.37E-01	8.80E-02	1.22E-03	4.61E-04	2.74E+00	9.46E-03	8.80E-01	6.77E+00
G_ERV3_050_POND_MAX	50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.37E-01	8.80E-02	1.22E-03	4.61E-04	2.74E+00	9.46E-03	8.80E-01	6.77E+00
G_RGV1_050_POND_MAX	50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.37E-01	8.80E-02	1.22E-03	4.61E-04	2.74E+00	9.46E-03	8.80E-01	6.77E+00
G_RGV2_050_POND_MAX	50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.37E-01	8.79E-02	1.22E-03	4.61E-04	2.74E+00	9.45E-03	8.79E-01	6.76E+00
G_RGV3_050_POND_MAX	50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.37E-01	8.79E-02	1.22E-03	4.61E-04	2.74E+00	9.45E-03	8.79E-01	6.76E+00
G_SLV1_050_POND_MAX	50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.37E-01	8.79E-02	1.22E-03	4.61E-04	2.74E+00	9.45E-03	8.79E-01	6.76E+00
G_SLV2_050_POND_MAX	50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.37E-01	8.79E-02	1.22E-03	4.61E-04	2.74E+00	9.45E-03	8.79E-01	6.76E+00
G_SLV3_050_POND_MAX	50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.37E-01	8.80E-02	1.22E-03	4.61E-04	2.74E+00	9.46E-03	8.80E-01	6.77E+00
G_STV1_050_POND_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	3.39E-01	1.46E-01	3.02E-03	1.14E-03	6.77E+00	1.57E-02	1.46E+00	1.12E+01
G_STV2_050_POND_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Silt	3.01E-01	1.29E-01	2.68E-03	1.01E-03	6.01E+00	1.39E-02	1.29E+00	9.93E+00
G_STV3_050_POND_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	5.90E-01	1.36E-01	5.27E-03	1.99E-03	1.18E+01	1.47E-02	1.36E+00	1.05E+01
G_VGV1_050_POND_MAX	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.37E-01	8.80E-02	1.22E-03	4.61E-04	2.74E+00	9.46E-03	8.80E-01	6.77E+00
G_VGV3_050_POND_MAX	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	8.94E-02	4.96E-02	7.99E-04	3.01E-04	1.79E+00	5.33E-03	4.96E-01	3.81E+00

[1]Risk Quotient = Estimated Dose/Toxicity Reference Value.
[2]USLE = Universal Soil Loss Equation, which predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors.

TABLE B-17

Potential Risks to Aquatic Species from Surface Runoff to Stream

SURFACE RUNOFF - Modeled in GLEAMS – TYPICAL APPLICATION RATE

GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE[2] Soil Erodibility Factor (ton/ac/EI)	Vegetation Type	Soil Type	Stream Concentrations (mg/L)		Risk Quotients - Acute			Risk Quotients - Chronic		
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte-brates	Non-Target Aquatic Plants	Fish	Aquatic Inverte-brates	Non-Target Aquatic Plants
G_BASE_SAND_005 _STREAM_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_005 _STREAM_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_005 _STREAM_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010 _STREAM_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Sand	5.64E-03	7.98E-05	5.03E-05	1.90E-05	1.13E-01	8.58E-06	7.98E-04	6.14E-03
G_BASE_CLAY_010 _STREAM_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Clay	6.50E-05	5.47E-07	5.80E-07	2.19E-07	1.30E-03	5.88E-08	5.47E-06	4.20E-05
G_BASE_LOAM_010 _STREAM_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Loam	5.14E-06	1.03E-07	4.58E-08	1.73E-08	1.03E-04	1.10E-08	1.03E-06	7.89E-06
G_BASE_SAND_025 _STREAM_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Sand	7.21E-04	2.12E-05	6.44E-06	2.43E-06	1.44E-02	2.28E-06	2.12E-04	1.63E-03
G_BASE_CLAY_025 _STREAM_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Clay	8.73E-04	4.34E-05	7.79E-06	2.94E-06	1.75E-02	4.67E-06	4.34E-04	3.34E-03
G_BASE_LOAM_025 _STREAM_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Loam	2.75E-03	1.02E-04	2.46E-05	9.26E-06	5.50E-02	1.10E-05	1.02E-03	7.88E-03
G_BASE_SAND_050 _STREAM_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Sand	8.42E-03	2.34E-04	7.52E-05	2.84E-05	1.68E-01	2.52E-05	2.34E-03	1.80E-02
G_BASE_CLAY_050 _STREAM_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay	4.55E-03	1.42E-04	4.06E-05	1.53E-05	9.10E-02	1.53E-05	1.42E-03	1.09E-02
G_BASE_LOAM_050 _STREAM_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.87E-03	9.40E-05	1.67E-05	6.31E-06	3.75E-02	1.01E-05	9.40E-04	7.23E-03
G_BASE_SAND_100 _STREAM_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Sand	6.43E-03	4.48E-04	5.74E-05	2.16E-05	1.29E-01	4.82E-05	4.48E-03	3.45E-02
G_BASE_CLAY_100 _STREAM_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Clay	9.29E-03	1.92E-04	8.29E-05	3.13E-05	1.86E-01	2.06E-05	1.92E-03	1.48E-02
G_BASE_LOAM_100 _STREAM_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.32E-03	3.50E-05	1.18E-05	4.43E-06	2.63E-02	3.76E-06	3.50E-04	2.69E-03
G_BASE_SAND_150 _STREAM_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Sand	1.17E-02	4.40E-04	1.04E-04	3.93E-05	2.34E-01	4.73E-05	4.40E-03	3.38E-02
G_BASE_CLAY_150 _STREAM_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Clay	8.63E-03	1.87E-04	7.71E-05	2.91E-05	1.73E-01	2.01E-05	1.87E-03	1.44E-02

TABLE B-17 (Cont.)

Potential Risks to Aquatic Species from Surface Runoff to Stream

SURFACE RUNOFF - Modeled in GLEAMS – TYPICAL APPLICATION RATE

GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE[2] Soil Erodibility Factor (ton/ac/EI)	Vegetation Type	Soil Type	Stream Concentrations (mg/L)		Risk Quotients - Acute			Risk Quotients - Chronic		
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte-brates	Non-Target Aquatic Plants	Fish	Aquatic Inverte-brates	Non-Target Aquatic Plants
G_BASE_LOAM_150_STREAM_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Loam	2.88E-03	1.09E-04	2.57E-05	9.70E-06	5.76E-02	1.18E-05	1.09E-03	8.41E-03
G_BASE_SAND_200_STREAM_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Sand	1.34E-02	4.15E-04	1.19E-04	4.49E-05	2.67E-01	4.46E-05	4.15E-03	3.19E-02
G_BASE_CLAY_200_STREAM_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Clay	7.16E-03	1.75E-04	6.39E-05	2.41E-05	1.43E-01	1.88E-05	1.75E-03	1.35E-02
G_BASE_LOAM_200_STREAM_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Loam	3.45E-03	1.86E-04	3.08E-05	1.16E-05	6.90E-02	2.00E-05	1.86E-03	1.43E-02
G_BASE_SAND_250_STREAM_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Sand	1.30E-02	3.89E-04	1.16E-04	4.37E-05	2.60E-01	4.18E-05	3.89E-03	2.99E-02
G_BASE_CLAY_250_STREAM_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Clay	5.84E-03	1.65E-04	5.21E-05	1.96E-05	1.17E-01	1.78E-05	1.65E-03	1.27E-02
G_BASE_LOAM_250_STREAM_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Loam	3.56E-03	2.42E-04	3.18E-05	1.20E-05	7.13E-02	2.61E-05	2.42E-03	1.87E-02
G_ARV1_050_STREAM_TYP	50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.64E-04	1.07E-05	2.36E-06	8.88E-07	5.28E-03	1.15E-06	1.07E-04	8.20E-04
G_ARV2_050_STREAM_TYP	50	100	0.05	0.015	0.401	Weeds (78)	Loam	6.78E-03	5.49E-04	6.05E-05	2.28E-05	1.36E-01	5.90E-05	5.49E-03	4.22E-02
G_ARV3_050_STREAM_TYP	50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	1.43E-02	1.48E-03	1.28E-04	4.83E-05	2.87E-01	1.59E-04	1.48E-02	1.14E-01
G_ERV1_050_STREAM_TYP	50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.87E-03	9.39E-05	1.67E-05	6.31E-06	3.75E-02	1.01E-05	9.39E-04	7.22E-03
G_ERV2_050_STREAM_TYP	50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.87E-03	9.39E-05	1.67E-05	6.31E-06	3.75E-02	1.01E-05	9.39E-04	7.22E-03
G_ERV3_050_STREAM_TYP	50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.87E-03	9.39E-05	1.67E-05	6.31E-06	3.75E-02	1.01E-05	9.39E-04	7.22E-03
G_RGV1_050_STREAM_TYP	50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.87E-03	9.39E-05	1.67E-05	6.31E-06	3.75E-02	1.01E-05	9.39E-04	7.22E-03
G_RGV2_050_STREAM_TYP	50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.87E-03	9.39E-05	1.67E-05	6.31E-06	3.75E-02	1.01E-05	9.39E-04	7.22E-03
G_RGV3_050_STREAM_TYP	50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.87E-03	9.39E-05	1.67E-05	6.31E-06	3.75E-02	1.01E-05	9.39E-04	7.22E-03
G_SLV1_050_STREAM_TYP	50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.87E-03	9.39E-05	1.67E-05	6.31E-06	3.75E-02	1.01E-05	9.39E-04	7.22E-03

TABLE B-17 (Cont.)

Potential Risks to Aquatic Species from Surface Runoff to Stream

GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE[2] Soil Erodibility Factor (ton/ac/EI)	Vegetation Type	Soil Type	Stream Concentrations (mg/L)		Risk Quotients - Acute			Risk Quotients - Chronic		
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte-brates	Non-Target Aquatic Plants	Fish	Aquatic Inverte-brates	Non-Target Aquatic Plants
SURFACE RUNOFF - Modeled in GLEAMS – TYPICAL APPLICATION RATE															
G_SLV2_050_STREAM_TYP	50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.87E-03	9.39E-05	1.67E-05	6.31E-06	3.75E-02	1.01E-05	9.39E-04	7.22E-03
G_SLV3_050_STREAM_TYP	50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.87E-03	9.39E-05	1.67E-05	6.31E-06	3.75E-02	1.01E-05	9.39E-04	7.22E-03
G_STV1_050_STREAM_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	2.24E-03	1.40E-04	2.00E-05	7.55E-06	4.49E-02	1.51E-05	1.40E-03	1.08E-02
G_STV2_050_STREAM_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt	2.14E-03	1.30E-04	1.91E-05	7.22E-06	4.29E-02	1.40E-05	1.30E-03	9.99E-03
G_STV3_050_STREAM_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	4.23E-03	1.39E-04	3.78E-05	1.43E-05	8.47E-02	1.50E-05	1.39E-03	1.07E-02
G_VGV1_050_STREAM_TYP	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.87E-03	9.39E-05	1.67E-05	6.31E-06	3.75E-02	1.01E-05	9.39E-04	7.22E-03
G_VGV2_050_STREAM_TYP	50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.87E-03	9.39E-05	1.67E-05	6.31E-06	3.75E-02	1.01E-05	9.39E-04	7.22E-03
G_VGV3_050_STREAM_TYP	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	1.27E-03	6.43E-05	1.13E-05	4.26E-06	2.53E-02	6.91E-06	6.43E-04	4.95E-03
MAXIMUM APPLICATION RATE															
G_BASE_SAND_005_STREAM_MAX	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_005_STREAM_MAX	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_005_STREAM_MAX	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010_STREAM_MAX	10	10	0.05	0.015	0.401	Weeds (78)	Sand	4.51E-02	6.38E-04	4.03E-04	1.52E-04	9.02E-01	6.86E-05	6.38E-03	4.91E-02
G_BASE_CLAY_010_STREAM_MAX	10	10	0.05	0.015	0.401	Weeds (78)	Clay	5.20E-04	4.37E-06	4.64E-06	1.75E-06	1.04E-02	4.70E-07	4.37E-05	3.36E-04
G_BASE_LOAM_010_STREAM_MAX	10	10	0.05	0.015	0.401	Weeds (78)	Loam	4.11E-05	8.21E-07	3.67E-07	1.38E-07	8.22E-04	8.83E-08	8.21E-06	6.31E-05
G_BASE_SAND_025_STREAM_MAX	25	10	0.05	0.015	0.401	Weeds (78)	Sand	5.77E-03	1.70E-04	5.15E-05	1.94E-05	1.15E-01	1.82E-05	1.70E-03	1.30E-02
G_BASE_CLAY_025_STREAM_MAX	25	10	0.05	0.015	0.401	Weeds (78)	Clay	6.98E-03	3.48E-04	6.23E-05	2.35E-05	1.40E-01	3.74E-05	3.48E-03	2.67E-02

TABLE B-17 (Cont.)

Potential Risks to Aquatic Species from Surface Runoff to Stream

SURFACE RUNOFF - Modeled in GLEAMS
MAXIMUM APPLICATION RATE

GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE[2] Soil Erodibility Factor (ton/ac/EI)	Vegetation Type	Soil Type	Stream Concentrations (mg/L)		Risk Quotients - Acute			Risk Quotients - Chronic		
								Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte-brates	Non-Target Aquatic Plants	Fish	Aquatic Inverte-brates	Non-Target Aquatic Plants
G_BASE_LOAM_025_STREAM_MAX	25	10	0.05	0.015	0.401	Weeds (78)	Loam	2.20E-02	8.19E-04	1.96E-04	7.41E-05	4.40E-01	8.81E-05	8.19E-03	6.30E-02
G_BASE_SAND_050_STREAM_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Sand	6.74E-02	1.87E-03	6.01E-04	2.27E-04	1.35E+00	2.01E-04	1.87E-02	1.44E-01
G_BASE_CLAY_050_STREAM_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Clay	3.64E-02	1.14E-03	3.25E-04	1.23E-04	7.28E-01	1.22E-04	1.14E-02	8.75E-02
G_BASE_LOAM_050_STREAM_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.50E-02	7.52E-04	1.34E-04	5.05E-05	3.00E-01	8.08E-05	7.52E-03	5.78E-02
G_BASE_SAND_100_STREAM_MAX	100	10	0.05	0.015	0.401	Weeds (78)	Sand	5.14E-02	3.59E-03	4.59E-04	1.73E-04	1.03E+00	3.86E-04	3.59E-02	2.76E-01
G_BASE_CLAY_100_STREAM_MAX	100	10	0.05	0.015	0.401	Weeds (78)	Clay	7.43E-02	1.54E-03	6.64E-04	2.50E-04	1.49E+00	1.65E-04	1.54E-02	1.18E-01
G_BASE_LOAM_100_STREAM_MAX	100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.05E-02	2.80E-04	9.41E-05	3.55E-05	2.11E-01	3.01E-05	2.80E-03	2.15E-02
G_BASE_SAND_150_STREAM_MAX	150	10	0.05	0.015	0.401	Weeds (78)	Sand	9.34E-02	3.52E-03	8.34E-04	3.15E-04	1.87E+00	3.78E-04	3.52E-02	2.71E-01
G_BASE_CLAY_150_STREAM_MAX	150	10	0.05	0.015	0.401	Weeds (78)	Clay	6.90E-02	1.50E-03	6.16E-04	2.32E-04	1.38E+00	1.61E-04	1.50E-02	1.15E-01
G_BASE_LOAM_150_STREAM_MAX	150	10	0.05	0.015	0.401	Weeds (78)	Loam	2.30E-02	8.74E-04	2.06E-04	7.76E-05	4.61E-01	9.40E-05	8.74E-03	6.73E-02
G_BASE_SAND_200_STREAM_MAX	200	10	0.05	0.015	0.401	Weeds (78)	Sand	1.07E-01	3.32E-03	9.54E-04	3.60E-04	2.14E+00	3.57E-04	3.32E-02	2.55E-01
G_BASE_CLAY_200_STREAM_MAX	200	10	0.05	0.015	0.401	Weeds (78)	Clay	5.73E-02	1.40E-03	5.11E-04	1.93E-04	1.15E+00	1.50E-04	1.40E-02	1.08E-01
G_BASE_LOAM_200_STREAM_MAX	200	10	0.05	0.015	0.401	Weeds (78)	Loam	2.76E-02	1.49E-03	2.47E-04	9.30E-05	5.52E-01	1.60E-04	1.49E-02	1.14E-01
G_BASE_SAND_250_STREAM_MAX	250	10	0.05	0.015	0.401	Weeds (78)	Sand	1.04E-01	3.11E-03	9.27E-04	3.49E-04	2.08E+00	3.35E-04	3.11E-02	2.39E-01
G_BASE_CLAY_250_STREAM_MAX	250	10	0.05	0.015	0.401	Weeds (78)	Clay	4.67E-02	1.32E-03	4.17E-04	1.57E-04	9.34E-01	1.42E-04	1.32E-02	1.02E-01
G_BASE_LOAM_250_STREAM_MAX	250	10	0.05	0.015	0.401	Weeds (78)	Loam	2.85E-02	1.94E-03	2.54E-04	9.60E-05	5.70E-01	2.09E-04	1.94E-02	1.49E-01
G_ARV1_050_STREAM_MAX	50	1	0.05	0.015	0.401	Weeds (78)	Loam	2.11E-03	8.53E-05	1.88E-05	7.11E-06	4.22E-02	9.17E-06	8.53E-04	6.56E-03

TABLE B-17 (Cont.)

Potential Risks to Aquatic Species from Surface Runoff to Stream

SURFACE RUNOFF - Modeled in GLEAMS – MAXIMUM APPLICATION RATE															
								Stream Concentrations (mg/L)		Risk Quotients - Acute			Risk Quotients - Chronic		
GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE[2] Soil Erodibility Factor (ton/ac/EI)	Vegetation Type	Soil Type	Acute Exposure Scenarios	Chronic Exposure Scenarios	Fish	Aquatic Inverte-brates	Non-Target Aquatic Plants	Fish	Aquatic Inverte-brates	Non-Target Aquatic Plants
G_ARV2_050_STREAM_MAX	50	100	0.05	0.015	0.401	Weeds (78)	Loam	5.42E-02	4.39E-03	4.84E-04	1.83E-04	1.08E+00	4.72E-04	4.39E-02	3.38E-01
G_ARV3_050_STREAM_MAX	50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	1.15E-01	1.18E-02	1.02E-03	3.86E-04	2.30E+00	1.27E-03	1.18E-01	9.10E-01
G_ERV1_050_STREAM_MAX	50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.50E-02	7.51E-04	1.34E-04	5.05E-05	3.00E-01	8.08E-05	7.51E-03	5.78E-02
G_ERV2_050_STREAM_MAX	50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.50E-02	7.51E-04	1.34E-04	5.05E-05	3.00E-01	8.08E-05	7.51E-03	5.78E-02
G_ERV3_050_STREAM_MAX	50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.50E-02	7.51E-04	1.34E-04	5.05E-05	3.00E-01	8.08E-05	7.51E-03	5.78E-02
G_RGV1_050_STREAM_MAX	50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.50E-02	7.51E-04	1.34E-04	5.05E-05	3.00E-01	8.08E-05	7.51E-03	5.78E-02
G_RGV2_050_STREAM_MAX	50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.50E-02	7.51E-04	1.34E-04	5.05E-05	3.00E-01	8.08E-05	7.51E-03	5.78E-02
G_RGV3_050_STREAM_MAX	50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.50E-02	7.51E-04	1.34E-04	5.05E-05	3.00E-01	8.08E-05	7.51E-03	5.78E-02
G_SLV1_050_STREAM_MAX	50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.50E-02	7.51E-04	1.34E-04	5.05E-05	3.00E-01	8.08E-05	7.51E-03	5.78E-02
G_SLV2_050_STREAM_MAX	50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.50E-02	7.51E-04	1.34E-04	5.05E-05	3.00E-01	8.08E-05	7.51E-03	5.78E-02
G_SLV3_050_STREAM_MAX	50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.50E-02	7.51E-04	1.34E-04	5.05E-05	3.00E-01	8.08E-05	7.51E-03	5.78E-02
G_STV1_050_STREAM_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.79E-02	1.12E-03	1.60E-04	6.04E-05	3.59E-01	1.21E-04	1.12E-02	8.64E-02
G_STV2_050_STREAM_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.71E-02	1.04E-03	1.53E-04	5.77E-05	3.43E-01	1.12E-04	1.04E-02	7.99E-02
G_STV3_050_STREAM_MAX	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	3.39E-02	1.11E-03	3.02E-04	1.14E-04	6.77E-01	1.20E-04	1.11E-02	8.58E-02
G_VGV1_050_STREAM_MAX	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.50E-02	7.51E-04	1.34E-04	5.05E-05	3.00E-01	8.08E-05	7.51E-03	5.78E-02
G_VGV2_050_STREAM_MAX	50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.50E-02	7.51E-04	1.34E-04	5.05E-05	3.00E-01	8.08E-05	7.51E-03	5.78E-02
G_VGV3_050_STREAM_MAX	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	1.01E-02	5.14E-04	9.04E-05	3.41E-05	2.03E-01	5.53E-05	5.14E-03	3.96E-02

[1]RQ = Risk Quotient = Estimated Dose/Toxicity Reference Value.
[2]USLE = Universal Soil Loss Equation, which predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors.

TABLE B-18

Potential Risks to Non-Target Terrestrial Plants from Surface Runoff

SURFACE RUNOFF - Modeled in GLEAMS - TYPICAL APPLICATION RATE										
GLEAMS ID	**Annual Precipitation (inches)**	**Application Area (acres)**	**Hydraulic Slope (ft/ft)**	**Surface Roughness**	**USLE[1] Soil Erodibility Factor (ton/ ac per EI)**	**Vegetation Type**	**Soil Type**	**Terrestrial Concentration (lb/acre)**	**Typical Species RQ[2]**	**Rare, Threatened, and Endangered Species RQ[2]**
G_BASE_SAND_005_TERR_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_005_TERR_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_005_TERR_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010_TERR_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_010_TERR_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Clay	6.56E-05	1.09E-05	6.56E-03
G_BASE_LOAM_010_TERR_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Loam	3.49E-07	5.81E-08	3.49E-05
G_BASE_SAND_025_TERR_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_025_TERR_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Clay	8.60E-04	1.43E-04	8.60E-02
G_BASE_LOAM_025_TERR_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Loam	1.04E-06	1.73E-07	1.04E-04
G_BASE_SAND_050_TERR_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_050_TERR_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay	4.97E-03	8.29E-04	4.97E-01
G_BASE_LOAM_050_TERR_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.57E-04	2.62E-05	1.57E-02
G_BASE_SAND_100_TERR_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Sand	6.37E-11	1.06E-11	6.37E-09
G_BASE_CLAY_100_TERR_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Clay	1.27E-02	2.12E-03	1.27E+00
G_BASE_LOAM_100_TERR_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Loam	2.09E-04	3.48E-05	2.09E-02
G_BASE_SAND_150_TERR_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_150_TERR_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Clay	1.43E-02	2.39E-03	1.43E+00
G_BASE_LOAM_150_TERR_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Loam	2.08E-04	3.46E-05	2.08E-02
G_BASE_SAND_200_TERR_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_200_TERR_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Clay	1.37E-02	2.29E-03	1.37E+00
G_BASE_LOAM_200_TERR_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.53E-04	2.55E-05	1.53E-02
G_BASE_SAND_250_TERR_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_250_TERR_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Clay	1.24E-02	2.06E-03	1.24E+00

TABLE B-18 (Cont.)

Potential Risks to Non-Target Terrestrial Plants From Surface Runoff

SURFACE RUNOFF - modeled in GLEAMS TYPICAL APPLICATION RATE										
GLEAMS ID	**Annual Precipitation (inches)**	**Application Area (acres)**	**Hydraulic Slope (ft/ft)**	**Surface Roughness**	**USLE[1] Soil Erodibility Factor (ton/ ac per EI)**	**Vegetation Type**	**Soil Type**	**Terrestrial Concentration (lb/acre)**	**Typical Species RQ[2]**	**Rare, Threatened, and Endangered Species RQ[2]**
G_BASE_LOAM_250_TERR_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Loam	1.05E-04	1.74E-05	1.05E-02
G_ARV1_050_TERR_TYP	50	1	0.05	0.015	0.401	Weeds (78)	Loam	1.54E-04	2.57E-05	1.54E-02
G_ARV2_050_TERR_TYP	50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.54E-04	2.57E-05	1.54E-02
G_ARV3_050_TERR_TYP	50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	1.54E-04	2.57E-05	1.54E-02
G_ERV1_050_TERR_TYP	50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.54E-04	2.57E-05	1.54E-02
G_ERV2_050_TERR_TYP	50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.55E-04	2.58E-05	1.55E-02
G_ERV3_050_TERR_TYP	50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.57E-04	2.61E-05	1.57E-02
G_RGV1_050_TERR_TYP	50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.55E-04	2.58E-05	1.55E-02
G_RGV2_050_TERR_TYP	50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.54E-04	2.57E-05	1.54E-02
G_RGV3_050_TERR_TYP	50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.54E-04	2.56E-05	1.54E-02
G_SLV1_050_TERR_TYP	50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.54E-04	2.56E-05	1.54E-02
G_SLV2_050_TERR_TYP	50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.54E-04	2.57E-05	1.54E-02
G_SLV3_050_TERR_TYP	50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.56E-04	2.60E-05	1.56E-02
G_STV1_050_TERR_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.75E-03	2.92E-04	1.75E-01
G_STV2_050_TERR_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.67E-03	2.78E-04	1.67E-01
G_STV3_050_TERR_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	4.28E-03	7.13E-04	4.28E-01
G_VGV1_050_TERR_TYP	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.55E-04	2.58E-05	1.55E-02
G_VGV2_050_TERR_TYP	50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.55E-04	2.58E-05	1.55E-02
G_VGV3_050_TERR_TYP	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	2.04E-04	3.39E-05	2.04E-02
MAXIMUM APPLICATION RATE										
G_BASE_SAND_005_TERR_max	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_005_TERR_max	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00

TABLE B-18 (Cont.)

Potential Risks to Non-Target Terrestrial Plants From Surface Runoff

SURFACE RUNOFF - Modeled in GLEAMS – MAXIMUM APPLICATION RATE										
GLEAMS ID	**Annual Precipitation (inches)**	**Application Area (acres)**	**Hydraulic Slope (ft/ft)**	**Surface Roughness**	**USLE[1] Soil Erodibility Factor (ton/ ac per EI)**	**Vegetation Type**	**Soil Type**	**Terrestrial Concentration (lb/acre)**	**Typical Species RQ[2]**	**Rare, Threatened, and Endangered Species RQ[2]**
G_BASE_LOAM_005_TERR_max	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010_TERR_max	10	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_010_TERR_max	10	10	0.05	0.015	0.401	Weeds (78)	Clay	5.25E-04	8.75E-05	5.25E-02
G_BASE_LOAM_010_TERR_max	10	10	0.05	0.015	0.401	Weeds (78)	Loam	2.79E-06	4.65E-07	2.79E-04
G_BASE_SAND_025_TERR_max	25	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_025_TERR_max	25	10	0.05	0.015	0.401	Weeds (78)	Clay	6.88E-03	1.15E-03	6.88E-01
G_BASE_LOAM_025_TERR_max	25	10	0.05	0.015	0.401	Weeds (78)	Loam	8.33E-06	1.39E-06	8.33E-04
G_BASE_SAND_050_TERR_max	50	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_050_TERR_max	50	10	0.05	0.015	0.401	Weeds (78)	Clay	3.98E-02	6.63E-03	3.98E+00
G_BASE_LOAM_050_TERR_max	50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.26E-03	2.10E-04	1.26E-01
G_BASE_SAND_100_TERR_max	100	10	0.05	0.015	0.401	Weeds (78)	Sand	5.10E-10	8.50E-11	5.10E-08
G_BASE_CLAY_100_TERR_max	100	10	0.05	0.015	0.401	Weeds (78)	Clay	1.02E-01	1.69E-02	1.02E+01
G_BASE_LOAM_100_TERR_max	100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.67E-03	2.79E-04	1.67E-01
G_BASE_SAND_150_TERR_max	150	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_150_TERR_max	150	10	0.05	0.015	0.401	Weeds (78)	Clay	1.15E-01	1.91E-02	1.15E+01
G_BASE_LOAM_150_TERR_max	150	10	0.05	0.015	0.401	Weeds (78)	Loam	1.66E-03	2.77E-04	1.66E-01
G_BASE_SAND_200_TERR_max	200	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_200_TERR_max	200	10	0.05	0.015	0.401	Weeds (78)	Clay	1.10E-01	1.83E-02	1.10E+01
G_BASE_LOAM_200_TERR_max	200	10	0.05	0.015	0.401	Weeds (78)	Loam	1.23E-03	2.04E-04	1.23E-01
G_BASE_SAND_250_TERR_max	250	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_250_TERR_max	250	10	0.05	0.015	0.401	Weeds (78)	Clay	9.89E-02	1.65E-02	9.89E+00
G_BASE_LOAM_250_TERR_max	250	10	0.05	0.015	0.401	Weeds (78)	Loam	8.37E-04	1.40E-04	8.37E-02
G_ARV1_050_TERR_max	50	1	0.05	0.015	0.401	Weeds (78)	Loam	1.24E-03	2.06E-04	1.24E-01

TABLE B-18 (Cont.)

Potential Risks to Non-Target Terrestrial Plants from Surface Runoff

SURFACE RUNOFF - Modeled in GLEAMS - MAXIMUM APPLICATION RATE										
GLEAMS ID	**Annual Precipitation (inches)**	**Application Area (acres)**	**Hydraulic Slope (ft/ft)**	**Surface Roughness**	**USLE[1] Soil Erodibility Factor (ton/ac per EI)**	**Vegetation Type**	**Soil Type**	**Terrestrial Concentration (lb/acre)**	**Typical Species RQ[2]**	**Rare, Threatened, and Endangered Species RQ[2]**
G_ARV2_050_TERR_max	50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.24E-03	2.06E-04	1.24E-01
G_ARV3_050_TERR_max	50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	1.23E-03	2.06E-04	1.23E-01
G_ERV1_050_TERR_max	50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.23E-03	2.05E-04	1.23E-01
G_ERV2_050_TERR_max	50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.24E-03	2.06E-04	1.24E-01
G_ERV3_050_TERR_max	50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.25E-03	2.09E-04	1.25E-01
G_RGV1_050_TERR_max	50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.24E-03	2.06E-04	1.24E-01
G_RGV2_050_TERR_max	50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.24E-03	2.06E-04	1.24E-01
G_RGV3_050_TERR_max	50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.23E-03	2.05E-04	1.23E-01
G_SLV1_050_TERR_max	50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.23E-03	2.05E-04	1.23E-01
G_SLV2_050_TERR_max	50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.23E-03	2.05E-04	1.23E-01
G_SLV3_050_TERR_max	50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.25E-03	2.08E-04	1.25E-01
G_STV1_050_TERR_max	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.40E-02	2.33E-03	1.40E+00
G_STV2_050_TERR_max	50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.34E-02	2.23E-03	1.34E+00
G_STV3_050_TERR_max	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	3.42E-02	5.70E-03	3.42E+00
G_VGV1_050_TERR_max	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.24E-03	2.06E-04	1.24E-01
G_VGV2_050_TERR_max	50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.24E-03	2.06E-04	1.24E-01
G_VGV3_050_TERR_max	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	1.63E-03	2.71E-04	1.63E-01

[1]USLE = Universal Soil Loss Equation, which predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors.
[2]RQ = Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-19

Potential Risk to Predatory Bird From Long-term Consumption of Contaminated Fish from Pond (Pond Impacted by Surface Runoff Modeled in GLEAMS)

Parameters/ Assumptions	Value	Units
Body weight (BW)	5.15	kg
Food ingestion rate (dry weight [dw]) [1]	0.1018	kg dw/day
Food ingestion rate (wet weight [ww])(ir) [2]	0.4072	kg ww/day
Bioconcentration factor (BCF)	2.63	L/kg fish
Proportion of diet contaminated (PC)	1	unitless
Toxicity reference value (TRV) [3]	1,000	mg/kg-bw/day

TYPICAL APPLICATION RATE

GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE[4] Soil Erodibility Factor (ton/ac per EI)	Vegetation Type	Soil Type	Pond Concentration (C_{pond} mg/L)	Concentrations in fish (C_{Fish}): C_{pond} × BCF	Dose estimates (D): (C_{Fish} × ir × PC) / BW	Risk Quotient[5]
G_BASE_SAND_005_POND_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_005_POND_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_005_POND_TYP	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010_POND_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Sand	1.28E-01	3.36E-01	2.65E-02	2.65E-05
G_BASE_CLAY_010_POND_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Clay	3.54E-04	9.32E-04	7.37E-05	7.37E-08
G_BASE_LOAM_010_POND_TYP	10	10	0.05	0.015	0.401	Weeds (78)	Loam	2.06E-04	5.42E-04	4.29E-05	4.29E-08
G_BASE_SAND_025_POND_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Sand	4.08E-03	1.07E-02	8.48E-04	8.48E-07
G_BASE_CLAY_025_POND_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Clay	1.70E-02	4.48E-02	3.54E-03	3.54E-06

TABLE B-19 (Cont.)

Potential Risk to Predatory Bird From Long-Term Consumption of Contaminated Fish From Pond (Pond Impacted by Surface Runoff Modeled in GLEAMS)

TYPICAL APPLICATION RATE											
GLEAMS ID	**Annual Precipitation (inches)**	**Application Area (acres)**	**Hydraulic Slope (ft/ft)**	**Surface Roughness**	**USLE[4] Soil Erodibility Factor (ton/ac per EI)**	**Vegetation Type**	**Soil Type**	**Pond Concentration (C_{pond} mg/L)**	**Concentrations in fish (C_{Fish}): C_{pond} × BCF**	**Dose estimates (D): (C_{Fish} × ir × PC) / BW**	**Risk Quotient[5]**
G_BASE_LOAM_025_POND_TYP	25	10	0.05	0.015	0.401	Weeds (78)	Loam	3.41E-02	8.97E-02	7.09E-03	7.09E-06
G_BASE_SAND_050_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Sand	2.16E-02	5.69E-02	4.50E-03	4.50E-06
G_BASE_CLAY_050_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.73E-02	4.56E-02	3.60E-03	3.60E-06
G_BASE_LOAM_050_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Loam	1.10E-02	2.89E-02	2.29E-03	2.29E-06
G_BASE_SAND_100_POND_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Sand	4.08E-02	1.07E-01	8.47E-03	8.47E-06
G_BASE_CLAY_100_POND_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Clay	9.52E-03	2.50E-02	1.98E-03	1.98E-06
G_BASE_LOAM_100_POND_TYP	100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.66E-03	4.36E-03	3.44E-04	3.44E-07
G_BASE_SAND_150_POND_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Sand	3.08E-02	8.11E-02	6.41E-03	6.41E-06
G_BASE_CLAY_150_POND_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Clay	7.25E-03	1.91E-02	1.51E-03	1.51E-06
G_BASE_LOAM_150_POND_TYP	150	10	0.05	0.015	0.401	Weeds (78)	Loam	4.36E-03	1.15E-02	9.06E-04	9.06E-07
G_BASE_SAND_200_POND_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Sand	1.95E-02	5.13E-02	4.06E-03	4.06E-06
G_BASE_CLAY_200_POND_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Clay	6.17E-03	1.62E-02	1.28E-03	1.28E-06
G_BASE_LOAM_200_POND_TYP	200	10	0.05	0.015	0.401	Weeds (78)	Loam	6.57E-03	1.73E-02	1.37E-03	1.37E-06
G_BASE_SAND_250_POND_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Sand	1.20E-02	3.17E-02	2.50E-03	2.50E-06
G_BASE_CLAY_250_POND_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Clay	5.50E-03	1.45E-02	1.14E-03	1.14E-06
G_BASE_LOAM_250_POND_TYP	250	10	0.05	0.015	0.401	Weeds (78)	Loam	7.92E-03	2.08E-02	1.65E-03	1.65E-06

TABLE B-19 (Cont.)

Potential Risk to Predatory Bird From Long-Term Consumption of Contaminated Fish From Pond (Pond Impacted by Surface Runoff Modeled in GLEAMS)

TYPICAL APPLICATION RATE											
GLEAMS ID	**Annual Precipitation (inches)**	**Application Area (acres)**	**Hydraulic Slope (ft/ft)**	**Surface Roughness**	**USLE[4] Soil Erodibility Factor (ton/ ac per EI)**	**Vegetation Type**	**Soil Type**	**Pond Concentration (C_{pond} mg/L)**	**Concentrations in fish (C_{Fish}): C_{pond} × BCF**	**Dose estimates (D): (C_{Fish} × ir × PC) / BW**	**Risk Quotient[5]**
G_ARV1_050_POND_TYP	50	1	0.05	0.015	0.401	Weeds (78)	Loam	1.05E-02	2.76E-02	2.18E-03	2.18E-06
G_ARV2_050_POND_TYP	50	100	0.05	0.015	0.401	Weeds (78)	Loam	1.12E-02	2.96E-02	2.34E-03	2.34E-06
G_ARV3_050_POND_TYP	50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	1.13E-02	2.97E-02	2.35E-03	2.35E-06
G_ERV1_050_POND_TYP	50	10	0.05	0.015	0.05	Weeds (78)	Loam	1.10E-02	2.89E-02	2.29E-03	2.29E-06
G_ERV2_050_POND_TYP	50	10	0.05	0.015	0.2	Weeds (78)	Loam	1.10E-02	2.89E-02	2.29E-03	2.29E-06
G_ERV3_050_POND_TYP	50	10	0.05	0.015	0.5	Weeds (78)	Loam	1.10E-02	2.89E-02	2.29E-03	2.29E-06
G_RGV1_050_POND_TYP	50	10	0.05	0.023	0.401	Weeds (78)	Loam	1.10E-02	2.89E-02	2.29E-03	2.29E-06
G_RGV2_050_POND_TYP	50	10	0.05	0.046	0.401	Weeds (78)	Loam	1.10E-02	2.89E-02	2.29E-03	2.29E-06
G_RGV3_050_POND_TYP	50	10	0.05	0.15	0.401	Weeds (78)	Loam	1.10E-02	2.89E-02	2.29E-03	2.29E-06
G_SLV1_050_POND_TYP	50	10	0.005	0.015	0.401	Weeds (78)	Loam	1.10E-02	2.89E-02	2.29E-03	2.29E-06
G_SLV2_050_POND_TYP	50	10	0.01	0.015	0.401	Weeds (78)	Loam	1.10E-02	2.89E-02	2.29E-03	2.29E-06
G_SLV3_050_POND_TYP	50	10	0.1	0.015	0.401	Weeds (78)	Loam	1.10E-02	2.89E-02	2.29E-03	2.29E-06
G_STV1_050_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.82E-02	4.80E-02	3.79E-03	3.79E-06
G_STV2_050_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.61E-02	4.24E-02	3.35E-03	3.35E-06
G_STV3_050_POND_TYP	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	1.70E-02	4.48E-02	3.54E-03	3.54E-06
G_VGV1_050_POND_TYP	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	1.10E-02	2.89E-02	2.29E-03	2.29E-06

TABLE B-19 (Cont.)

Potential Risk to Predatory Bird from Long-term Consumption of Contaminated Fish from Pond (Pond Impacted by Surface Runoff Modeled in GLEAMS)

GLEAMS ID	Annual Precipitation (inches)	Application Area (acres)	Hydraulic Slope (ft/ft)	Surface Roughness	USLE[4] Soil Erodibility Factor (ton/ ac per EI)	Vegetation Type	Soil Type	Pond Concentration (C_{pond} mg/L)	Concentrations in fish (C_{Fish}): C_{pond} × BCF	Dose estimates (D): (C_{Fish} × ir × PC) / BW	Risk Quotient[5]
TYPICAL APPLICATION RATE											
G_VGV2_050_POND_TYP	50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	1.10E-02	2.89E-02	2.29E-03	2.29E-06
G_VGV3_050_POND_TYP	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	6.20E-03	1.63E-02	1.29E-03	1.29E-06
MAXIMUM APPLICATION RATE											
G_BASE_SAND_005_POND_max	5	10	0.05	0.015	0.401	Weeds (78)	Sand	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_CLAY_005_POND_max	5	10	0.05	0.015	0.401	Weeds (78)	Clay	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_LOAM_005_POND_max	5	10	0.05	0.015	0.401	Weeds (78)	Loam	0.00E+00	0.00E+00	0.00E+00	0.00E+00
G_BASE_SAND_010_POND_max	10	10	0.05	0.015	0.401	Weeds (78)	Sand	1.02E+00	2.69E+00	2.12E-01	2.12E-04
G_BASE_CLAY_010_POND_max	10	10	0.05	0.015	0.401	Weeds (78)	Clay	2.83E-03	7.45E-03	5.89E-04	5.89E-07
G_BASE_LOAM_010_POND_max	10	10	0.05	0.015	0.401	Weeds (78)	Loam	1.65E-03	4.34E-03	3.43E-04	3.43E-07
G_BASE_SAND_025_POND_max	25	10	0.05	0.015	0.401	Weeds (78)	Sand	3.26E-02	8.59E-02	6.79E-03	6.79E-06
G_BASE_CLAY_025_POND_max	25	10	0.05	0.015	0.401	Weeds (78)	Clay	1.36E-01	3.58E-01	2.83E-02	2.83E-05
G_BASE_LOAM_025_POND_max	25	10	0.05	0.015	0.401	Weeds (78)	Loam	2.73E-01	7.17E-01	5.67E-02	5.67E-05
G_BASE_SAND_050_POND_max	50	10	0.05	0.015	0.401	Weeds (78)	Sand	1.73E-01	4.55E-01	3.60E-02	3.60E-05
G_BASE_CLAY_050_POND_max	50	10	0.05	0.015	0.401	Weeds (78)	Clay	1.39E-01	3.65E-01	2.88E-02	2.88E-05
G_BASE_LOAM_050_POND_max	50	10	0.05	0.015	0.401	Weeds (78)	Loam	8.80E-02	2.31E-01	1.83E-02	1.83E-05
G_BASE_SAND_100_POND_max	100	10	0.05	0.015	0.401	Weeds (78)	Sand	3.26E-01	8.57E-01	6.78E-02	6.78E-05

TABLE B-19 (Cont.)

Potential Risk to Predatory Bird from Long-term Consumption of Contaminated Fish from Pond (Pond Impacted by Surface Runoff Modeled in GLEAMS)

MAXIMUM APPLICATION RATE											
GLEAMS ID	**Annual Precipitation (inches)**	**Application Area (acres)**	**Hydraulic Slope (ft/ft)**	**Surface Roughness**	**USLE[4] Soil Erodibility Factor (ton/ac per EI)**	**Vegetation Type**	**Soil Type**	**Pond Concentration (C_{pond} mg/L)**	**Concentrations in fish (C_{Fish}): C_{pond} × BCF**	**Dose estimates (D): (C_{Fish} × ir × PC) / BW**	**Risk Quotient[5]**
G_BASE_CLAY_100_POND_max	100	10	0.05	0.015	0.401	Weeds (78)	Clay	7.61E-02	2.00E-01	1.58E-02	1.58E-05
G_BASE_LOAM_100_POND_max	100	10	0.05	0.015	0.401	Weeds (78)	Loam	1.33E-02	3.49E-02	2.76E-03	2.76E-06
G_BASE_SAND_150_POND_max	150	10	0.05	0.015	0.401	Weeds (78)	Sand	2.47E-01	6.48E-01	5.13E-02	5.13E-05
G_BASE_CLAY_150_POND_max	150	10	0.05	0.015	0.401	Weeds (78)	Clay	5.80E-02	1.52E-01	1.21E-02	1.21E-05
G_BASE_LOAM_150_POND_max	150	10	0.05	0.015	0.401	Weeds (78)	Loam	3.49E-02	9.17E-02	7.25E-03	7.25E-06
G_BASE_SAND_200_POND_max	200	10	0.05	0.015	0.401	Weeds (78)	Sand	1.56E-01	4.11E-01	3.25E-02	3.25E-05
G_BASE_CLAY_200_POND_max	200	10	0.05	0.015	0.401	Weeds (78)	Clay	4.93E-02	1.30E-01	1.03E-02	1.03E-05
G_BASE_LOAM_200_POND_max	200	10	0.05	0.015	0.401	Weeds (78)	Loam	5.26E-02	1.38E-01	1.09E-02	1.09E-05
G_BASE_SAND_250_POND_max	250	10	0.05	0.015	0.401	Weeds (78)	Sand	9.63E-02	2.53E-01	2.00E-02	2.00E-05
G_BASE_CLAY_250_POND_max	250	10	0.05	0.015	0.401	Weeds (78)	Clay	4.40E-02	1.16E-01	9.14E-03	9.14E-06
G_BASE_LOAM_250_POND_max	250	10	0.05	0.015	0.401	Weeds (78)	Loam	6.34E-02	1.67E-01	1.32E-02	1.32E-05
G_ARV1_050_POND_max	50	1	0.05	0.015	0.401	Weeds (78)	Loam	8.40E-02	2.21E-01	1.75E-02	1.75E-05
G_ARV2_050_POND_max	50	100	0.05	0.015	0.401	Weeds (78)	Loam	8.99E-02	2.36E-01	1.87E-02	1.87E-05
G_ARV3_050_POND_max	50	1,000	0.05	0.015	0.401	Weeds (78)	Loam	9.03E-02	2.38E-01	1.88E-02	1.88E-05
G_ERV1_050_POND_max	50	10	0.05	0.015	0.05	Weeds (78)	Loam	8.79E-02	2.31E-01	1.83E-02	1.83E-05
G_ERV2_050_POND_max	50	10	0.05	0.015	0.2	Weeds (78)	Loam	8.80E-02	2.31E-01	1.83E-02	1.83E-05

TABLE B-19 (Cont.)

Potential Risk to Predatory Bird from Long-term Consumption of Contaminated Fish from Pond (Pond Impacted by Surface Runoff Modeled in GLEAMS)

MAXIMUM APPLICATION RATE											
GLEAMS ID	**Annual Precipitation (inches)**	**Application Area (acres)**	**Hydraulic Slope (ft/ft)**	**Surface Roughness**	**USLE[4] Soil Erodibility Factor (ton/ ac per EI)**	**Vegetation Type**	**Soil Type**	**Pond Concentration (C_{pond} mg/L)**	**Concentrations in fish (C_{Fish}): C_{pond} × BCF**	**Dose estimates (D): (C_{Fish} × ir × PC) / BW**	**Risk Quotient[5]**
G_ERV3_050_POND_max	50	10	0.05	0.015	0.5	Weeds (78)	Loam	8.80E-02	2.31E-01	1.83E-02	1.83E-05
G_RGV1_050_POND_max	50	10	0.05	0.023	0.401	Weeds (78)	Loam	8.80E-02	2.31E-01	1.83E-02	1.83E-05
G_RGV2_050_POND_max	50	10	0.05	0.046	0.401	Weeds (78)	Loam	8.79E-02	2.31E-01	1.83E-02	1.83E-05
G_RGV3_050_POND_max	50	10	0.05	0.15	0.401	Weeds (78)	Loam	8.79E-02	2.31E-01	1.83E-02	1.83E-05
G_SLV1_050_POND_max	50	10	0.005	0.015	0.401	Weeds (78)	Loam	8.79E-02	2.31E-01	1.83E-02	1.83E-05
G_SLV2_050_POND_max	50	10	0.01	0.015	0.401	Weeds (78)	Loam	8.79E-02	2.31E-01	1.83E-02	1.83E-05
G_SLV3_050_POND_max	50	10	0.1	0.015	0.401	Weeds (78)	Loam	8.80E-02	2.31E-01	1.83E-02	1.83E-05
G_STV1_050_POND_max	50	10	0.05	0.015	0.401	Weeds (78)	Silt Loam	1.46E-01	3.84E-01	3.03E-02	3.03E-05
G_STV2_050_POND_max	50	10	0.05	0.015	0.401	Weeds (78)	Silt	1.29E-01	3.39E-01	2.68E-02	2.68E-05
G_STV3_050_POND_max	50	10	0.05	0.015	0.401	Weeds (78)	Clay Loam	1.36E-01	3.59E-01	2.84E-02	2.84E-05
G_VGV1_050_POND_max	50	10	0.05	0.015	0.401	Shrubs (79)	Loam	8.80E-02	2.31E-01	1.83E-02	1.83E-05
G_VGV2_050_POND_max	50	10	0.05	0.015	0.401	Rye Grass (54)	Loam	8.80E-02	2.31E-01	1.83E-02	1.83E-05
G_VGV3_050_POND_max	50	10	0.05	0.015	0.401	Conifer + Hardwood (71)	Loam	4.96E-02	1.30E-01	1.03E-02	1.03E-05

[1]Calculated using algorithm developed by Nagy (1987) for all birds; where food ingestion rate (kg dw/day) = 0.0582×(BW)^0.651.
[2]Assumes fish are 75% water (USEPA 1993; Table 4-1 - value for bony fishes).
[3]Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.
[4]USLE = Universal Soil Loss Equation, which predicts soil loss as a function of soil erodibility, topography, rainfall/runoff, cover, and support management factors.
[5]Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-20

Potential Risks to Non-Target Terrestrial Plants from Herbicide in Dust Deposited From Wind Erosion

WIND EROSION - Modeled in CALPUFF – TYPICAL APPLICATION RATE							
				Typical Species		Rare, Threatened, and Endangered Species	
Cal Puff Scenario ID	Watershed Location	Distance from Receptor (km)	Terrestrial Concentration (lb/acre)	TRV[1]	RQ[2]	TRV[1]	RQ[2]
dust_MT_0.5_typ	MT	0.5	2.69E-06	0.03	8.96E-05	0.01	2.69E-04
dust_MT_5_typ	MT	5	1.52E-06	0.03	5.07E-05	0.01	1.52E-04
dust_MT_50_typ	MT	50	1.82E-10	0.03	6.08E-09	0.01	1.82E-08
dust_OR_0.5_typ	OR	0.5	1.54E-06	0.03	5.13E-05	0.01	1.54E-04
dust_OR_5_typ	OR	5	5.87E-07	0.03	1.96E-05	0.01	5.87E-05
dust_OR_50_typ	OR	50	2.07E-10	0.03	6.88E-09	0.01	2.07E-08
dust_WY_0.5_typ	WY	0.5	3.04E-07	0.03	1.01E-05	0.01	3.04E-05
dust_WY_5_typ	WY	5	2.10E-07	0.03	6.99E-06	0.01	2.10E-05
dust_WY_50_typ	WY	50	5.16E-11	0.03	1.72E-09	0.01	5.16E-09
MAXIMUM APPLICATION RATE							
dust_MT_0.5_max	MT	0.5	2.15E-05	0.03	7.17E-04	0.01	2.15E-03
dust_MT_5_max	MT	5	1.22E-05	0.03	4.06E-04	0.01	1.22E-03
dust_MT_50_max	MT	50	1.64E-09	0.03	5.48E-08	0.01	1.64E-07
dust_OR_0.5_max	OR	0.5	1.23E-05	0.03	4.10E-04	0.01	1.23E-03
dust_OR_5_max	OR	5	4.69E-06	0.03	1.56E-04	0.01	4.69E-04
dust_OR_50_max	OR	50	1.65E-09	0.03	5.51E-08	0.01	1.65E-07
dust_WY_0.5_max	WY	0.5	2.43E-06	0.03	8.11E-05	0.01	2.43E-04
dust_WY_5_max	WY	5	1.68E-06	0.03	5.59E-05	0.01	1.68E-04
dust_WY_50_max	WY	50	4.13E-10	0.03	1.38E-08	0.01	4.13E-08

[1] Toxicity Reference Value (TRV) - TRVs relate the dose of a compound with a potentially adverse effect. TRVs were selected during a review of the ecotoxicological literature.
[2] Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-21

Potential Risks to Aquatic Species from Accidental Spill to Pond (Acute Exposure)

Parameters/Assumptions		Value	Units
Volume of pond (Vp)		1,011,715	L
Volume of spill (Vspill)			
	Truck ($Vspill_t$)	757	L
Amount of spill			
	Mass of herbicide in helicopter	130	lb
Herbicide concentration in mixture (Cm)[1]			
	Truck mixture (Cm_t)	19,174.30	mg/L

Scenario	Concentrations in water (Cw): Cm × Vspill / Vp	Units	Risk Quotients[2]		
			Fish	Aquatic Invertebrates	Non-Target Aquatic Plants
Truck spill into pond	14.35	mg/L	0.1281	4.83E-02	2.87E+02
Helicopter spill into pond	58.28	mg/L	0.5204	1.96E-01	1.17E+03

[1] Based on herbicide mixed for the maximum application rate, where truck spray rate is 25 gallons per acre.
Cm = [application rate x (1/spray rate)] converted from lb/gallon to mg/L.
[2`] Risk Quotient = Estimated Dose/Toxicity Reference Value.

TABLE B-22

Potential Risks to Aquatic Species From Accidental Direct Spray of Pond and Stream (Acute Exposure)

Parameters/Assumptions	Rate	Value	Units
Pond			
Application rates (R)	Typical	0.5	lb/acre
	Maximum	4	lb/acre
Area of pond (Area)		0.25	acre
Volume of pond (Vol)		1,011,715	L
Mass sprayed on pond (R x Area)	Typical	56,699	mg
	Maximum	453,592	mg
Concentration in pond water (Mass/Volume)	Typical	0.0560	mg/L
	Maximum	0.4483	mg/L
Stream			
Width of stream		2	m
Length of stream impacted by direct spray		636.15	m
Area of stream impacted by spray (Area)		1,272.3	m2
Depth of stream		0.2	m
Instantaneous volume of stream impacted by direct spray (Vol)		254,460	L
Mass sprayed on stream (R x Area)	Typical	0.157	lb
	Maximum	1.258	lb
Mass sprayed on stream - converted to mg	Typical	71,303.530	mg
	Maximum	57,0428.239	mg
Concentration in stream water (Mass/Vol)	Typical	0.2802	mg/L
	Maximum	2.2417	mg/L

Scenario	Application Rate	Concentration in water (mg/L)	Fish	Risk Quotients[1]	
				Aquatic Invertebrates	Non-Target Aquatic Plants
Acute					
Direct spray to pond	Typical application	5.60E-02	5.00E-04	1.89E-04	1.12E+00
	Maximum application	4.48E-01	4.00E-03	1.51E-03	8.97E+00
Direct spray to stream	Typical application	2.80E-01	2.50E-03	9.43E-04	5.60E+00
	Maximum application	2.24E+00	2.00E-02	7.55E-03	4.48E+01
Chronic					
Direct spray to pond	Typical application	5.60E-02	6.03E-03	5.60E-01	4.31E+00
	Maximum application	4.48E-01	4.82E-02	4.48E+00	3.45E+01
Direct spray to stream	Typical application	2.80E-01	3.01E-02	2.80E+00	2.16E+01
	Maximum application	2.24E+00	2.41E-01	2.24E+01	1.72E+02

[1] Risk Quotient = Estimated Dose/Toxicity Reference Value.

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APPENDIX C

List of Rare, Threatened, and Endangered Species for 17 BLM States

TABLE C-2
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																	
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Amphibians																				
Ambystoma californiense	salamander, California tiger	I[(1)]; V[(2)]			E[(a)]															
Ambystoma tigrinum stebbinsi	salamander, Sonora tiger	I/Inv[(1)]; C/R[(2)]		E																
Batrachoseps aridus	salamander, desert slender	Inv			E															
Bufo baxteri	toad, Wyoming	I																		E
Bufo californicus	toad, arroyo (=arroyo southwestern)	H[(1)]; Inv[(2)]			E															
Rana aurora draytonii	frog, California red-legged	H[(1)]; Inv[(2)]			T[(b)]															
Rana chiricahuensis	frog, Chiricahua leopard	H[(1)]; Inv[(2)]		T							T									
Birds																				
Brachyramphus marmoratus marmoratus	murrelet, marbled	Ps			T									T				T		
Charadrius alexandrinus nivosus	plover, western snowy	G		T	T	T			T	T	T		T	T		T	T	T		
Charadrius melodus	plover, piping	H																		
Empidonax traillii extimus	flycatcher, southwestern willow	I		E	E	E				E	E					E	E			
Falco femoralis septentrionalis	falcon, northern aplomado	C														E				
Glaucidium brasilianum cactorum	pygmy-owl, cactus ferruginous	C		E																
Grus americana	crane, whooping	O [Ps,H]				E[(c)],XN	E[(c)],XN	E[(c)]	E[(c)]		E[(c)],XN	E[(c)]	E[(c)]		E[(c)]	E[(c)]	E[(c)],XN		E[(c)],XN[(d)]	
Gymnogyps californianus	condor, California	C		XN	E												XN			
Haliaeetus leucocephalus	eagle, bald	Ps		T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
Pelecanus occidentalis	pelican, brown	P			E									E		E		E		
Pipilo crissalis eremophilus	towhee, Inyo California	O [G, I]			T															
Polioptila californica californica	gnatcatcher, coastal California	I			T															
Polysticta stelleri	eider, Steller's	I	T[(e)]																	
Rallus longirostris yumanensis	rail, Yuma clapper	C		E	E															
Somateria fischeri	eider, spectacled	O [H, Inv]	T																	

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Sterna antillarum	tern, least	Ps				E[f]		E[f]	E[f]		E[f]	E[f]	E[f]		E[f]	E[f]			
Strix occidentalis caurina	owl, northern spotted	C			T									T				T	
Strix occidentalis lucida	owl, Mexican spotted	C		T		T					T					T	T		
Vireo bellii pusillus	vireo, least Bell's	I			E														
Crustaceans																			
Branchinecta conservatio	fairy shrimp, Conservancy				E														
Branchinecta longiantenna	fairy shrimp, longhorn				E														
Branchinecta lynchi	fairy shrimp, vernal pool				T									T					
Gammarus desperatus	amphipod, Noel's										PE[g]								
Lepidurus packardi	tadpole shrimp, vernal pool				E														
Thermosphaeroma thermophilus	isopod, Socorro										E								
Fish																			
Acipenser transmontanus	sturgeon, white						E[i]	E[i]											
Catostomus microps	sucker, Modoc				E														
Catostomus warnerensis	sucker, Warner													T					
Chasmistes brevirostris	sucker, shortnose				E									E					
Chasmistes cujus	cui-ui									E									
Chasmistes liorus	sucker, June																E		
Crenichthys baileyi baileyi	springfish, White River									E									
Crenichthys baileyi grandis	springfish, Hiko White River									E									
Crenichthys nevadae	springfish, Railroad Valley									T									
Cyprinella formosa	shiner, beautiful			T							T								
Cyprinodon diabolis	pupfish, Devils Hole									E									
Cyprinodon macularius	pupfish, desert			E	E														
Cyprinodon nevadensis mionectes	pupfish, Ash Meadows Amargosa									E									
Cyprinodon nevadensis pectoralis	pupfish, Warm Springs									E									
Cyprinodon radiosus	pupfish, Owens				E														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Deltistes luxatus	sucker, Lost River				E									E					
Empetrichthys latos	poolfish, Pahrump									E									
Eremichthys acros	dace, desert									T									
Gambusia nobilis	gambusia, Pecos										E					E			
Gasterosteus aculeatus williamsoni	stickleback, unarmored threespine				E														
Gila bicolor mohavensis	chub, Mohave tui				E														
Gila bicolor snyderi	chub, Owens tui				E														
Gila bicolor ssp.	chub, Hutton tui													T[(j)]					
Gila bicolor vaccaceps	chub, Cowhead Lake tui				PE[(k)]														
Gila boraxobius	chub, Borax Lake													E					
Gila cypha	chub, humpback			E		E											E		
Gila ditaenia	chub, Sonora			T															
Gila elegans	chub, bonytail			E	E	E				E							E		
Gila intermedia	chub, Gila			PE[(l)]							PE[(l)]								
Gila purpurea	chub, Yaqui			E															
Gila robusta jordani	chub, Pahranagat roundtail									E									
Gila seminuda	chub, Virgin River			E						E							E		
Hybognathus amarus	minnow, Rio Grande silvery										E					E			
Ictalurus pricei	catfish, Yaqui			T															
Lepidomeda albivallis	spinedace, White River									E									
Lepidomeda mollispinis pratensis	spinedace, Big Spring									T									
Lepidomeda vittata	spinedace, Little Colorado			T															
Meda fulgida	spikedace			T							T								
Moapa coriacea	dace, Moapa									E									
Notropis girardi	shiner, Arkansas River										T[(m)]		T[(m)]			T[(m)]			
Notropis simus pecosensis	shiner, Pecos bluntnose										T								
Oncorhynchus keta	salmon, chum													T[(n)]				T[(n,o)]	
Oncorhynchus kisutch	salmon, coho				T[(p)]									T					

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Oncorhynchus mykiss	steelhead				E[(q)],T[(p,r,s,t)]		T[(u)]							T[(u,v,w,x)]				E[(y)],T[(w,x)]	
Oncorhynchus nerka	salmon, sockeye						E[(z)]							E[(z)]				E[(z)],T[(aa)]	
Oncorhynchus tshawytscha	salmon, chinook				E[(ab)],T[(ac,ad)]		T[(ae)]							T[(v,x)]				E[(af)],T[(v,ae,ag)]	
Oncorhynchus clarki henshawi	trout, Lahontan cutthroat				T					T				T			T		
Oncorhynchus clarki stomias	trout, greenback cutthroat					T													
Oncorhynchus gilae	trout, Gila			E							E								
Oregonichthys crameri	chub, Oregon													E					
Plagopterus argentissimus	woundfin			E[(ah)], XN						E[(ah)]	E[(ah)], XN						E[(ah)]		
Poeciliopsis occidentalis occidentalis	topminnow, Gila (incl. Yaqui)			E							E								
Poeciliopsis occidentalis sonoriensis	topminnow, Gila (incl. Yaqui)			E															
Ptychocheilus lucius	pikeminnow (=squawfish), Colorado			E[(ai)],XN	XN	XN											XN		XN
Rhinichthys osculus lethoporus	dace, Independence Valley speckled									E									
Rhinichthys osculus nevadensis	dace, Ash Meadows speckled									E									
Rhinichthys osculus oligoporus	dace, Clover Valley speckled									E									
Rhinichthys osculus ssp.	dace, Foskett speckled													T[(aj)]					
Rhinichthys osculus thermalis	dace, Kendall Warm Springs																		E
Salvelinus confluentus	trout, bull						T	T		T				T				T	
Scaphirhynchus albus	sturgeon, pallid							E	E			E			E				
Tiaroga cobitis	minnow, loach			T							T								
Xyrauchen texanus	sucker, razorback			E	E	E				E	E						E		E

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																	
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Insect																				
Ambrysus amargosus	naucorid, Ash Meadows									T									
Boloria acrocnema	butterfly, Uncompahgre fritillary					E													
Desmocerus californicus dimorphus	beetle, valley elderberry longhorn				T														
Euphydryas editha quino	butterfly, Quino checkerspot				E														
Euproserpinus euterpe	moth, Kern primrose sphinx				T														
Hesperia leonardus montana	skipper, Pawnee montane					T													
Icaricia icarioides fenderi	butterfly, Fender's blue													E					
Nicrophorus americanus	beetle, American burying								E				E		E				
Pseudocopaeodes eunus obscurus	skipper, Carson wandering				E					E									
Speyeria zerene hippolyta	butterfly, Oregon silverspot				T									T				T	
Mammals																			
Antilocapra americana sonoriensis	pronghorn, Sonoran	H		E															
Brachylagus idahoensis	rabbit, pygmy	H																$E^{(ak)}$	
Canis lupus	wolf, gray	C		$E^{(al)}$,$XN^{(am)}$	$T^{(an)}$	$E^{(al)}$,$T^{(an)}$	XN,$T^{(an)}$	XN,$T^{(an)}$	$T^{(ao)}$	$T^{(an)}$	$XN^{(am)}$	$T^{(ao)}$	$E^{(al)}$	$T^{(an)}$	$T^{(ao)}$	$XN^{(am)}$	$E^{(al)}$,$T^{(an)}$	$T^{(an)}$	XN,$T^{(an)}$
Cynomys parvidens	prairie dog, Utah	H															T		
Dipodomys heermanni morroensis	kangaroo rat, Morro Bay	H			E														
Dipodomys ingens	kangaroo rat, giant	G			E														
Dipodomys nitratoides exilis	kangaroo rat, Fresno	H			E														
Dipodomys nitratoides nitratoides	kangaroo rat, Tipton	G			E														
Dipodomys stephensi	kangaroo rat, Stephens'	G			E														
Enhydra lutris nereis	otter, southern sea	C			XN,$T^{©}$														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Eumetopias jubatus	sea-lion, Steller	C	E(ap),T(aq)		T(aq)									T(aq)				T(aq)	
Herpailurus (=Felis) yaguarundi tolteca	jaguarundi, Sinaloan	C		E															
Leopardus (=Felis) pardalis	ocelot	C		E												E			
Leptonycteris curasoae yerbabuenae	bat, lesser long-nosed	N, F		E							E								
Leptonycteris nivalis	bat, Mexican long-nosed	H									E					E			
Lynx canadensis	lynx, Canada	C				T	T	T										T	T
Microtus californicus scirpensis	vole, Amargosa	H			E														
Microtus mexicanus hualpaiensis	vole, Hualapai Mexican	H		E															
Mustela nigripes	ferret, black-footed	C		XN,E(c)		XN,E(c)		XN,E(c)							XN,E(c)		XN,E(c)		XN,E(c)
Neotoma fuscipes riparia	woodrat, riparian (=San Joaquin Valley)	H			E														
Odocoileus virginianus leucurus	deer, Columbian white-tailed	H												E(ak)				E(ak)	
Ovis canadensis	sheep, bighorn	H			E(ar)														
Ovis canadensis californiana	sheep, bighorn	Gm			E(as)														
Panthera onca	jaguar	C		E							E					E			
Rangifer tarandus caribou	caribou, woodland	H					E											E	
Spermophilus brunneus brunneus	squirrel, northern Idaho ground	H					T												
Ursus arctos horribilis	bear, grizzly	O [H, I, Ps]					T(at)	T(at)										T(ag)	T(ag)
Vulpes macrotis mutica	fox, San Joaquin kit	C			E														
Zapus hudsonius preblei	mouse, Preble's meadow jumping	O [Inv, H]				T													T
Molluscs																			
Assiminea pecos	snail, Pecos assiminea										PE(g)					PE(g)			
Fontelicella idahoensis	springsnail, Idaho						E												
Helminthoglypta walkeriana	snail, Morro shoulderband (=Banded dune)				E														
Lanx sp.	limpet, Banbury Springs						E												

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	General Diet of Vertebrates	State Listed																
			AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Oxyloma haydeni kanabensis	ambersnail, Kanab			E													E		
Physa natricina	snail, Snake River physa						E												
Pyrgulopsis bruneauensis	springsnail, Bruneau Hot						E												
Pyrgulopsis neomexicana	springsnail, Socorro										E								
Pyrgulopsis roswellensis	springsnail, Roswell										PE[g]								
Taylorconcha serpenticola	snail, Bliss Rapids						T												
Tryonia alamosae	springsnail, Alamosa										E								
Tryonia kosteri	snail, Koster's tryonia										PE[g]								
Valvata utahensis	snail, Utah valvata						E										E		
Reptiles																			
Crotalus willardi obscurus	rattlesnake, New Mexican ridge-nosed	C									T								
Gambelia silus	lizard, blunt-nosed leopard	I			E														
Gopherus agassizii	tortoise, desert	H		T(SA)[au], T[av]	T(SA)[au], T[av]					T(SA)[au], T[av]							T(SA)[au], T[av]		
Thamnophis gigas	snake, giant garter	Ps			T														
Uma inornata	lizard, Coachella Valley fringe-toed	O [H, I]			T														

General Diet

[1]For amphibians, refers to juvenille stage only
[2]For amphibians, refers to adult stage only
C = Carnivore; meat-eating
F = Frugivore; fruit-eating
G = Granivore; seed-eating
Gm = Gramnivore; grass-eating
H = Herbivore; plant-eating
I = Insectivore; insect-eating
Inv = Invertevore; invertebrate-eating
N = Nectivore; nectar-eating
O = Omnivore; generalist

(a) Santa Barbara and Sonoma Counties
(b) subspecies range clarified
(c) except where XN
(d) western half
(e) breeding population
(at) except where listed as experimental population
(f) interior population
(g) proposed for listing February 12, 2002
(i) proposed for listing but resolved March 17, 2000
(j) Hutton
(k) proposed for listing March 30, 1998
(l) proposed for listing August 9, 2002

(v) lower Columbia River
(w) middle Columbia River
(x) upper Willamette River
(y) upper Columbia River Basin
(z) Snake River, ID stock wherever found
(aa) Ozette Lake
(ab) winter Sacramento River
(ac) Central Valley spring run
(ad) coastal
(ae) fall and spring/summer Snake River
(af) spring upper Columbia River

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Ps = Piscivore; fish-eating	(m) Arkansas River Basin	(ag) Puget Sound
R = Ranivore; frog-eating	(n) Columbia River	(ah) except Gila River drainage
V = Vermivore; earthworm-eating	(o) summer-run Hood Canal	(ai) except Salt and Verde River
drainages		
Status	(p) central coast	(aj) Foskett
T = Threatened	(q) southern coast	(ak) Columbia Basin DPS
E = Endangered	(r) Central Valley	(al) Southwestern Distinct
Population Segment		
XN = Experimental population	(s) south central coast	(am) Mexican gray wolf,
P = Proposed		experimental population
T(SA) = Similarity in appearance to a threatened taxon	(t) northern Segment	(an) Western Distinct Population
(u) Snake River Basin (ao) Eastern Distinct Population		

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Taxanomic Name	Common Name	State Listed																
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Acanthomintha ilicifolia	thornmint, San Diego			T														
Agave arizonica	agave, Arizona		E															
Allium munzii	onion, Munz's			E														
Ambrosia pumila	ambrosia, San Diego			E														
Amsonia kearneyana	blue-star, Kearney's		E															
Arabis mcdonaldiana	rock-cress, McDonald's			E									E					
Arctomecon humilis	bear-poppy, dwarf															E		
Arctostaphylos morroensis	manzanita, Morro			T														
Arctostaphylos myrtifolia	manzanita, Ione			T														
Arenaria paludicola	sandwort, Marsh			E									E				E	
Argemone pleiacantha ssp. pinnatisecta	poppy, Sacramento prickly									E								
Asclepias welshii	milkweed, Welsh's		T													T		
Astragalus albens	milk-vetch, Cushenbury			E														
Astragalus ampullarioides	milk-vetch, Shivwitz															E		
Astragalus applegatei	milk-vetch, Applegate's												E					
Astragalus brauntonii	milk-vetch, Braunton's			E														
Astragalus desereticus	milk-vetch, Deseret															T		
Astragalus holmgreniorum	milk-vetch, Holmgren		E													E		
Astragalus humillimus	milk-vetch, Mancos				E					E								
Astragalus jaegerianus	milk-vetch, Lane Mountain			E														
Astragalus lentiginosus var. coachellae	milk-vetch, Coachella Valley			E														
Astragalus lentiginosus var. piscinensis	milk-vetch, Fish Slough			T														
Astragalus magdalenae var. peirsonii	milk-vetch, Peirson's			T														
Astragalus montii	milk-vetch, heliotrope															T		
Astragalus osterhoutii	milk-vetch, Osterhout				E													
Astragalus phoenix	milk-vetch, Ash meadows								T									
Astragalus tricarinatus	milk-vetch, triple-ribbed			E														
Atriplex coronata var. notatior	crownscale, San Jacinto Valley			E														
Baccharis vanessae	baccharis, Encinitas			T														
Berberis nevinii	barberry, Nevin's			E														
Brodiaea filifolia	brodiaea, thread-leaved			T														
Calystegia stebbinsii	morning-glory, Stebbins'			E														
Camissonia benitensis	evening-primrose, San Benito			T														
Carex specuicola	sedge, Navajo		T													T		
Castilleja campestris ssp. succulenta	owl's-clover, fleshy			T														
Castilleja levisecta	paintbrush, golden												T				T	

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Caulanthus californicus	jewelflower, California			E														
Ceanothus roderickii	ceanothus, Pine Hill			E														
Centaurium namophilum	centaury, spring-loving			T					T									
Chamaesyce hooveri	spurge, Hoover's			T														
Chlorogalum purpureum	amole, purple			T														
Chorizanthe howellii	spineflower, Howell's			E														
Chorizanthe orcuttiana	spineflower, Orcutt's			E														
Chorizanthe pungens var. pungens	spineflower, Monterey			T														
Cirsium fontinale var. obispoense	thistle, Chorro Creek bog			E														
Cirsium loncholepis	thistle, La Graciosa			E														
Clarkia springvillensis	clarkia, Springville			T														
Coryphantha robbinsorum	cactus, Cochise pincushion		T															
Coryphantha scheeri var. robustispina	cactus, Pima pineapple		E															
Coryphantha sneedii var. leei	cactus, Lee pincushion									T								
Coryphantha sneedii var. sneedii	cactus, Sneed pincushion									E					E			
Cycladenia jonesii (=humilis)	Cycladenia, Jones		T													T		
Deinandra (=Hemizonia) conjugens	tarplant, Otay			T														
Dodecahema leptoceras	spineflower, slender-horned			E														
Dudleya cymosa ssp. marcescens	dudleya, marcescent			T														
Echinocactus horizonthalonius var. nicholii	cactus, Nichol's Turk's head		E															
Echinocereus fendleri var. kuenzleri	cactus, Kuenzler hedgehog									E								
Echinocereus triglochidiatus var. arizonicus	cactus, Arizona hedgehog		E															
Enceliopsis nudicaulis var. corrugata	sunray, Ash Meadows								T									
Eremalche kernensis	mallow, Kern			E														
Eriastrum densifolium ssp. sanctorum	woolly-star, Santa Ana River			E														
Erigeron decumbens var. decumbens	daisy, Willamette												E					
Erigeron maguirei	daisy, Maguire															T		
Erigeron parishii	daisy, Parish's			T														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Erigeron rhizomatus	fleabane, Zuni		T							T								
Eriodictyon altissimum	mountain balm, Indian Knob			E														
Eriodictyon capitatum	yerba santa, Lompoc			E														
Eriogonum apricum (incl. var. prostratum)	buckwheat, Ione (incl. Irish Hill)			E														
Eriogonum gypsophilum	wild-buckwheat, gypsum									T								
Eriogonum ovalifolium var. vineum	buckwheat, cushenbury			E														
Eriogonum ovalifolium var. williamsiae	buckwheat, steamboat								E									
Eriogonum pelinophilum	wild-buckwheat, clay-loving				E													
Erysimum menziesii	wallflower, Menzies'			E														
Eutrema penlandii	mustard, Penland alpine fen				T													
Fremontodendron californicum ssp. decumbens	flannelbush, Pine Hill			E														
Fremontodendron mexicanum	flannelbush, Mexican			E														
Fritillaria gentneri	Fritillary, Gentner's												E					
Galium californicum ssp. sierrae	bedstraw, El Dorado			E														
Gaura neomexicana var. coloradensis	Butterfly plant, Colorado				T			T										T
Gilia tenuiflora ssp. arenaria	gilia, Monterey			E														
Grindelia fraxino-pratensis	gumplant, Ash Meadows			T					T									
Hackelia venusta	stickseed, showy																E	
Hedeoma todsenii	pennyroyal, Todsen's									E								
Helianthus paradoxus	sunflower, Pecos (=puzzle, =paradox)									T					T			
Howellia aquatilis	howellia, water			T		T	T						T				T	
Ipomopsis sancti-spiritus	ipomopsis, Holy Ghost									E								
Ivesia kingii var. eremica	ivesia, Ash Meadows								T									
Lasthenia conjugens	goldfields, Contra Costa			E														
Layia carnosa	layia, beach			E														
Lepidium barnebyanum	ridge-cress, Barneby															E		
Lesquerella congesta	bladderpod, Dudley Bluffs				T													
Lesquerella tumulosa	bladderpod, kodachrome															E		
Lilaeopsis schaffneriana var. recurva	water-umbel, Huachuca		E															
Lilium occidentale	lily, Western			E									E					

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Limnanthes floccosa grandiflora	Meadowfoam, large-flowered wooly												E					
Limnanthes floccosa ssp. californica	meadowfoam, Butte County			E														
Lomatium bradshawii	desert-parsley, Bradshaw's												E				E	
Lomatium cookii	lomatium, Cook's												E					
Lupinus sulphureus (=oreganus) ssp. kincaidii (=var. kincaidii)	Lupine, Kincaid's												T				T	
Mentzelia leucophylla	blazingstar, Ash Meadows								T									
Mirabilis macfarlanei	four-o'clock, MacFarlane's					T							T					
Monolopia (=Lembertia) congdonii	wooly-threads, San Joaquin			E														
Nitrophila mohavensis	niterwort, Amargosa			E					E									
Opuntia treleasei	cactus, Bakersfield			E														
Orcuttia californica	Orcutt grass, California			E														
Orcuttia inaequalis	Orcutt grass, San Joaquin			T														
Orcuttia pilosa	Orcutt grass, hairy			E														
Orcuttia tenuis	Orcutt grass, slender			T														
Oxytheca parishii var. goodmaniana	oxytheca, cushenbury			E														
Pediocactus (=Echinocactus,=Utahia) sileri	cactus, Siler pincushion		T													T		
Pediocactus bradyi	cactus, Brady pincushion		E															
Pediocactus despainii	cactus, San Rafael															E		
Pediocactus knowltonii	cactus, Knowlton				E					E								
Pediocactus peeblesianus peeblesianus	cactus, Peebles Navajo		E															
Pediocactus winkleri	cactus, Winkler															T		
Penstemon haydenii	penstemon, blowout							E										E
Penstemon penlandii	beardtongue, Penland				E													
Phacelia argillacea	phacelia, clay															E		
Phacelia formosula	phacelia, North Park				E													
Phlox hirsuta	phlox, Yreka			E														
Physaria obcordata	twinpod, Dudley Bluffs				T													
Plagiobothrys hirtus	popcornflower, rough												E					
Platanthera praeclara	orchid, western prairie fringed							T			T	T						
Pogogyne nudiuscula	mesa-mint, Otay			E														
Primula maguirei	primrose, Maguire															T		
Pseudobahia bahiifolia	sunburst, Hartweg's golden			E														
Pseudobahia peirsonii	sunburst, San Joaquin adobe			T														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Purshia (=Cowania) subintegra	Cliff-rose, Arizona		E															
Ranunculus aestivalis (=acriformis)	Buttercup, autumn															E		
Schoenocrambe argillacea	reed-mustard, clay															T		
Schoenocrambe barnebyi	reed-mustard, Barneby															E		
Schoenocrambe suffrutescens	reed-mustard, shrubby															E		
Sclerocactus glaucus	Cactus, Uinta Basin hookless				T											T		
Sclerocactus mesae-verdae	cactus, Mesa Verde				T					T								
Sclerocactus wrightiae	cactus, Wright fishhook															E		
Senecio layneae	butterweed, Layne's			T														
Sidalcea keckii	Checker-mallow, Keck's			E														
Sidalcea nelsoniana	checker-mallow, Nelson's												T				T	
Sidalcea oregana var. calva	checkermallow, Wenatchee Mountains																E	
Silene spaldingii	Catchfly, Spalding's					T	T						T				T	
Spiranthes delitescens	ladies'-tresses, Canelo Hills		E															
Spiranthes diluvialis	ladies'-tresses, Ute				T	T	T	T								T	T	T
Spiranthes parksii	ladies'-tresses, Navasota														E			
Stephanomeria malheurensis	wire-lettuce, Malheur												E					
Streptanthus albidus ssp. albidus	jewelflower, Metcalf Canyon			E														
Streptanthus niger	jewelflower, Tiburon			E														
Styrax texanus	snowbells, Texas														E			
Suaeda californica	seablite, California			E														
Swallenia alexandrae	grass, Eureka Dune			E														
Taraxacum californicum	taraxacum, California			E														
Thelypodium howellii spectabilis	thelypody, Howell's spectacular												T					
Thelypodium stenopetalum	mustard, slender-petaled			E														
Thlaspi californicum	penny-cress, Kneeland Prairie			E														
Thymophylla tephroleuca	dogweed, ashy														E			
Thysanocarpus conchuliferus	fringepod, Santa Cruz Island			E														
Townsendia aprica	townsendia, Last Chance															T		
Trichostema austromontanum ssp. compactum	bluecurls, Hidden Lake			T														
Trifolium amoenum	clover, showy Indian			E														
Trifolium trichocalyx	clover, Monterey			E														
Tuctoria greenei	tuctoria, Greene's			E														
Tuctoria mucronata	grass, Solano			E														

TABLE C-2 (Cont.)
List of Rare, Threatened, and Endangered Plant Species Found on BLM Lands in 17 Western States

Taxanomic Name	Common Name	State Listed																
		AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	OK	OR	SD	TX	UT	WA	WY
Verbena californica	vervain, Red Hills			T														
Verbesina dissita	crownbeard, big-leaved			T														
Yermo xanthocephalus	yellowhead, desert																	T
Zizania texana	wild-rice, Texas														E			

Status
T = Threatened
E = Endangered

APPENDIX D

Review of Confidential Business Information Memo

MEMORANDUM

To:	Mark Gerath, ENSR	**Date:**	November 2, 2004
From:	Karl Ford, BLM		
RE:	Review of Confidential Business Information on Inert Ingredients Herbicides Proposed for Use on BLM Lands		

Pesticide products contain both "active" and "inert" ingredients. The terms "active ingredient" (a.i.) and "inert ingredient" have been defined by Federal law, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), since 1947. An a.i. is one that prevents, destroys, repels, or mitigates a pest, or is a plant regulator, defoliant, desiccant, or nitrogen stabilizer. By law, the a.i. must be identified by name on the label together with its percentage by weight. An inert ingredient is simply any ingredient in the product that is not intended to affect a target pest. For example, isopropyl alcohol may be an a.i. and antimicrobial pesticide in some products; however, in other products, it is used as a solvent and may be considered an inert ingredient. The law does not require inert ingredients to be identified by name and percentage on the label, but the total percentage of such ingredients must be declared.

In September 1997, the U.S. Environmental Protection Agency (USEPA) issued **Pesticide Regulation Notice 97-6** which encourages manufacturers, formulators, producers, and registrants of pesticide products to voluntarily substitute the term "other ingredients" as a heading for the "inert" ingredients in the ingredient statement. The USEPA made this change after learning the results of a consumer survey on the use of household pesticides. Many comments from the public and the consumer interviews prompted USEPA to discontinue the use of the term "inert." Many consumers are misled by the term "inert ingredient," believing it to mean "harmless." Since neither the federal law nor the regulations define the term "inert" on the basis of toxicity, hazard or risk to humans, non-target species, or the environment, it should not be assumed that all inert ingredients are non-toxic.

The Bureau of Land Management (BLM) scientists received clearance from USEPA to review Confidential Business Information (CBI) on inert compounds identified in products containing the following ten a.i.:

- Sulfometuron methyl
- Fluridone
- Dicamba (as an a.i. in the herbicide Overdrive)
- Diquat
- Diflufenzopyr
- Imazapic
- Diuron
- Bromacil
- Chlorsulfuron
- Tebuthiuron

The information received listed the inert ingredients, their chemical abstract number, supplier, USEPA registration number, percentage of the formulation, and purpose in the formulation. Because this information is confidential, this information, including the name of the ingredients may not be disclosed.

The USEPA has a listing of regulated inert ingredients at http://www.epa.gov/opprd001/inerts/index.html. This listing categorizes inert ingredients into four categories. The listing of categories and the number of inert ingredients found among the ingredients listed for the herbicides are shown below:

- Inert Ingredients of Toxicological Concern. None.
- Potentially Toxic Inert Ingredients. None.
- Inerts of Unknown Toxicity. 12.
- Inerts of Minimal Toxicity. Over 50.
- Nine inerts were not found on USEPA's lists.

Toxicity information was also searched via the following sources:

- TOMES (a proprietary toxicological database including USEPA's Integrated Risk Information System [IRIS], the Hazardous Substance Data Bank [HSDB], the Registry of Toxic Effects of Chemical Substances (RTECS)
- USEPA's ECOTOX database which includes AQUIRE
- TOXLINE, a literature searching tool
- Material Safety Data Sheets (MSDSs) from suppliers
- Other sources, such as the Farm Chemicals Handbook
- Other cited literature sources.

Relatively little toxicity information was found. A few acute studies on aquatic or terrestrial species were reported. Little chronic data, no cumulative effects data, and almost no indirect effects data (food chain species) were found.

A number of the List 4 compounds are naturally-occurring earthen materials (e.g., clay materials or simple salts) that would produce no toxicity at applied concentrations. However, some of the inerts, particularly the List 3 inert compounds and unlisted compounds, may have moderate to high potential toxicity to aquatic species based on MSDSs or published data.

As a tool to evaluate List 3 and unlisted inerts in the ecological risk assessment, the exposure concentration of the inert compound was calculated and compared to toxicity information. Toxicity information from the above sources was used in addition to the work of Dorn et al. (1997), Wong et al. (1997), Lewis (1991), and Muller (1980) concerning aquatic toxicity of surfactants. These sources generally suggested that acute toxicity to aquatic life for surfactants and anti-foam agents ranged from 1-10 mg/L, and that chronic toxicity ranged to as low as 0.1 mg/L.

Exposure concentrations were computed using Groundwater Loading Effects of Agricultural Management Systems (GLEAMS). Inert compounds incorporated into the herbicide mixture are generally considered to be very stable compounds and tend to be highly mobile in the environment, primarily because of their inability to react with other materials or compounds. However, while these inert compounds are very mobile and relatively inactive they can potentially be toxic to aquatic organisms. To quantify the potential toxicity of inert compounds to aquatic organisms, the concentration of an inert compound in a river or pond adjacent to an herbicide application area was predicted using the GLEAMS model. The GLEAMS model was set up to simulate the effects of a generalized inert

compound in the previously described "base-case" watershed with a sand soil type. The chemical characteristics of the generalized inert compound were set at extremely high/low environmental fate values to describe it as a very mobile and stable compound; the application rate of the inert compound was fixed at 1 pound (lb) a.i./acre. The watershed characteristics were that of a typical sand watershed with atmospheric conditions representative of Medford, Oregon. The annual precipitation rate used in the inert compound simulation was 50 in/year, distributed in the same fashion as during a representative precipitation year in Medford, Oregon. The simulation was run to quasi-steady state conditions and the daily-predicted inert compound export rates from a single steady-state year of the simulation were used to calculate the annual average (chronic) and annual maximum 3-day average river and pond inert compound concentrations. The following table indicates the predicted river and pond concentrations for the inert compound resulting from an application rate of 1 lb a.i./acre. The concentrations per 1 lb a.i./acre application rate for each of eight herbicides simulated by GLEAMS, using the same watershed type, atmospheric conditions, and precipitation rate, is also listed for comparison.

Ratio of Concentration to Herbicide Application Rate (mg/L per lb a.i./acre)				
Herbicide	Average Annual River	Maximum 3 Day Average River	Average Annual Pond	Maximum 3 Day Average Pond
Diflufenzopyr	5.39E-06	3.33E-04	8.38E-04	7.52E-03
Imazapic	3.64E-04	8.19E-03	2.64E-02	5.45E-02
Sulfometuron	1.87E-04	5.81E-03	1.19E-02	3.77E-02
Tebuthiuron	4.68E-04	1.68E-02	4.33E-02	2.04E-01
Diuron	2.74E-04	4.67E-03	2.27E-02	3.35E-02
Bromacil	5.73E-04	1.72E-02	4.18E-02	1.27E-01
Chlorsulfuron	1.27E-04	2.31E-03	1.79E-02	5.31E-02
Dicamba	3.25E-04	1.30E-02	2.03E-02	1.72E-01
Inert Compound	**1.20E-03**	**3.80E-02**	**3.20E-01**	**6.90E-01**

The results of the GLEAMS simulations from the table above indicate that the ratio of river or pond concentration to application rate is highest for the inert compound. This was expected because of the extent that the chemical parameters were adjusted to represent a highly mobile and stable compound. In the case of the river, the concentrations were largely the result of characteristics related to the inert compound's mobility but in the pond the stability of the compound was also important. The inert compound concentrations were predicted to be higher than the concentrations of each herbicide in all cases, albeit to varying degrees, and the extent of these higher concentrations was similar between each of the four statistical measures.

The exposure concentration was estimated by multiplying the percentage of the inert in the formulation times the application rate in pounds/acre times the dilution rates shown in the above table. Due to the constraints of the CBI process, the inerts of potential interest can not be disclosed but the following observations were made. Low application rates for sulfometuron methyl, fluridone, diquat, dicamba, diflufenzopyr, and imazapic resulted in low exposure concentrations of inerts of much less than 1 mg/L in all cases including the worst case (maximum 3-day pond) scenario. Higher application rates for diuron and bromacil yielded higher exposure concentrations of surfactant inerts, exceeding 1 mg/L for the maximum pond scenario. These results suggest that the inert compounds of diuron and bromacil may contribute acute toxicity to aquatic organisms if they reach the aquatic environment. Inerts did not seem to be an issue with chlorsulfuron and tebuthiuron.

This approach to estimating the exposure concentration will have relatively little uncertainty for several exposure scenarios such as spills where subsequent fate processes are relatively unimportant. Considerably more uncertainty will occur in scenarios that account for the physical-chemical properties of the constituent (e.g., the GLEAMS-dependent scenarios). The exposure concentration models are very conservative, e.g. if there is uncertainty, the exposure concentrations are likely to be overestimated, not underestimated. Considerable uncertainty also exists with the toxicity information as many of these substances had no specific toxicity information and toxicity information for surfactants was used as a surrogate.

References

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