U.S. Department of Agriculture (USDA) Forest Service (FS)
Human Health and Ecological Risk Assessment (HHERA)

Sulfometuron Methyl Report Addendum

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1. Executive Summary

This document serves as an Addendum to the Human Health and Ecological Risk Assessment (HHERA) for the herbicide sulfometuron methyl (and its formulated products Oust and Oust XP®), which was conducted for the United States Department of Agriculture (USDA) Forest Service (FS) in 2004 (USDA/FS 2004; referred to in this report as the 2004 HHERA). An FS HHERA for sulfometuron methyl was originally conducted and published in 1998 (USDA/FS 1998). After a thorough review of the current uses of sulfometuron methyl by the FS and toxicological studies conducted since publication of the 2004 HHERA, human health and ecological risks were re-evaluated using the FS risk assessment worksheets (i.e., WorkSheet Maker Version 6.02.20). The 2004 HHERA and this Addendum follow the approach of previous FS national HHERAs and FS risk assessment guidance, as posted on the FS Pesticide Management and Coordination website.

The quantitative risk characterization summarized in this HHERA Addendum is based on the hazard quotient (HQ), which is defined as the anticipated exposure (milligrams active ingredient per kilogram per day [mg a.i./kg/day] or milligrams active ingredient per liter [mg a.i./L]) divided by a non-carcinogenic toxicity value (mg a.i./kg/day or mg a.i./L) that is not likely to be associated with adverse effects. Note that sulfometuron methyl is not considered a carcinogen (United States Environmental Protection Agency [USEPA]/Office of Pesticide Programs [OPP] 2006; USDA/FS 2004), and therefore, a cancer risk estimate has not been calculated. An HQ >1 is defined as the level of concern, such that HQs ≤1 indicate that adverse effects are not likely to occur. HQs >1 and <2 represent a minimal level of concern, and HQs ≥2 represent a more serious level of concern. The level of concern increases with increasing HQ values exceeding 1.

The 2004 HHERA used the typical, or central, application rate of 0.045 pounds of active ingredient per acre (lb a.i./acre). This re-evaluation used the maximum application rate of 0.38 lb a.i./acre, an approximately eight-fold increase in application rate. The use of the maximum application rate is now standard practice for the FS HHERA program.

It should be noted that the WorkSheet Maker tool's exposure inputs and methodology have been revised over time; however, there were no significant changes in exposure inputs between 2004 and this Addendum. Toxicity data were reviewed, but there were no changes to the toxicity data from the 2004 HHERA. Using the higher application rate, this Addendum reassessed non-cancer hazards to human health (e.g., workers and the general public); terrestrial receptors (e.g., mammals, birds, insects, and non-target plants); and aquatic receptors (e.g., fish, aquatic invertebrates, aquatic macrophytes, and algae). As discussed in this Addendum, the increase in application rate had no to minimal effects on the human health risk characterization but greatly increased the level of concern to aquatic and terrestrial plants.

Human Health Assessment: Human health HQs were calculated for workers and the general public. No toxicity input values for human health were revised from the 2004 HHERA; therefore, all increases in HQs for workers and the general public are due to the increased application rate used herein, as well as revised exposure assumptions discussed in greater detail in Section 4. For most exposure scenarios, updated HQs are <1, indicating negligible concern to workers and the general public. The only changes in the human health risk characterization are chronic exposure of workers, where the upper-bound HQ increased from <1 to 1.5 (for backpack application) or 3 (for ground broadcast foliar application); water consumption by a child after an accidental spill, where the upper-bound HQ increased from <1 to 1.1; and chronic ingestion of contaminated vegetation by an adult female, where the upper-bound HQ increased from <1 to 4. There is an increased level of concern for these exposure scenarios.

Ecological Assessment for Terrestrial Species: The risk assessment for terrestrial species was updated for mammals, birds, terrestrial insects (including honeybees), and non-target terrestrial plants based on the maximum application rate. No toxicity input values for terrestrial receptors were revised from the 2004 HHERA. The updated HQ calculations for mammals resulted in small increases in upper-bound HQs (1.7-3) for acute exposure to contaminated vegetation and moderate increases in upper-bound HQs (1.8-21) for chronic exposure to contaminated fruit and vegetation. Increased hazards to birds followed a similar pattern, with upper-bound HQs of 1.2-2 for non-accidental acute exposure to contaminated broadleaf foliage and short grass, and upper-bound HQs of 4-52 observed for chronic exposure to contaminated fruit, broadleaf foliage, tall grass, and short grass. For terrestrial insects and honeybees, all HQs were <1. For plants, HQs due to direct spray and spray drift were quite high in the 2004 HHERA (upper-bound HQs of 1,875 and 58 for sensitive and tolerant species, respectively); the eight-fold increase in application rate in this Addendum increased upper-bound HQs accordingly (upper-bound HQs of 15,833 and 487 for sensitive and tolerant plants, respectively). For plants exposed to contaminated runoff, HQs for sensitive and tolerant species also increased substantially (2004 upper-bound HQs: 57 and 1.9, respectively; upper-bound HQs in this updated assessment: 1,944 and 67, respectively). Hazards to plants from irrigation (HQs: <1-399) and wind erosion (HQs: <1-2) scenarios were also significant. Because sulfometuron methyl is an herbicide, significant hazards to plants are expected.

Ecological Assessment for Aquatic Species: For aquatic species, hazards were assessed for fish, amphibians, aquatic invertebrates, aquatic macrophytes, and algae. Toxicity input values were unchanged from those used in the 2004 HHERA. In both the 2004 HHERA and this updated assessment, no unacceptable hazards were identified for fish or aquatic invertebrates. For amphibians, there was an increase in level of concern for accidental acute and chronic exposure scenarios (upper-bound HQs of 18 and 14, respectively). In the 2004 HHERA, slight concerns to aquatic macrophytes were observed for non-accidental acute exposure (upper-bound HQ: 4) and high levels of concern were observed for accidental acute exposure (HQs: 469-3,965). In this updated assessment, given the eight-fold increase in application rate, high hazards were observed for aquatic macrophytes for accidental acute (HQs: 397-32,803), non-accidental acute (HQs: 4-101), and chronic (HQs: 2-51) exposure scenarios. For sensitive algal species, hazards from accidental acute exposure to sulfometuron methyl remained high in this updated assessment (HQs: 33-2,755) but were much lower for non-accidental acute and chronic exposure scenarios (HQs: <1-8). Tolerant algal species exhibited moderate hazards based on accidental acute exposure (HQs: <1-19), but other exposure scenarios resulted in no significant concerns (HQs: <1). Significant hazards to aquatic plants are expected, as sulfometuron methyl is an herbicide.

Conclusions: The 2025 risk characterization based on an increased application rate resulted in several changes to risk characterizations compared to the 2004 HHERA. Note that in the 2004 HHERA, nearly all HQs were <1 except for HQs for terrestrial and aquatic plants. For the following exposure scenarios and receptors in the revised 2025 HHERA, upper-bound HQs were ≥2:

- Human health:
    - Worker, general (chronic) exposure after ground broadcast foliar application.
    - General public (adult female), chronic exposure through ingestion of contaminated vegetation.
- Terrestrial receptors:
    - Mammals, acute exposure to contaminated short grass.
    - Mammals, chronic exposure to contaminated broadleaf foliage.
    - Mammals, chronic exposure to contaminated tall grass.
    - Mammals, chronic exposure to contaminated short grass.
    - Birds, non-accidental acute exposure to contaminated short grass.
    - Birds, chronic exposure to contaminated fruit.

  - Birds, chronic exposure to contaminated broadleaf foliage.
  - Birds, chronic exposure to contaminated tall grass.
  - Birds, chronic exposure to contaminated short grass.
  - Plants (sensitive and tolerant species), exposure to direct spray and spray drift.
  - Plants (sensitive and tolerant species), exposure to runoff.
  - Plants (sensitive and tolerant species), exposure to contaminated irrigation water.
  - Plants (sensitive species), exposure to wind erosion.
- Aquatic receptors:
  - Amphibians, acute exposure from an accidental spill.
  - Amphibians, chronic exposure.
  - Aquatic macrophytes, acute exposure from an accidental spill.
  - Aquatic macrophytes, acute non-accidental exposure.
  - Aquatic macrophytes, chronic exposure.
  - Algae, sensitive and tolerant, acute exposure from an accidental spill.
  - Algae, sensitive, acute non-accidental exposure.
  - Algae, sensitive, chronic exposure.

2. Introduction

The USDA FS is responsible for managing National Forest System Land to provide a mix of goods and services to the public, including access to national forests; livestock grazing; timber management; visual quality; water quality; and vegetation, wildlife, and fish diversity. Each Forest Land and Resource Management Plan details specific resource management objectives and output goals, which may require the implementation of integrated pest and vegetation management programs when using pesticides. To comply with the National Environmental Policy Act (NEPA) of 1969 as amended (40 CFR 1500-1508), the FS evaluates the noncancer hazards to humans, wildlife, other non-target organisms, and the environment due to current or future pest or vegetation management programs. Since the 1980s, the FS has supported the development and deployment of HHERAs of chemicals proposed for use by the FS. Prior to the use of any pesticides on forest lands, an HHERA must be prepared to evaluate potential human health and ecological effects.

The FS uses sulfometuron methyl, an herbicide, in vegetation management programs. The original HHERA for sulfometuron methyl was published in 1998, and the most recent HHERA was published in 2004 (USDA/FS 2004). Since that publication, the FS has revised its use of sulfometuron methyl, specifically using a higher application rate. In addition, more recent toxicity studies applicable to human and ecological targets are available.

This Addendum updates the risk assessments for human health and ecological effects of the use of the sulfometuron methyl formulation Oust and Oust XP in FS programs using new application rate information and a review of toxicity information; however, much of the information presented in the 2004 HHERA still applies and is referenced herein.

3. Chemical Information

3.1. Chemical Description and Commercial Formulations

Sulfometuron methyl is the common name for 2-[[[[(4,6-dimethyl-2-pyrimidinyl)- amino] carbonyl] amino] sulfonyl] benzoic acid methyl ester. The commercial formulation of sulfometuron methyl used by the FS is Oust XP. This formulation is produced by DuPont and Bayer and contains sulfometuron methyl (75%) as the only active ingredient. Oust XP is a dispersible granule that is mixed in water and applied as a spray or impregnated on dry, bulk fertilizer. Oust XP is used for general weed control on terrestrial non-crop sites and for selective weed control in certain types of unimproved turf grasses. When applied as a spray, Oust XP controls weeds by both pre-emergence and post-emergence activity. Attachments 2 and 3 summarize the physical and chemical properties that were used in WorkSheet Maker for modeling the fate and transport of sulfometuron methyl.

Environmental fate of sulfometuron methyl is discussed in the 2004 HHERA, and models are used to estimate exposure concentrations in surface water bodies (see Section 4.2.1 of this Addendum). This HHERA is conservative in that it does not incorporate degradation of sulfometuron methyl into the exposure concentrations. For example, the half-life of sulfometuron methyl in water ranges from 43.6 to 113 days (at pH of 7), but degradation of the compound following application was not considered in the exposure point concentrations in surface water.

3.2. Application Methods

Sulfometuron methyl may be applied by directed foliar, broadcast foliar, or aerial methods; however, the aerial application method is not used in FS programs and was not modeled in either the 2004 HHERA or this Addendum. Directed foliar and broadcast foliar methods were evaluated in 2004 and re-evaluated for this Addendum. The broadcast foliar application method is the most common application method for sulfometuron methyl in FS programs. With booms mounted on a tractor or other heavy-duty vehicle, workers will typically treat 11 to 21 acres/hour. In selective foliar applications, the herbicide sprayer or container is carried by backpack, and the herbicide is applied to selected target vegetation. Application crews may treat up to shoulder-high brush, which means that chemical contact with the arms, hands, or face is plausible. To reduce the likelihood of significant exposure, application crews are directed not to walk through treated vegetation. Usually, a worker treats approximately 0.5 acre/hour, with a plausible range of 0.25 to 1 acre/hour.

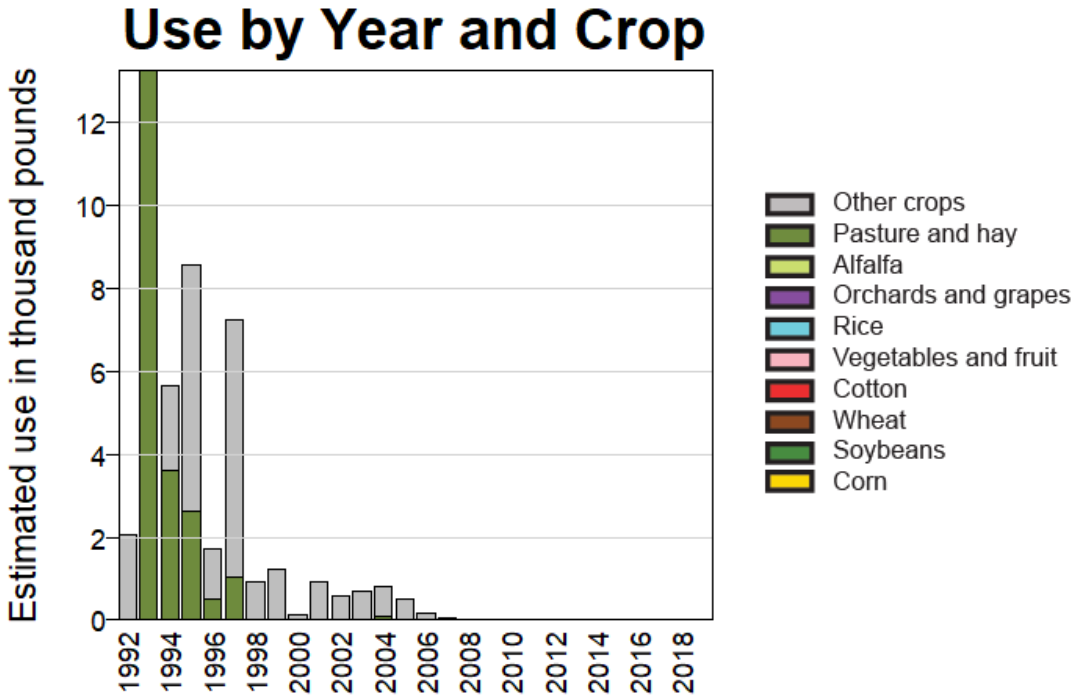
3.3. Application Rates

The labeled application rates for Oust and Oust XP range from 0.03 lb a.i./acre to 0.38 lb a.i./acre. The application rate used in this Addendum increased by approximately 8.4-fold, from 0.045 lb a.i./acre (used in the 2004 HHERA) to 0.38 lb a.i./acre (used in this Addendum). The 2004 HHERA used the typical (central) application rate of 0.045 lb a.i./acre; current practice requires evaluation of the highest application rate (0.38 lb a.i./acre). The ground application volumes of 5, 15, and 40 gallons of water per acre are unchanged from the 2004 HHERA. However, due to the increased application rate, the concentrations in field solution used in this Addendum are 1.13, 3.0, and 9.1 mg a.i./mL, respectively. These concentrations are approximately 10-fold higher than concentrations in field solutions used in the 2004 HHERA (0.13, 0.36, and 1.1 mg a.i./mL, respectively).

3.4. Use Statistics

Oust XP is used in agriculture; however, overall use has declined from 1992 to 2007, with little to no use from 2007 to 2018, as shown in Figure 1 (United States Geological Survey [USGS] 2018). Approximately 24,000 lbs a.i. were used by the FS from 2019 to 2023, primarily in Region 9 (Eastern FS Region).

Figure 1. U.S. Geological Survey EPest-High Agricultural Use Estimates for Sulfometuron in 2018



4. HHERA Update

This HHERA update involves review of toxicological information available since the 2004 HHERA, review of application rates, and recalculation of HQs using the FS WorkSheet Maker risk assessment tool. According to the USEPA OPP, sulfometuron methyl is in the process of being reregistered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The Reregistration Eligibility Decision (RED) was published in 2008 (USEPA/OPP 2008), and various HHERAs and toxicological information are available in the USEPA public dockets at https://www.regulations.gov.

4.1. Literature Search

An FS-contracted information scientist conducted literature searches for sulfometuron methyl in January 2024 to identify toxicity information on sulfometuron methyl published since the previous 2004 HHERA. The PubMed database was searched, as well as the following databases via EBSCOhost: AGRICOLA, Biological Abstracts, CAB Abstracts, Environment Complete, and Global Health. Searches were date-limited from the year 2003 forward. The search terms consisted of the Chemical Abstracts Service (CAS) Registry number 74222-97-2; the chemical name sulfometuron methyl; and other synonyms identified using the Comptox Chemicals Dashboard, Common Chemistry, and other sources. The literature search results were stored and deduplicated in an Endnote library. Database query strings are provided in Attachment 1.

The National Pesticide Information Retrieval System (NPIRS) was searched by CAS Registry number from 2003 to January 2024 to obtain master record identifier (MRID) numbers and references of studies that have been submitted to the USEPA, largely in support of product registrations. Two hundred and ten MRID submissions were identified; 22 of these were requested from USEPA. Data Evaluation Records (DERs; USEPA-produced reviews of individual submitted studies) for three of these MRIDs were obtained from USEPA. Other sources of grey literature (i.e., information produced by organizations outside of traditional commercial or academic publishing) were searched using the terms sulfometuron, sulfometuron-methyl, and 74222-97-2. Results from the grey literature searches were screened, and selected references were added to the Endnote library. The additional grey literature sources searched are listed in Attachment 1.

4.2. Human Health Risk Assessment

The four steps in a human health risk assessment are hazard identification, exposure assessment, dose-response assessment, and risk characterization. The hazard identification process involves the examination of available scientific data, such as mechanisms of action, toxicokinetics, and toxicity, to determine the potential adverse health effects associated with exposure to a chemical. For sulfometuron methyl, no changes were made to the hazard identification from the 2004 HHERA, and no toxicity values were revised (see Section 4.2.2). The exposure assessment, dose-response assessment, and risk characterization are discussed in the following sections.

4.2.1. Exposure Assessment

Exposure assessment is a process in risk assessment that identifies potential receptors of contamination or chemical releases, exposure routes, and exposure point concentrations for environmental media to which a receptor may be exposed.

Calculations of exposure in this Addendum are based on the maximum application rate of 0.38 lb a.i./acre, which is higher than the application rate used in the 2004 HHERA (0.045 lb a.i./acre). The application rate, along with the concentration of sulfometuron methyl in field solution, was used to determine the exposure point concentration used in the hazard calculations. For exposure scenarios involving bodies of water (e.g., spills followed by water or fish consumption), the USDA Groundwater

Loading Effects of Agricultural Management Systems (GLEAMS) model was used to model concentrations of sulfometuron methyl in surface water (see Attachment 2).

In the 2004 HHERA and in this Addendum, exposure scenarios are presented for both workers and members of the general public. Two types of exposure scenarios are considered: general exposures resulting from the normal handling and application of the compound and accidental/incidental exposures involving specific events that might occur during application. Exposures were assessed using Excel workbooks generated through WorkSheet Maker and included as Attachment 3. These worksheets detail the exposure scenarios assessed (e.g., accidental direct spray of child, accidental spill on hand) and the exposure parameters used (e.g., body weight, skin surface area).

4.2.2. Dose-Response Assessment

Toxicity values used in the updated human health hazard calculations are shown in Table 1; the test material for these studies was technical sulfometuron methyl (approximately 98% a.i.). The acute and chronic reference doses (RfDs) for sulfometuron methyl used in the 2004 HHERA are also used in this Addendum. The acute RfD of 0.87 mg a.i./kg body weight per day is based on a no-observed-adverse-effect-level (NOAEL) in rats of 86.6 mg a.i./kg/day for decreased maternal and fetal body weight in a gestational exposure study; a total uncertainty factor (UF) of 100 (10 for extrapolating from animals to humans and 10 for extrapolating to sensitive individuals within the human population) (Lu 1981) was applied. The lowest-observed-adverse-effect-level (LOAEL) in this study was 433 mg a.i./kg/day. In the 2008 RED (USEPA/OPP 2008), an acute RfD of 0.275 mg a.i./kg/day was determined based on a chronic dog feeding study with a NOAEL of 27.5 mg a.i./kg/day. However, mild hemolytic anemia was observed at this concentration, indicating that 27.5 mg a.i./kg/day was a LOAEL, not a NOAEL. Therefore, the acute RfD of 0.87 mg a.i./kg/day was used for this Addendum.

Table 1. Human Health Toxicity Values Used in the Updated Sulfometuron Methyl HHERA Addendum

Receptor	Duration	Endpoint	Previous Value	Updated Value	Source
Worker	Acute	RfD	0.87 mg a.i./kg/day	Unchanged	Lu 1981
Worker	Chronic	RfD	0.02 mg a.i./kg/day	Unchanged	Mullin 1984
General Public	Acute	RfD	0.87 mg a.i./kg/day	Unchanged	Lu 1981
General Public	Chronic	RfD	0.02 mg a.i./kg/day	Unchanged	Mullin 1984

Note: Test material was technical sulfometuron methyl (~98% a.i.).
Abbreviations: a.i. = active ingredient; bw = body weight; HHERA = Human Health and Ecological Risk Assessment; kg = kilogram; mg = milligram; RfD = reference dose

The chronic RfD of 0.02 mg a.i./kg/day used in the 2004 HHERA is based on a NOAEL of 2 mg a.i./kg/day for anemia in a two-year feeding study in rats (Mullin 1984); a total UF of 100 (10 for extrapolating from animals to humans and 10 for extrapolating to sensitive individuals within the human population) was applied. In the 2008 RED (USEPA/OPP 2008), a chronic RfD of 0.275 mg a.i./kg/day was derived from a chronic feeding study in dogs with a NOAEL of 27.5 mg a.i./kg/day. As discussed above, the 27.5 mg a.i. kg/day was actually a LOAEL, not a NOAEL. The lower chronic RfD (0.02 mg a.i./kg/day) was retained in this Addendum as a conservative measure.

4.2.3. Risk Characterization

The HQs for exposure of workers and the general public to sulfometuron methyl are shown in Tables 2-5 for the two application methods previously described in Section 3.2: backpack directed foliar and ground broadcast foliar. The ground broadcast foliar application method is the most common technique used by the FS. It typically includes using a tractor and a boom to broadcast the material. HQs from the 2004 HHERA are shown for comparison. Most HQs are unchanged from 2004, with a few HQs slightly higher due to the increased application rate. For workers, all HQs are <1 except for upper-bound chronic HQs for general exposure (1.5 and 3 for backpack and ground broadcast foliar applications, respectively) (Tables 2a and 2b). For the general public, upper-bound HQs slightly >1 are estimated for acute accidental exposures of children (from water consumption after a spill) (Tables 3a and 3b). Nonaccidental acute exposures of the general public result in HQs <1 for all exposure scenarios (Tables 4a and 4b). The only HQ that exceeded 1 for chronic/long-term exposure was for adult females ingesting contaminated vegetation (Tables 5a and 5b). The increased application rate for sulfometuron methyl does not appear to have a substantial effect on the risk characterization for workers and the general public for acute or chronic exposures.

Table 2a. Hazard Quotients (HQs)[1] for General and Accidental Exposures of Workers – Backpack Directed Foliar

Exposure Scenario	2004[2]	2025
General exposure (chronic)	<1	<1-1.5
Accidental/incidental exposure (acute): Glove, 1 minute	<1	<1
Accidental/incidental exposure (acute): Glove, 1 hour	<1	<1
Accidental/incidental exposure (acute): Spill on hands, 1 hour	<1	<1
Accidental/incidental exposure (acute): Spill on lower legs, 1 hour	<1	<1

Table 2b. Hazard Quotients (HQs)[1] for General and Accidental Exposures of Workers – Ground Broadcast Foliar

Exposure Scenario	2004[2]	2025
General exposure (chronic)	<1	<1-3
Accidental/incidental exposure (acute): Glove, 1 minute	<1	<1
Accidental/incidental exposure (acute): Glove, 1 hour	<1	<1
Accidental/incidental exposure (acute): Spill on hands, 1 hour	<1	<1
Accidental/incidental exposure (acute): Spill on lower legs, 1 hour	<1	<1

[1]HQ ranges are for lower- to upper-bound exposure estimates. HQs listed as <1 or ≤1 (with no range) indicate that HQs for lower, central, and upper estimates are all ≤1.
[2]Acute HQs in the 2004 HHERA were not reported by application method.
Abbreviations: HHERA = Human Health and Ecological Risk Assessment
Key: Cells are colored for the highest HQ:
HQ≤1 HQ>1-<2 HQ≥2

Table 3a. Hazard Quotients (HQs) [1] for Acute Accidental Exposures of the General Public – Backpack Directed Foliar

Exposure Scenario	2004[2]	2025
Direct spray of child, whole body	<1	<1
Direct spray of adult female, feet and lower legs	<1	<1
Water consumption (spill), child	<1	<1-1.1

Exposure Scenario	2004[2]	2025
Fish consumption (spill), adult male	<1	<1
Fish consumption (spill), subsistence population	<1	<1

Table 3b. Hazard Quotients (HQs) [1] for Acute Accidental Exposures of the General Public – Ground Broadcast Foliar

Exposure Scenario	2004[2]	2025
Direct spray of child, whole body	<1	<1
Direct spray of adult female, feet and lower legs	<1	<1
Water consumption (spill), child	<1	<1-1.1
Fish consumption (spill), adult male	<1	<1
Fish consumption (spill), subsistence population	<1	<1

[1]HQ ranges are for lower to upper-bound exposure estimates. HQs listed as <1 or ≤1 (with no range) indicate that HQs for lower, central, and upper estimates are all ≤1.
[2]HQs in the 2004 HHERA were not reported by application method.
Abbreviations: HHERA = Human Health and Ecological Risk Assessment
Key: Cells are colored for the highest HQ:
HQ≤1 HQ>1-<2 HQ≥2

Table 4a. Hazard Quotients (HQs)[1] for Nonaccidental Acute Exposures of the General Public – Backpack Directed Foliar

Exposure Scenario	2004[2]	2025
Dermal contact with vegetation, shorts, and t-shirt, adult female	<1	<1
Ingestion of contaminated fruit, adult female	<1	<1
Ingestion of contaminated vegetation, adult female	<1	<1
Swimming, 1-hour, adult female	NA	<1
Water consumption, child	<1	<1
Fish consumption, adult male	<1	<1
Fish consumption, subsistence population	<1	<1

Table 4b. Hazard Quotients (HQs)[1] for Nonaccidental Acute Exposures of the General Public – Ground Broadcast Foliar

Exposure Scenario	2004[2]	2025
Dermal contact with vegetation, shorts, and t-shirt, adult female	<1	<1
Ingestion of contaminated fruit, adult female	<1	<1
Ingestion of contaminated vegetation, adult female	<1	<1
Swimming, 1-hour, adult female	NA	<1
Water consumption, child	<1	<1
Fish consumption, adult male	<1	<1
Fish consumption, subsistence population	<1	<1

[1]HQ ranges are for lower to upper-bound exposure estimates. HQs listed as <1 or ≤1 (with no range) indicate that HQs for lower, central, and upper estimates are all ≤1.
[2]HQs in the 2004 HHERA were not reported by application method.
Abbreviations: HHERA = Human Health and Ecological Risk Assessment; NA = not assessed
Key: Cells are colored for the highest HQ:

HQ≤1 HQ>1-<2 HQ≥2

Table 5a. Hazard Quotients (HQs)[1] for Chronic/Longer Term Exposures of the General Public – Backpack Directed Foliar

Exposure Scenario	2004[2]	2025
Ingestion of contaminated fruit, adult female	<1	<1
Ingestion of contaminated vegetation, adult female	<1	<1-4
Water consumption, adult male	<1	<1
Fish consumption, adult male	<1	<1
Fish consumption, subsistence population	<1	<1

Table 5b. Hazard Quotients (HQs)[1] for Chronic/Longer Term Exposures of the General Public – Ground Broadcast Foliar

Exposure Scenario	2004[2]	2025
Ingestion of contaminated fruit, adult female	<1	<1
Ingestion of contaminated vegetation, adult female	<1	<1-4
Water consumption, adult male	<1	<1
Fish consumption, adult male	<1	<1
Fish consumption, subsistence population	<1	<1

[1]HQ ranges are for lower to upper-bound exposure estimates. HQs listed as <1 or ≤1 (with no range) indicate that HQs for lower, central, and upper estimates are all ≤1.
[2]HQs in the 2004 HHERA were not reported by application method.
Abbreviations: HHERA = Human Health and Ecological Risk Assessment; NA = not assessed
Key: Cells are colored for the highest HQ:
HQ≤1 HQ>1-<2 HQ≥2

4.3. Ecological Risk Assessment

Ecological risk assessment involves hazard identification, exposure assessment, dose-response assessment, and risk characterization. The hazard identification for ecological risk assessment describes the possible adverse effects associated with sulfometuron methyl to ecological receptors through a review of the available toxicological literature. No changes were made to the hazard identification for sulfometuron methyl from the 2004 HHERA. The exposure assessment, dose-response assessment, and risk characterization are discussed below.

4.3.1. Exposure Assessment

A standard set of exposure assessments for terrestrial and aquatic organisms is provided in the Excel workbooks for sulfometuron methyl (Attachment 3). The workbooks contain a set of worksheets that detail each exposure scenario. In FS risk assessments, the methodology and results of calculations are provided in the worksheets. For each exposure scenario, the worksheets provide the calculation of an exposure dose that is compared to dose-response values described in Section 4.3.2. These dose-response values are used to calculate HQs. Calculations of exposure are based on the maximum application rate, which has been updated to 0.38 lb a.i./acre from the 0.045 lb a.i./acre used in the 2004 HHERA.

As sulfometuron methyl is an herbicide, all terrestrial and aquatic organisms aside from plants are considered “non-target.” This HHERA Addendum, similar to the 2004 HHERA, evaluates potential effects on mammals, birds, terrestrial invertebrates (including honeybees), terrestrial non-target

plants, amphibians, and aquatic organisms, including fish, aquatic invertebrates, aquatic macrophytes, and algae. Details of exposure scenarios and exposure parameters evaluated are provided in Attachment 3.

4.3.2. Dose-Response Assessment

Toxicity values used in the updated ecological risk calculations are shown in Tables 6a and 6b, and summaries of toxicity studies reviewed for this Addendum are provided in Attachment 4. Studies were conducted using either technical sulfometuron methyl (approximate purity of 98% a.i.) or formulated sulfometuron methyl product (i.e., Oust or Oust XP; 75% a.i.). Cases where it was not clear whether the test material was technical sulfometuron methyl or formulated product are noted in the tables. Review of newly available DERs and peer-reviewed literature published after the 2004 HHERA did not identify lower (i.e., more conservative) toxicity values. Therefore, for assessments of terrestrial and aquatic targets, the acute and chronic toxicity values (NOAELs and no-observed-adverse-effect-concentrations [NOAECs], respectively) used in the 2004 HHERA are also used in this Addendum.

Table 6a. Ecological Toxicity Values Used in the Updated Sulfometuron Methyl HHERA Addendum – Terrestrial Receptors

Receptor	Duration	Endpoint	Previous Value	Updated Value	Source
Mammals	Acute	NOAEL	87 mg a.i./kg bw[1]	Unchanged	Lu 1981
Mammals	Chronic	NOAEL	2 mg a.i./kg bw/day[1]	Unchanged	Mullin 1984
Birds	Acute	NOAEL	312 mg a.i./kg bw[1]	Unchanged	Dudeck and Bristol 1981
Birds	Chronic	NOAEL	2 mg a.i./kg bw/day[1]	Unchanged	Lu 1981
Honeybee	Oral	NOAEL	1075 mg a.i./kg bw[1]	Unchanged	Hoxter and Smith 1990
Honeybee	Contact	NOAEL	1075 mg a.i./kg bw[1]	Unchanged	Hoxter and Smith 1990
Terrestrial invertebrates	Acute	NOAEL	1075 mg a.i./kg bw[1]	Unchanged	Hoxter and Smith 1990
Terrestrial plants, sensitive	Drift	NOAEL	0.000024 lb a.i./acre[2]	Unchanged	McKelvey 1995
Terrestrial plants, sensitive	Pre-emergence	NOAEL	0.0000086 lb a.i./acre[2]	Unchanged	McKelvey 1995
Terrestrial plants, tolerant	Drift	NOAEL	0.00078 lb a.i./acre[2]	Unchanged	McKelvey 1995
Terrestrial plants, tolerant	Pre-emergence	NOAEL	0.00025 lb a.i./acre[2]	Unchanged	McKelvey 1995

Table 6b. Ecological Toxicity Values Used in the Updated Sulfometuron Methyl HHERA Addendum – Aquatic Receptors

Receptor	Duration	Endpoint	Previous Value	Updated Value	Source
Fish, sensitive	Acute	NOAEC	7.3 mg a.i./L[1]	Unchanged	Muska and Driscoll 1982
Fish, sensitive	Chronic	NOAEC	1.17 mg a.i./L[1]	Unchanged	Muska and Driscoll 1982
Fish, tolerant	Acute	NOAEC	150 mg a.i./L[1]	Unchanged	Brown 1994a, 1994b
Fish, tolerant	Chronic	NOAEC	1.17 mg a.i./L[1]	Unchanged	Muska and Driscoll 1982
Aquatic invertebrates, sensitive	Acute	NOAEC	75 mg a.i./L[2]	Unchanged	Naqvi and Hawkins 1989
Aquatic invertebrates, sensitive	Chronic	NOAEC	0.19 mg a.i./L[1]	Unchanged	Derived from the tolerant NOAEC using a relative potency factor of 32 (see 2004 HHERA)
Aquatic invertebrates, tolerant	Acute	NOAEC	1,800 mg a.i./L[2]	Unchanged	Wetzel 1984
Aquatic invertebrates, tolerant	Chronic	NOAEC	6.1 mg a.i./L[1]	Unchanged	Baer 1990
Aquatic plants (macrophytes), sensitive	-	NOAEC	0.00021 mg a.i./L[1]	Unchanged	Kannuck and Sloman 1995
Aquatic plants (macrophytes), tolerant	-	NOAEC	0.00021 mg a.i./L[1]	Unchanged	Kannuck and Sloman 1995
Aquatic plants (Algae), sensitive	-	NOAEC	0.0025 mg a.i./L[1]	Unchanged	Hoberg 1990
Aquatic plants (Algae), tolerant	-	NOAEC	0.37 mg a.i./L[1]	Unchanged	Thompson 1994
Amphibians	Acute	NOAEC	0.38 mg a.i./L[3]	Unchanged	Fort et al. 1999
Amphibians	Chronic	NOAEC	0.00075 mg a.i./L[3]	Unchanged	Fort et al. 1999

[1]Test material was technical sulfometuron methyl (~98% a.i.).
[2]Test material was formulated product (Oust; ~75% a.i.).
[3]Test material uncertain (likely Oust).
Abbreviations: a.i. = active ingredient; bw = body weight; L = liter; lb = pound; mg = milligram; NA = not available; NOAEC = no-observed-adverse-effect concentration; NOAEL = no-observed-adverse-effect level

4.3.3. Risk Characterization

The HQs for exposure of ecological receptors to sulfometuron methyl are shown in Tables 7 through 12 for backpack directed foliar and ground broadcast foliar application methods. HQs from the 2004 HHERA are shown for comparison. Note that the 2004 HHERA ecological risk assessment did not calculate HQs for all exposure scenarios evaluated in this Addendum (e.g., consumption of contaminated fish by mammals, consumption of contaminated water by birds, exposure by terrestrial insects other than honeybees). These are noted as "NA" for 2004 in Tables 7 through 12 and have been addressed in this Addendum.

4.3.3.1. Mammals

The risk characterization for mammals used the acute and chronic NOAELs for technical sulfometuron methyl from the 2004 HHERA. Therefore, any changes in risk between the 2004 HHERA and this Addendum are due to the higher application rate. As shown in Tables 7a and 7b and 8a and 8b, HQs for all exposure scenarios in the 2004 HHERA were <1, indicating no risk to mammals. Using the higher application rate, HQs for several exposure scenarios are >1, indicating an increased level of concern for mammals. The exposure pathways resulting in HQs >1 are acute and chronic exposure of mammals to contaminated short grass (with upper-bound HQs of 3 and 21, respectively), acute and chronic exposure to contaminated tall grass (upper-bound HQs of 1.4 and 10, respectively), acute and chronic exposure to contaminated broadleaf foliage (upper-bound HQs of 1.7 and 12, respectively), and chronic exposure to contaminated fruit (upper-bound HQ of 1.8).

Table 7a. Hazard Quotients (HQs)[1] for Accidental Acute Exposures of Mammals to Sulfometuron Methyl – Backpack Directed Foliar

Exposure Scenario	2004[2]	2025
Direct spray (100% absorption)	<1	<1
Consumption of contaminated water	<1	<1
Consumption of contaminated fish	NA	<1

Table 7b. Hazard Quotients (HQs)[1] for Accidental Acute Exposures of Mammals to Sulfometuron Methyl – Ground Broadcast Foliar

Exposure Scenario	2004[2]	2025
Direct spray (100% absorption)	<1	<1
Consumption of contaminated water	<1	<1
Consumption of contaminated fish	NA	<1

[1]HQ ranges are for lower to upper-bound exposure estimates. HQs listed as <1 or ≤1 (with no range) indicate that HQs for lower, central, and upper estimates are all ≤1.
[2]HQs in the 2004 HHERA were not reported by application method.
Abbreviations: HHERA = Human Health and Ecological Risk Assessment; NA = not assessed
Key: Cells are colored for the highest HQ:
HQ≤1 HQ>1-<2 HQ≥2

Table 8a. Hazard Quotients (HQs)[1] for Non-Accidental Acute and Chronic/Longer Term Exposures of Mammals to Sulfometuron Methyl – Backpack Directed Foliar

Exposure Scenario	2004[2]	2025
Acute exposure: Contaminated fruit	<1	<1
Acute exposure: Contaminated broadleaf foliage	<1	<1-1.7
Acute exposure: Contaminated tall grass	<1	<1-1.4

Exposure Scenario	2004[2]	2025
Acute exposure: Contaminated short grass	<1	<1-3
Acute exposure: Contaminated insects	<1	<1
Acute exposure: Contaminated water	<1	<1
Acute exposure: Contaminated fish	NA	<1
Acute exposure: Contaminated small mammal (after direct spray)	<1	<1
Chronic/longer term exposure: Contaminated fruit	<1	<1-1.8
Chronic/longer term exposure: Contaminated broadleaf foliage	<1	<1-12
Chronic/longer term exposure: Contaminated tall grass	<1	<1-10
Chronic/longer term exposure: Contaminated short grass	<1	<1-21
Chronic/longer term exposure: Contaminated water	<1	<1
Chronic/longer term exposure: Contaminated fish	NA	<1

Table 8b. Hazard Quotients (HQs)[1] for Non-Accidental Acute and Chronic/Longer Term Exposures of Mammals to Sulfometuron Methyl – Ground Broadcast Foliar

Exposure Scenario	2004[2]	2025
Acute exposure: Contaminated fruit	<1	<1
Acute exposure: Contaminated broadleaf foliage	<1	<1-1.7
Acute exposure: Contaminated tall grass	<1	<1-1.4
Acute exposure: Contaminated short grass	<1	<1-3
Acute exposure: Contaminated insects	<1	<1
Acute exposure: Contaminated water	<1	<1
Acute exposure: Contaminated fish	NA	<1
Acute exposure: Contaminated small mammal (after direct spray)	<1	<1
Chronic/longer term exposure: Contaminated fruit	<1	<1-1.8
Chronic/longer term exposure: Contaminated broadleaf foliage	<1	<1-12
Chronic/longer term exposure: Contaminated tall grass	<1	<1-10
Chronic/longer term exposure: Contaminated short grass	<1	<1-21
Chronic/longer term exposure: Contaminated water	<1	<1
Chronic/longer term exposure: Contaminated fish	NA	<1

[1]HQ ranges are for lower- to upper-bound exposure estimates for small to large mammals. HQs listed as <1 or ≤1 (with no range) indicate that HQs for lower, central, and upper estimates are all ≤1.
[2]HQs in the 2004 HHERA were not reported by application method.
Abbreviations: HHERA = Human Health and Ecological Risk Assessment; NA = not assessed
Key: Cells are colored for the highest HQ:
HQ≤1 HQ>1-<2 HQ≥2

4.3.3.2. Birds

The risk characterization for birds used the acute and chronic NOAELs for technical sulfometuron methyl from the 2004 HHERA, and increases in HQs shown in Tables 9a and 9b are due to the higher application rate used in this Addendum. In the 2004 HHERA, no HQs exceeded 1 for any exposure scenarios assessed. However, assessments for the higher application rate resulted in HQs >1 for some exposures. The only acute exposure pathways with HQs slightly exceeding 1 are non-accidental acute exposure to contaminated short grass (upper-bound HQ of 2) and to contaminated broadleaf foliage (upper-bound HQ of 1.2). For birds, higher HQs due to chronic exposure to sulfometuron methyl were observed compared to those derived using the lower application rate in the 2004

HHERA. Chronic exposure to contaminated fruit and vegetation (broadleaf foliage, tall grass, and short grass) by birds resulted in upper-bound HQs of 4, 29, 24, and 52, respectively.

Table 9a. Hazard Quotients (HQs)[1] for Accidental and Non-Accidental Acute and Chronic/Longer Term Exposures of Birds to Sulfometuron Methyl – Backpack Directed Foliar

Exposure Scenario	2004[2]	2025
Accidental acute exposure: Consumption of contaminated water	NA	<1
Accidental acute exposure: Consumption of contaminated fish	<1	<1
Non-accidental acute exposure: Contaminated fruit	NA	<1
Non-accidental acute exposure: Contaminated broadleaf foliage	<1	<1-1.2
Non-accidental acute exposure: Contaminated tall grass	<1	≤1
Non-accidental acute exposure: Contaminated short grass	<1	<1-2
Non-accidental acute exposure: Contaminated water	NA	<1
Non-accidental acute exposure: Contaminated insects	<1	<1
Non-accidental acute exposure: Contaminated small mammal (after direct spray)	<1	<1
Non-accidental acute exposure: Contaminated fish	<1	<1
Chronic/longer term exposure: Contaminated fruit	NA	<1-4
Chronic/longer term exposure: Contaminated broadleaf foliage	<1	<1-29
Chronic/longer term exposure: Contaminated tall grass	<1	<1-24
Chronic/longer term exposure: Contaminated short grass	<1	<1-52
Chronic/longer term exposure: Contaminated water	NA	<1
Chronic/longer term exposure: Contaminated fish	<1	<1

Table 9b. Hazard Quotients (HQs)[1] for Accidental and Non-Accidental Acute and Chronic/Longer Term Exposures of Birds to Sulfometuron Methyl – Ground Broadcast Foliar

Exposure Scenario	2004[2]	2025
Accidental acute exposure: Consumption of contaminated water	NA	<1
Accidental acute exposure: Consumption of contaminated fish	<1	<1
Non-accidental acute exposure: Contaminated fruit	NA	<1
Non-accidental acute exposure: Contaminated broadleaf foliage	<1	<1-1.2
Non-accidental acute exposure: Contaminated tall grass	<1	≤1
Non-accidental acute exposure: Contaminated short grass	<1	<1-2
Non-accidental acute exposure: Contaminated water	NA	<1
Non-accidental acute exposure: Contaminated insects	<1	<1
Non-accidental acute exposure: Contaminated small mammal (after direct spray)	<1	<1
Non-accidental acute exposure: Contaminated fish	<1	<1
Chronic/longer term exposure: Contaminated fruit	NA	<1-4
Chronic/longer term exposure: Contaminated broadleaf foliage	<1	<1-29
Chronic/longer term exposure: Contaminated tall grass	<1	<1-24
Chronic/longer term exposure: Contaminated short grass	<1	<1-52
Chronic/longer term exposure: Contaminated water	NA	<1
Chronic/longer term exposure: Contaminated fish	<1	<1

[1]HQ ranges are for lower- to upper-bound exposure estimates for small to large birds. HQs listed as <1 or ≤1 (with no range) indicate that HQs for lower, central, and upper estimates are all ≤1.
[2]HQs in the 2004 HHERA were not reported by application method.
Abbreviations: HHERA = Human Health and Ecological Risk Assessment; NA = not assessed
Key: Cells are colored for the highest HQ:
HQ≤1 HQ>1-<2 HQ≥2

4.3.3.3. Honeybees and Other Terrestrial Invertebrates

The risk characterization for terrestrial invertebrates and honeybees used the acute oral and contact NOAELs for technical sulfometuron methyl from the 2004 HHERA. As shown in Tables 10a and 10b, honeybee exposure to sulfometuron methyl via drift resulted in HQs <1, consistent with the 2004 HHERA, despite the higher application rate used in this Addendum. For terrestrial insects, exposure to fruit by large insects, exposure to broadleaf vegetation by small insects, and exposure to short and long grass resulted in HQs <1. Note that these scenarios were not evaluated in the 2004 HHERA. For honeybees, no changes in ecological risk were observed based on the higher application rate.

Table 10a. Hazard Quotients (HQs)[1] for Acute Exposures of Terrestrial Invertebrates and Honeybees to Sulfometuron Methyl – Backpack Directed Foliar

Exposure Scenario	2004[2]	2025
Honeybee: Drift	<1	<1
Terrestrial Insects: Fruit/large insects	NA	<1
Terrestrial Insects: Broadleaf/small insects	NA	<1
Terrestrial Insects: Short grass	NA	<1
Terrestrial Insects: Long grass	NA	<1

Table 10b. Hazard Quotients (HQs)[1] for Acute Exposures of Terrestrial Invertebrates and Honeybees to Sulfometuron Methyl – Ground Broadcast Foliar

Exposure Scenario	2004[2]	2025
Honeybee: Drift	<1	<1
Terrestrial Insects: Fruit/large insects	NA	<1
Terrestrial Insects: Broadleaf/small insects	NA	<1
Terrestrial Insects: Short grass	NA	<1
Terrestrial Insects: Long grass	NA	<1

[1]HQ ranges are for lower to upper-bound exposure estimates. HQs listed as <1 or ≤1 (with no range) indicate that HQs for lower, central, and upper estimates are all ≤1.
[2]HQs in the 2004 HHERA were not reported by application method.
Abbreviations: HHERA = Human Health and Ecological Risk Assessment; NA = not assessed
Key: Cells are colored for the highest HQ:
HQ≤1 HQ>1-<2 HQ≥2

4.3.3.4. Terrestrial Plants

The risk characterization for non-target terrestrial plants used the same NOAELs for formulated sulfometuron methyl (Oust) for sensitive and tolerant plants as the 2004 HHERA. Two of the four exposure scenarios evaluated in this Addendum (see Tables 11a and 11b) were also evaluated in the 2004 HHERA: direct spray/spray drift and runoff. Upper-bound HQs exceeded 1 in the 2004 HHERA for both of these scenarios for both sensitive and tolerant plants. However, for the direct spray/spray drift scenario, HQs for both sensitive and tolerant plants in this Addendum are much higher than in the 2004 HHERA (upper-bound HQ of 15,833 for sensitive plants versus 2004 upper-

bound HQ of 1,875; upper-bound HQ of 487 for tolerant plants versus 2004 upper-bound HQ of 58). Additionally, HQs for exposure to sulfometuron methyl via runoff are much higher than those derived in the 2004 HHERA (upper-bound HQ of 1,944 for sensitive species versus 2004 upper-bound HQ of 57; upper-bound HQ of 67 for tolerant species versus 2004 upper-bound HQ of 1.9). The two additional exposure scenarios not evaluated in 2004 are exposure due to irrigation and wind erosion. HQs for tolerant plants due to wind erosion were less than 1; upper-bound HQs for sensitive plants exposed via wind erosion only slightly exceeded 1 (HQ=2). For irrigation, HQs for tolerant plants ranged from <1 to 12, and HQs for sensitive non-target terrestrial plants ranged from 1.8 to 399. For non-target terrestrial plants, there is a high level of concern for the direct spray/spray drift, runoff, and irrigation scenarios. This is a significant change from the 2004 HHERA and is primarily due to the approximately eight-fold increase in application rate. Since sulfometuron methyl is an herbicide, significant impacts to plants are expected.

Table 11a. Hazard Quotients (HQs)[1] for Exposure of Terrestrial Plants to Sulfometuron Methyl – Backpack Directed Foliar

Exposure Scenario	2004[2]	2025
Direct spray and spray drift	S: 1.5-1,875	S: 5-15,833
Direct spray and spray drift	T: <1-58	T: <1-487
Runoff[3]	S: <1-57	S:59-1,944
Runoff	T: <1-1.9	T: 2-67
Irrigation	NA	S: 1.8-399
Irrigation	NA	T: <1-12
Wind erosion	NA	S: <1-2
Wind erosion	NA	T: <1

Table 11b. Hazard Quotients (HQs)[1] for Exposure of Terrestrial Plants to Sulfometuron Methyl – Ground Broadcast Foliar

Exposure Scenario	2001[2]	2024
Direct spray and spray drift	S: 1.5-1,875	S: 17-15,833
Direct spray and spray drift	T: <1-58	T: <1-487
Runoff[3]	S: <1-57	S: 59-1,944
Runoff	T: <1-1.9	T: 2-67
Irrigation	NA	S: 1.8-399
Irrigation	NA	T: <1-12
Wind erosion	NA	S: <1-2
Wind erosion	NA	T: <1

[1]HQs listed as <1 or ≤1 (with no range) indicate that HQs for lower, central, and upper estimates are all ≤1.
[2]HQs in the 2004 HHERA were not reported by application method.
[3]HQs in the 2004 HHERA for the runoff scenario are reported for loam across a range of annual rainfall amounts, with HQs>1 only occurring at annual rainfall of 100 inches or greater.
Abbreviations: HHERA = Human Health and Ecological Risk Assessment; NA = not assessed; S = sensitive species; T = tolerant species
Key: Cells are colored for the highest HQ:
HQ≤1 HQ>1-<2 HQ≥2

4.3.3.5. Aquatic Organisms

HQs for aquatic organisms based on exposure to sulfometuron methyl are shown in Tables 12a and 12b. For all aquatic organisms, the toxicity values used in the 2004 HHERA were also used in this evaluation. For fish and aquatic invertebrates, HQs based on accidental and non-accidental acute exposure and chronic exposure are unchanged from the 2004 HHERA (HQs <1). For amphibians, HQs due to non-accidental acute exposure to sulfometuron methyl were less than 1 both in the 2004 HHERA and in this Addendum. Upper-bound HQs for accidental acute exposure and chronic exposure are higher in this Addendum than in the 2004 HHERA (HQs of 18 and 14, respectively). Given that the same acute and chronic NOAECs for amphibians were used in both 2004 and this Addendum, the increase in HQs is due to the increased application rate.

Table 12a. Hazard Quotients (HQs)[1] for Exposure of Aquatic Organisms to Sulfometuron Methyl – Backpack Directed Foliar

Exposure Scenario	2004[2]	2025
Fish: Accidental acute[3]	S: <1	S: <1
Fish: Accidental acute	T: <1	T: <1
Fish: Non-accidental acute	S: <1	S: <1
Fish: Non-accidental acute	T: <1	T: <1
Fish: Chronic/longer term	S: <1	S: <1
Fish: Chronic/longer term	T: <1	T: <1
Amphibians: Accidental acute[4]	<1-2	S: <1-18
Amphibians: Accidental acute	<1-2	T: <1-18
Amphibians: Non-accidental acute	<1	S: <1
Amphibians: Non-accidental acute	<1	T: <1
Amphibians: Chronic/longer term	<1	S: <1-14
Amphibians: Chronic/longer term	<1	T: <1-14
Aquatic invertebrates: Accidental acute	S: <1	S: <1
Aquatic invertebrates: Accidental acute	T: <1	T: <1
Aquatic invertebrates: Non-accidental acute	S: <1	S: <1
Aquatic invertebrates: Non-accidental acute	T: <1	T: <1
Aquatic invertebrates: Chronic/longer term	S: <1	S: <1
Aquatic invertebrates: Chronic/longer term	T: <1	T: <1
Aquatic macrophytes: Accidental acute[4]	469-3,965	S: 397-32,803
Aquatic macrophytes: Accidental acute	469-3,965	T: 397-32,803
Aquatic macrophytes: Non-accidental acute	<1-4	S: 4-101
Aquatic macrophytes: Non-accidental acute	<1-4	T: 4-101
Aquatic macrophytes: Chronic/longer term	<1	S: 2-51
Aquatic macrophytes: Chronic/longer term	<1	T: 2-51
Algae: Accidental acute	S: 39-333	S: 33-2,755
Algae: Accidental acute	T: <1-2	T: <1-19
Algae: Non-accidental acute	S: <1	S: <1-8
Algae: Non-accidental acute	T: <1	T: <1
Algae: Chronic/longer term	S: <1	S: <1-4

Exposure Scenario	2004[2]	2025
Algae: Chronic/longer term	T: <1	T: <1

Table 12b. Hazard Quotients (HQs)[1] for Exposure of Aquatic Organisms to Sulfometuron Methyl – Ground Broadcast Foliar

Exposure Scenario	2004[2]	2025
Fish: Accidental acute[3]	S: <1	S: <1
Fish: Accidental acute	T: <1	T: <1
Fish: Non-accidental acute	S: <1	S: <1
Fish: Non-accidental acute	T: <1	T: <1
Fish: Chronic/longer term	S: <1	S: <1
Fish: Chronic/longer term	T: <1	T: <1
Amphibians: Accidental acute[3,4]	<1-2	S: <1-18
Amphibians: Accidental acute	<1-2	T: <1-18
Amphibians: Non-accidental acute	<1	S: <1
Amphibians: Non-accidental acute	<1	T: <1
Amphibians: Chronic/longer term	<1	S: <1-14
Amphibians: Chronic/longer term	<1	T: <1-14
Aquatic invertebrates: Accidental acute[3]	S: <1	S: <1
Aquatic invertebrates: Accidental acute	T: <1	T: <1
Aquatic invertebrates: Non-accidental acute	S: <1	S: <1
Aquatic invertebrates: Non-accidental acute	T: <1	T: <1
Aquatic invertebrates: Chronic/longer term	S: <1	S: <1
Aquatic invertebrates: Chronic/longer term	T: <1	T: <1
Aquatic macrophytes: Accidental acute[3,4]	469-3,965	S: 397-32,803
Aquatic macrophytes: Accidental acute	469-3.965	T: 397-32,803
Aquatic macrophytes: Non-accidental acute	<1-4	S: 4-101
Aquatic macrophytes: Non-accidental acute	<1-4	T: 4-101
Aquatic macrophytes: Chronic/longer term	<1	S: 2-51
Aquatic macrophytes: Chronic/longer term	<1	T: 2-51
Algae: Accidental acute[3]	S: 39-333	S: 33-2,755
Algae: Accidental acute	T: <1-2	T: <1-19
Algae: Non-accidental acute	S: <1	S: <1-8
Algae: Non-accidental acute	T: <1	T: <1
Algae: Chronic/longer term	S: <1	S: <1-4
Algae: Chronic/longer term	T: <1	T: <1

[1]HQs listed as <1 or ≤1 (with no range) indicate that HQs for lower, central, and upper estimates are all ≤1.
[2]HQs in the 2004 HHERA were not reported by application method.
[3]The 2004 HHERA does not discuss acute accidental exposure of aquatic organisms in the text; however, the worksheets in Supplements 1 and 2 of the HHERA report HQs for accidental spill, peak EEC, and longer-term EEC. In this table, accidental spill HQs are reported as accidental acute HQs (not discussed in the text of the 2004 HHERA), peak EEC HQs are reported as non-accidental acute HQs (discussed as acute HQs in the text of the 2004 HHERA), and longer-term EEC HQs are reported as chronic HQs (discussed as chronic HQs in the text of the 2004 HHERA).
[4]The 2004 HHERA did not evaluate sensitive and tolerant species for amphibians or aquatic macrophytes.

Abbreviations: HHERA = Human Health and Ecological Risk Assessment; NA = not assessed; S = sensitive species; T = tolerant species
Key: Cells are colored for the highest HQ:

HQ≤1 HQ>1-<2 HQ≥2

NOAECs for aquatic macrophytes and algae used in the 2004 HHERA are also used in this Addendum. As shown in Tables 12a and 12 b, HQs from accidental acute exposure of aquatic macrophytes and algae to sulfometuron methyl were high in the 2004 HHERA and increased substantially in this Addendum. This is consistent with the approximately eight-fold increase in application rate. Non-accidental acute and chronic exposure to sulfometuron methyl resulted in much higher HQs in this Addendum compared to the 2004 HHERA for aquatic macrophytes (upper-bound HQs of 101 and 51, respectively, compared to 2004 upper-bound HQs of 4 and <1). For tolerant non-target algal species, HQs did not change from those observed in the 2004 HHERA due to non-accidental acute or chronic exposure to sulfometuron methyl (all HQs <1). HQs for sensitive algae are slightly higher for non-accidental acute and chronic exposure in this Addendum than in the 2004 HHERA (upper-bound HQs of 8 and 4, respectively, compared to 2004 HQs <1). The difference in HQs for aquatic organisms is due to the higher application rate. For aquatic macrophytes and algae, HQs for the acute accidental exposure scenario are extremely high and represent significant impacts. Given that sulfometuron methyl is an herbicide, these impacts are anticipated.

5. References

For this risk assessment Addendum, toxicologically relevant MRID studies were not available. All data attributed to specific MRID studies were taken from DERs developed by USEPA for MRID studies and are listed in the table below (sorted by MRID number). All other references cited in the document follow.

Table 13. MRID Studies

MRID	Citation
MRID50034001	Cadwgan, G., et al. (2016) Metabolism of [Phenyl (U)-14C] and [Pyrimidine-2-14C] Sulfometuron Methyl in Bermuda Grass. Study Number: AMR 906-87. Unpublished study prepared and submitted by E. I. du Pont de Nemours and Company. 86 p.
MRID50034012	Vincent, D.R. (1989) Metabolism of sulfometuron methyl in rats. E.I. du Pont de Nemours and Company, Inc., Haskell Laboratory for Toxicology and Industrial Medicine, Newark, DE. Project IDs: Haskell Laboratory Report No. 140-88 and Du Pont AMR #907-87. February 3, 1989. MRID 50034012. Unpublished.
MRID50034013	Krsmanovic, L. and K. Divi. (2010) Sulfometuron methyl (DPX-T5648) technical: Mouse bone marrow erythrocyte micronucleus test following oral administration. BioReliance, Rockville, MD. Laboratory Study No.: AD10DN.123.BTL; DuPont-30986, September 10, 2010. MRID 50034013. Unpublished.

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Attachments

Attachment 1 – Literature Search Documentation

Attachment 2 – Documentation for Use of GLEAMS

Attachment 3 – Documentation for Worksheets Version 2.02 HHERAs

Attachment 4 – Studies of Toxicity to Ecological Receptors of Sulfometuron Methyl Published Since the 2004 HHERA

Attachment 1 – Literature Search Documentation

Table 1-1. Literature Search Strings

Database	Query String
Pubmed	("sulfometuron methyl"[nm] OR 74222-97-2[rn] OR "2-[[[[(4,6-Dimethyl-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]benzoic acid, Methyl ester"[tw] OR "Aa 5648"[tw] OR "Benzoic acid, 2-(((((4,6-dimethyl-2-pyrimidinyl)amino)carbonyl)amino)sulfonyl)-, methyl ester"[tw] OR "Benzoic acid, 2-[[[[(4,6-dimethyl-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-, methyl ester"[tw] OR "Benzoic acid, o-((3-(4,6-dimethyl-2-pyrimidinyl)ureido)sulfonyl)-, methyl ester"[tw] OR "Curavial"[tw] OR "DPX 5648"[tw] OR "DPX-T5648"[tw] OR "Methyl 2-(((((4,6-dimethyl-2-pyrimidinyl)amino)carbonyl)amino)sulphonyl)benzoate"[tw] OR "Methyl 2-{[(4,6-dimethylpyrimidin-2-yl)carbamoyl]sulfamoyl}benzoate"[tw] OR "Methyl-2-(((((4,6-dimethyl-2-pyrimidinyl)amino)carbonyl)amino)sulfonyl)benzoate"[tw] OR "Methyl-2-((((4,6-dimethyl-2-pyrimidinyl)amino)carbonyl)sulfonyl)benzoate"[tw] OR "Oust XP"[tw] OR "Sulfomethuron-methyl"[tw] OR "Sulfometuron"[tw]) AND 2003:3000[dp]
EBSCOhost[1]	SU (Sulfometuron OR "2-[[[[(4,6-Dimethyl-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]benzoic acid, Methyl ester" OR "Aa 5648" OR "Benzoic acid, 2-(((((4,6-dimethyl-2-pyrimidinyl)amino)carbonyl)amino)sulfonyl)-, methyl ester" OR "Benzoic acid, 2-[[[[(4,6-dimethyl-2-pyrimidinyl)amino]carbonyl]amino]sulfonyl]-, methyl ester" OR "Benzoic acid, o-((3-(4,6-dimethyl-2-pyrimidinyl)ureido)sulfonyl)-, methyl ester" OR "Curavial" OR "DPX 5648" OR "DPX-T5648" OR "Methyl 2-(((((4,6-dimethyl-2-pyrimidinyl)amino)carbonyl)amino)sulphonyl)benzoate" OR "Methyl 2-{[(4,6-dimethylpyrimidin-2-yl)carbamoyl]sulfamoyl}benzoate" OR "Methyl-2-(((((4,6-dimethyl-2-pyrimidinyl)amino)carbonyl)amino)sulfonyl)benzoate" OR "Methyl-2-((((4,6-dimethyl-2-pyrimidinyl)amino)carbonyl)sulfonyl)benzoate" OR "Oust XP" OR "Sulfomethuron-methyl" OR "Sulfometuron") OR TX "74222-97-2"

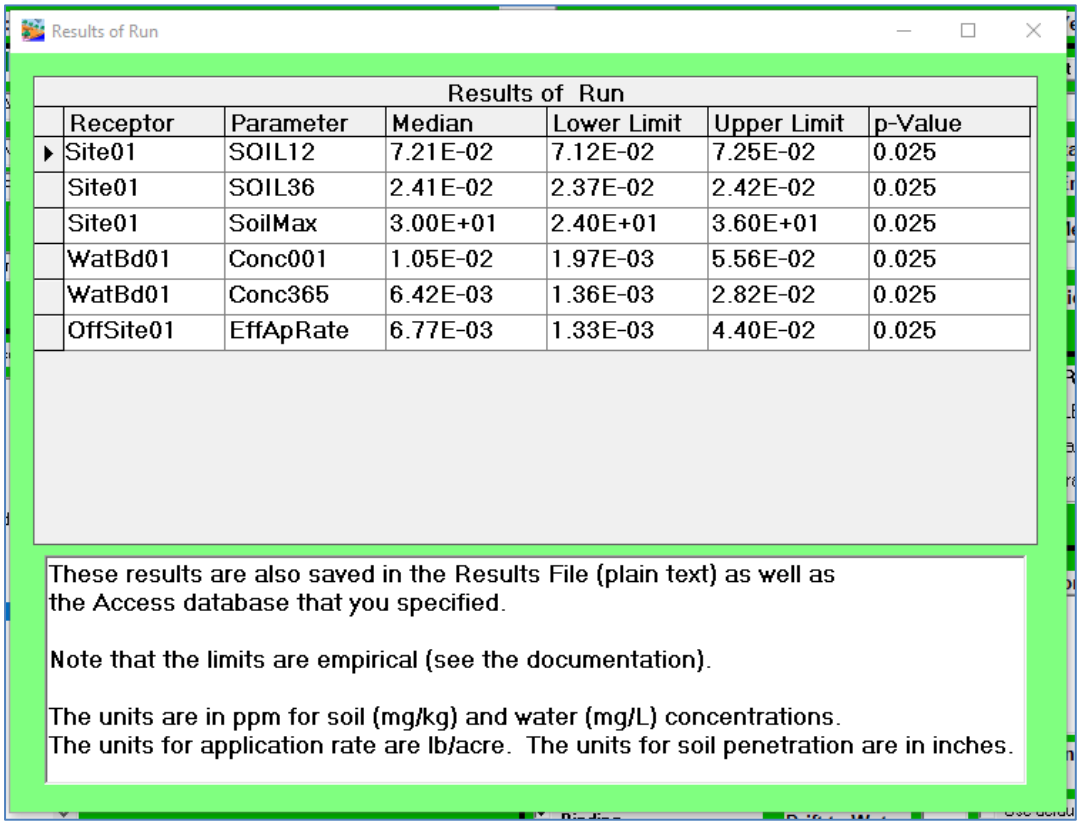
[1]Databases: AGRICOLA, Biological Abstracts, CAB Abstracts, Environment Complete, and Global Health.

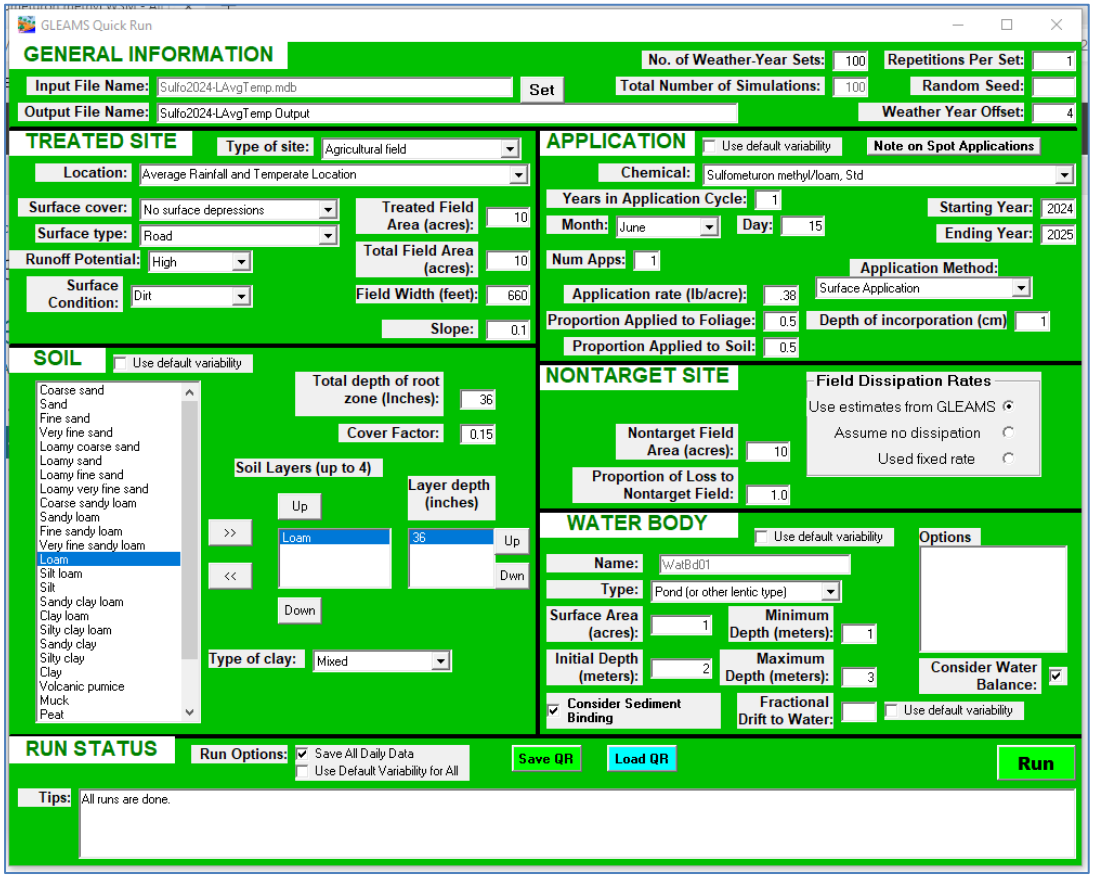
Table 1-2. Grey Literature Sources Searched

Source	URL(s)
AICIS	https://services.industrialchemicals.gov.au/search-assessments/
ATSDR	https://www.atsdr.cdc.gov/toxicological-profiles/about/index.html
CalEPA	https://oehha.ca.gov/chemicals
ChemView	https://chemview.epa.gov/chemview
ECETOC	https://www.ecetoc.org/publications/
ECHA	https://chem.echa.europa.eu/
ECOTOX	https://cfpub.epa.gov/ecotox/
EFSA	https://www.efsa.europa.eu/en/search
FDA	https://www.fda.gov/
IARC	https://monographs.iarc.who.int/list-of-classifications
INCHEM	https://www.inchem.org/#/
IRIS	https://iris.epa.gov/AdvancedSearch/
J-CHECK	http://www.safe.nite.go.jp/jcheck/search.action?request_locale=en
JECDB	http://dra4.nihs.go.jp/mhlw_data/jsp/SearchPageENG.jsp
NIEHS	http://www.niehs.nih.gov/
NPIRS	https://www.npirs.org/
NTP	https://ntp.niehs.nih.gov/
NTRL	https://ntrl.ntis.gov/NTRL/
OECD	https://www.echemportal.org/echemportal/ and https://hpvchemicals.oecd.org/UI/Search.aspx
OSHA	https://www.osha.gov/chemicaldata/
Pesticide Chemical Search	https://ordspub.epa.gov/ords/pesticides/f?p=chemicalsearch:1
PPRTV	https://www.epa.gov/pprtv/provisional-peer-reviewed-toxicity-values-pprtvs-assessments
PubChem	https://pubchem.ncbi.nlm.nih.gov/
Regulations.gov	https://www.regulations.gov/
WHO	https://apps.who.int/iris/

Abbreviations: AICIS = Australian Industrial Chemicals Introduction Scheme; ATSDR = Agency for Toxic Substances and Disease Registry; CalEPA = California Environmental Protection Agency; ECETOC = European Centre for Ecotoxicology and Toxicology of Chemicals; ECHA = European Chemicals Agency; EFSA = European Food Safety Authority; FDA = Food and Drug Administration; IARC = International Agency for Research on Cancer; IRIS = Integrated Risk Information System; J-CHECK = Japan Chemicals Collaborative Knowledge database; JECDB = Japan Existing Chemical Data Base; NIEHS = National Institute of Environmental Health Sciences; NPIRS = National Pesticide Information Retrieval System; NTP = National Toxicology Program; NTRL = National Technical Reports Library; OECD = Organisation for Economic Co-operation and Development; OSHA = Occupational Safety and Health Administration; PPRTV = Provisional Peer-Reviewed Toxicity Value; WHO = World Health Organization

Attachment 2 – Documentation for Use of GLEAMS





Attachment 3 – Documentation for Worksheets Version 2.02 HHERAs

Table 1: General Information on Chemical

Field	Value	Note
ChemCode	Sulfo2024	Use up to 12 characters. Anything beyond 12 characters is ignored. If the **ChemCode** is currently in use, this code may be changed by the program. This will not impact your ability to run WorksheetMaker with the new or the preexisting chemical.
ChemName	Sulfometuron Methyl 2024	Enter the name of the chemical here. Up to 255 characters are allowed.
TypePesticide	Herbicide	If appropriate, enter one of the following: **Herbicide, Insecticide, Piscicide, Rodenticide,** or **Fungicide.** You can use another name or leave this blank.
RA_Number		If you are using a risk assessment or other document, you may want to enter a reference number with a maximum of 50 characters. You can leave this blank.
RA_Date	12/1/2024	You can enter a date in this field or leave it blank.
Table Type	ChemsAvail	Do not change this row.

Table 2: Chemical Properties

InfoType	PropCode	Receptor	Value	Units	Reference
BscInfo	MW		364.38	grams/mole	Budavari (1989)
BscInfo	WS		300	mg/L	Budavari (1989)
BscInfo	Kow		0.347	unitless	Stevenson (1988)
Kinetics	T12_C	Fruit	10	days	Knisel and Davis (2000)
Kinetics	T12_L	Fruit	10	days	Knisel and Davis (2000)
Kinetics	T12_U	Fruit	10	days	Knisel and Davis (2000)
Kinetics	T12_C	VegNOS	10	days	Knisel and Davis (2000)
Kinetics	T12_L	VegNOS	10	days	Knisel and Davis (2000)
Kinetics	T12_U	VegNOS	10	days	Knisel and Davis (2000)
BCF	BCF_Ed_Ac		3	L/kg fish	Harvey (1981, 1990)
BCF	BCF_Ed_Ch		7	L/kg fish	Harvey (1981, 1990)
BCF	BCF_WF_Ac		3.5	L/kg fish	Harvey (1981, 1990)
BCF	BCF_WF_Ch		6	L/kg fish	Harvey (1981, 1990)
DrmAbs	Kp_C		0.0000051	cm/hour	Prev worksheet B01
DrmAbs	Kp_L		0.000002	cm/hour	Prev worksheet B01
DrmAbs	Kp_U		0.000013	cm/hour	Prev worksheet B01
DrmAbs	ka_C		0.00022	per hour	Prev worksheet B01
DrmAbs	ka_L		0.000048	per hour	Prev worksheet B01
DrmAbs	ka_U		0.00098	per hour	Prev worksheet B01
Table Type	ChemProps	Do not change this row.			

Table 3: Toxicity Values

Receptor	Dur	Sens	Route	Endpoint	Value	Units	Reference
Hum	Ac			RfD	0.87	mg/kg bw	
Hum	Ch			RfD	0.02	mg/kg bw/day	
Hum	Ch			CancRisk		mg/kg bw/day	
AdlFe	Ac			RfD	0.87	mg/kg bw/day	
AdlFe	Ch			RfD	0.02	mg/kg bw	
Wrkr	Ch			RfD	0.02	mg/kg bw/day	
Mam	Ac			NOAEL	87	mg/kg bw	
Mam	Ch			NOAEL	2	mg/kg bw/day	
MamCrn	Ac			NOAEL	87	mg/kg bw	
MamCrn	Ch			NOAEL	2	mg/kg bw/day	
Brd	Ac			NOAEL	312	mg/kg bw	
Brd	Ch			NOAEL	2	mg/kg bw/day	
HonBee	Ac		Oral	NOAEL	1075	mg/kg bw	
HonBee	Ac		Contact	NOAEL	1075	mg/kg bw	
InsectHerb	Ac			NOAEL	1075	mg/kg bw	
TrPlnt	VegVig	Sn		NOAEL	0.000024	lb/acre	
TrPlnt	VegVig	Tl		NOAEL	0.00078	lb/acre	
TrPlnt	SdlE	Sn		NOAEL	0.0000086	lb/acre	
TrPlnt	SdlE	Tl		NOAEL	0.00025	lb/acre	
AqInv	Ac	Sn		NOAEC	75	mg/L	
AqInv	Ac	Tl		NOAEC	1800	mg/L	
AqInv	Ch	Sn		NOAEC	0.19	mg/L	
AqInv	Ch	Tl		NOAEC	6.1	mg/L	
Amph	Ac	Sn		NOAEC	0.38	mg/L	
Amph	Ac	Tl		NOAEC	0.38	mg/L	
Amph	Ch	Sn		NOAEC	0.00075	mg/L	
Amph	Ch	Tl		NOAEC	0.00075	mg/L	
Fsh	Ac	Sn		NOAEC	7.3	mg/L	
Fsh	Ac	Tl		NOAEC	150	mg/L	
Fsh	Ch	Sn		NOAEC	1.17	mg/L	
Fsh	Ch	Tl		NOAEC	1.17	mg/L	
Alg		Sn		NOAEC	0.0025	mg/L	
Alg		Tl		NOAEC	0.37	mg/L	
Mcrph		Sn		NOAEC	0.00021	mg/L	
Mcrph		Tl		NOAEC	0.00021	mg/L	
Table Type	ToxVals	Do not change this row.					

Table 4: Water Contamination Rates

Dur	Modifier	Value	Reference
Ac	C	0.0105	GLEAMS Driver
Ac	L	0.00197	GLEAMS Driver
Ac	U	0.0556	GLEAMS Driver
Ch	C	0.00642	GLEAMS Driver
Ch	L	0.00136	GLEAMS Driver
Ch	U	0.0282	GLEAMS Driver
Table Type	AmbientWat	Do not change this row	

Table 5: Offsite Contamination of Soil

Dur	Modifier	Value	Reference
Ac	C	0.00677	GLEAMS Driver
Ac	L	0.00133	GLEAMS Driver
Ac	U	0.044	GLEAMS Driver
Table Type	RunoffRates	Do not change this row	

Table 8: Template for Foliar Application Formulation

Code	Item	Value	Permitted Values	Comment
STANDARD REQUIRED ITEMS				
FormName	Formulation Name	Oust/OustXP	Any text	Commercial name on product label
ChemName	Pesticide name	Sulfometuron Methyl 2024	Name	This must correspond to the name of a pesticide that is in WorksheetMaker.
FormType	Type of Formulation	Liquid	`Liquid`, `Granular`, or `Powder`	
PerCentActive	Percent active ingredient	75	Number	A numeric value for the per cent (w/w) a.i. or a.e. in the formulation. For weak acids, enter the % a.e. Do not enter the value as a proportion. Thus, for a sixty percent a.i. or a.e. enter 60 rather than 0.6. You can enter a % sign but this will be ignored.
LbPerGal	Lbs a.i. or a.e./gallon		Number, `ULV`, or blank	A numeric value for the pounds a.i. or a.e. per gallon in the formulation. For weak acids, enter the lbs a.e./gallon. Leave blank for granular or powder formulations. For ultralow volume applications, simply enter ULV in the Value column. If ULV is used, the bulk density of the formulation must be entered as a Special Property. See below.
ActiveType	Classification of active ingredient.	a.i.	`a.i.` or `a.e.`	Use a.e. for esters of weak acids.
ApRt	Application rate	0.045, 0.03, 0.38	Number or CLU	Use units of lbs/acre. Use a.e. for weak acids or their esters and a.i. for other pesticides.
ApVol	Application volume	15, 5, 40	Number or CLU	Gallons per acre of field solution.
ApMethod	Application method(s)	Bkpk, Boom	`Aerial`, `Bkpk`, and/or `Boom`	Use any or all of the codes to the left for aerial application (`Aerial`), backpack application (`Bkpk`), or ground boom (`Boom`)

Attachment 4 – Studies of Toxicity to Ecological Receptors of Sulfometuron Methyl Published Since the 2004 HHERA

Table 4-1a. Studies of Acute and Chronic Toxicity to Terrestrial Invertebrates of Technical-Grade Sulfometuron Methyl Published Since the 2004 HHERA

Study Basis	Species	Exposure	Response	Reference
Chronic (repeated dose)	Soil bacteria	Technical-grade sulfometuron methyl (purity: 98.9% a.i.) in acetone. Application rate: 20 mg/ha (equivalent to 0.000018 lb a.i./acre), along with negative control. Bench experiment: Applied to Amazonian soil; samples were incubated 80 days, and abundance and richness of the bacterial community was measured periodically throughout the incubation period. Location: Brazil	NOAEL: 0.000018 lb a.i./acre LOAEL: >0.000018 lb a.i./acre Bacterial community abundance and richness were not clearly or significantly affected by sulfometuron methyl treatment compared to negative controls.	Alvarez et al. (2021)
Chronic (repeated dose)	Soil bacteria	Technical-grade sulfometuron methyl (purity: 98.9% a.i.) in acetone. Application rate: 0 and 33 g a.i./ha (equivalent to 0.029 lb a.i./acre). Bench experiment: Applied to Brazilian soil surface; carbon transformation by soil microbiota, bacteria community structure, and bacteria diversity were measured 7, 14, 28, and 42 days after treatment (DAT). Location: Brazil	NOAEL: <0.029 lb a.i./acre LOAEL: 0.029 lb a.i./acre LOAEL is based on significant increase in released CO_2 in sandy soil at 42 DAT compared to negative control, though no significant effects were seen in clay soil. Species richness was lower in treatment compared to controls in both clay and sandy soils; diversity in the bacterial community (measured by the Shannon-Weiner community index) was lower in treatment compared to controls in clay soil but higher in sandy soil.	Reis et al. (2019)

Abbreviations: a.i. = active ingredient; DAT = days after treatment; g = gram; ha = hectare; HHERA = Human Health and Ecological Risk Assessment; lb = pound; LOAEL = lowest-observed-adverse-effect level; mg = milligram; NOAEL = no-observed-adverse-effect level

Table 4-1b. Studies of Acute and Chronic Toxicity to Terrestrial Invertebrates of Formulated Sulfometuron Methyl Published Since the 2004 HHERA

Study Basis	Species	Exposure	Response	Reference
Chronic	Fungi (*Ectomycorrhizae*)	Formulated sulfometuron methyl product (Oust®, 75% a.i.). Application rate: 0.14 and 0.28 kg a.i./ha (equivalent to 0.13 and 0.25 lb a.i./acre), and negative control. Greenhouse experiment: Applied to soil surface at the onset of lateral root development of Ponderosa pine (*Pinus ponderosa*), Douglas fir (*Pseudosuga menziesii*), and white fir (*Abies concolor*) seedlings. Soils were analyzed for mycorrhizal counts, microbial biomass, and respiration immediately after harvest. Location: Northern California	NOAEL: 0.25 lb a.i./acre LOAEL: >0.25 lb a.i./acre No significant adverse effects on mycorrhizal formation, microbial biomass, or respiratory activity.	Busse et al. (2004)

Abbreviations: a.i. = active ingredient; DAT = days after treatment; ha = hectare; HHERA = Human Health and Ecological Risk Assessment; kg = kilogram; lb = pound; LOAEL = lowest-observed-adverse-effect level; mg = milligram; NOAEL = no-observed-adverse-effect level

Table 4-2a. Studies of Toxicity to Terrestrial Plants of Technical-Grade Sulfometuron Methyl Published Since the 2004 HHERA

Species	Exposure	Response	Reference
Lettuce (*Lactuca sativa*; 'Lucy Brown' and 'Vanda' cultivars) 5 seedlings/dose	Technical-grade sulfometuron methyl (purity not reported) in 0.1% v/v mineral oil. Application rate: 0, 0.45, 0.90, 1.35, and 1.80 g a.i./ha (equivalent to 0, 0.0004, 0.0008, 0.0012, and 0.0016 lb a.i./acre). Field study: Applied via backpack spray to 'Lucy Brown' at the beginning of head formation and to 'Vanda' at the 6-7 leaf growth stage. Evaluated fresh and dry biomass, number of leaves, chlorophyll content, quantum efficiency of photosystem II, lipid peroxidation, hydrogen peroxide content, and enzyme activity. Location: São Paulo, Brazil	NOAEL: <0.0.0004 lb a.i./acre LOAEL: 0.0004 lb a.i./acre LOAEL is based on significant decrease in biomass (fresh: Lucy Brown only; dry: both cultivars), and significant decrease in chlorophyll content (both cultivars) and chlorophyll A fluorescence (Vanda only).	de Souza Rodrigues et al. (2021)
Potato (*Solanum tuberosum;* Russet Burbank)	Assumed to be technical-grade sulfometuron methyl (purity not reported). Application rate: 0, 7.5, 15, 30, 60, 120, 240, 480, and 960 ppt (equivalent to 0, 0.0000075, 0.000015, 0.00003, 0.00006, 0.00012, 0.00024, 0.00048, and 0.00096 mg a.i./L). Field experiment: Applied to soil immediately prior to planting via rototiller to 8 cm depth. Evaluated plant height, visual injury, biomass, and root and tuber ratings midseason, and overall yield at the end of the season. Location: Idaho	NOAEL: <0.0000075 mg a.i./L LOAEL: 0.0000075 mg a.i./L LOAEL is based on significant increase in root and tuber injury ratings compared to controls ($p \leq 0.05$) during midseason visual evaluations.	Hutchinson et al. (2007)

Peanuts (*Arachis hypogaea*), Cotton (*Gossypium hirsutum*), Potato (*Solanum tuberosum*), Coffee (*Coffea arabica*), Beans (*Phaseolus vulgaris*), Sunflower (*Helianthus annuus*), Cassava (*Manihot esculenta*), Rubber (*Hevea brasiliensis*), Soybean (*Glycine max*), and Grapes (*Vitis vinifera*) 4 pots/treatment (1-4 plants per pot)	Assumed to be technical-grade sulfometuron methyl (purity not reported). Application rate: 7.5 and 15 g/ha (0.007 and 0.013 lb a.i./acre), along with negative control. Field experiment: Applied via backpack sprayer. Plants were evaluated for injury beginning 7 days after application (DAA), as well as for height and weight and other characteristics specific to the plant species evaluated. Location: São Paulo, Brazil	**Peanut, Cotton, Potato, Bean, Sunflower, Soybean, and Grape:** NOAEL: <0.007 lb a.i./acre LOAEL: 0.007 lb a.i./acre Peanut: LOAEL is based on significant increase in plant injury compared to controls (16-30% increase; $p<0.05$). Cotton: LOAEL is based on significant increase in plant injury (16-27% increase; $p<0.05$) and significant decreases in plant height (33% decrease; $p<0.05$) and dry weight (33% decrease; $p<0.05$) compared to negative controls. Potato: LOAEL is based on significant increase in plant injury compared to negative controls at 14 days after application (5% increase; $p<0.05$) and significant decrease in tuber weight compared to negative controls (32% decrease; $p<0.05$). Bean: LOAEL is based on significant increase (23-28%; $p<0.05$) in plant injury compared to controls, and significant decreases in seed weight (98%), number of seeds per plant (94%), and number of pods per plant (88%) compared to controls ($p<0.05$). Sunflower: LOAEL is based on significant increase (51-83%; $p<0.05$) in plant injury compared to controls, and significant decreases in plant height (50%),shoot dry weight (52%) and head dry weight (74%) compared to controls ($p<0.05$). Soybean: LOAEL is based on significant increase (27-73%; $p<0.05$) in plant injury compared to controls, significant decreases in shoot dry weight (35%), number of pods per plant (86%), and pod fresh weight (93%) compared to controls ($p<0.05$).	Correia and Leite (2012)

Species	Exposure	Response	Reference
		Grape: LOAEL is based on significant increase in plant injury (5-49%; p<0.05) compared to controls, and significant decreases in the number of clusters per plant (82%) and cluster fresh weight (98%) compared to controls (p<0.05). **Coffee, Citrus, Cassava, Rubber:** NOAEL: >0.013 lb a.i./acre No significant effect of sulfometuron methyl on plant characteristics for coffee, citrus, cassava, and rubber plants compared to controls.	
Giant miscanthus (*Miscanthus* x *giganteus*) 7 pots/treatment	Assumed to be technical-grade sulfometuron methyl (purity not reported) and 0.25% v/v adjuvant nonionic surfactant. Application rate: 105 g a.i./ha (equivalent to 0.09 lb a.i./acre), along with a nontreated control. Field experiment: Applied via CO2 backpack sprayer to giant miscanthus when shoots had an average height of 40 cm. Plants were evaluated for crop injury and shoot height 2 and 4 weeks after treatment (WAT). Shoot dry biomass was evaluated 4 WAT and re-evaluated 8 WAT for shoot regrowth. Location: Tifton, Georgia	NOAEL: <0.09 lb a.i./acre LOAEL: 0.09 lb a.i./acre LOAEL is based on significant decrease in shoot height, shoot dry weight, and shoot regrowth compared to control (28-43%, 81%, and 49% decreases, respectively), as well as a significant increase (25-30%) in crop injury compared to nontreated control (p<0.05).	Li et al. (2013)

Abbreviations: a.i. = active ingredient; cm = centimeter; d = days; DAE = days after emergence; DAT = days after treatment; EC_{25} = 25th percentile effects concentration; g = gram; ha = hectare; HHERA = Human Health and Ecological Risk Assessment; I_{50} = concentration causing 50% inhibition; kg = kilogram; L = liter; lb = pound; LOAEL = lowest-observed-adverse-effect level; MAT = months after treatment; mg = milligram; NOAEL = no-observed-adverse-effect level; ppt = parts per trillion; USDA = United States Department of Agriculture; v = volume; WAT = weeks after treatment

Table 4-2b. Studies of Toxicity to Terrestrial Plants of Formulated Sulfometuron Methyl Product Published Since the 2004 HHERA

Species	Exposure	Response	Reference
Monocots Corn (*Zea mays*) Oat (*Avena sativa*) California brome (*Bromus carinatus*) Dicots Soybean (*Glycine Max*) Lettuce (*Lactuca sativa*) Western buttercup (*Ranunculus occidentalis*) 6 plants/dose	Formulated sulfometuron methyl product, Oust®75DF (assuming 75% a.i.) and 0.25% v/v nonionic surfactant (Preference™). Application rate: 0.224 and 7 g product/ha (equivalent to 0.00015 and 0.0047 lb a.i./acre assuming 75% a.i.) with negative and solvent controls (field application rate: 52 g a.i./ha). Greenhouse experiment: Applied to plants grown in range of soils (native to Maryland and Oregon) via overhead trolley sprayer 2 weeks after emergence (WAE); 14-day vegetative vigor test. Location: Oregon	**Most sensitive monocot:** Corn (dry weight and shoot height) NOAEL: <0.00015 lb a.i./acre LOAEL: 0.00015 lb a.i./acre Oat (dry weight and shoot height) NOAEL: <0.00015 lb a.i./acre LOAEL: 0.00015 lb a.i./acre California brome (shoot height) NOAEL: <0.00015 lb a.i./acre LOAEL: 0.00015 lb a.i./acre **Most sensitive dicot:** Soybean (dry weight and shoot height) NOAEL: <0.00015 lb a.i./acre LOAEL: 0.00015 lb a.i./acre Lettuce (dry weight and shoot height) NOAEL: <0.00015 lb a.i./acre LOAEL: 0.00015 lb a.i./acre Western buttercup (dry weight and shoot height) NOAEL: <0.00015 lb a.i./acre LOAEL: 0.00015 lb a.i./acre	Bidelspach et al. (2008)

Species	Exposure	Response	Reference
Grasses (*Andropogon virginicus*, *Aristida stricta*, *Saccharum alopecuroides*, *Sorghastrum secundum*, and *Sporobolus junceus*) Legumes (*Crotalaria rotundifolia*, *Desmodium floridanum*, *Lespedeza angustifolia*) Flowers (*Helianthus angustifolia*, *Rudbeckia hirta*) 3 seed flats/growth stage/dose (seed flats: 3-5 seeds/cell, 40 or 45 cells/flat)	Formulated sulfometuron methyl product (Oust, 75% a.i.). Application rate: 0.14 and 0.27 kg product/ha (equivalent to 0.09 and 0.18 lb a.i./acre), and negative control. Greenhouse experiment: Sprayed on seedlings of different ages (0 [pre-emergent] and 30 and 60 [post-emergent] days old). Plants were visually assessed for leaf damage 30 DAA and then dried to determine dry weight biomass. Location: Georgia	**Biomass:** NOAEL: <0.09 lb a.i./acre LOAEL: 0.09 lb a.i./acre Significant reduction in aboveground dry weight biomass compared to control (p≤0.05) in four grasses (*A. stricta* 0, 30, and 60 d; *S. alopecuroides* 30 d; and *S. secundum* 0 d; and *S. junceus* 30 and 60 d); three legumes (*C. rotundifolia* 0 and 30 d; *D. floridanum* 0, 30, and 60d; *L. angustifolia* 0, 30, and 60d); and two composites (*H. angustifolia* 0, 30, and 60 d; and *R. hirta* 0 and 30 d). Phytotoxicity scores ranging from 7-9 (heavy injury, near death, and death) were observed in three grasses (*Aristida stricta*, *S. alopecuroides*, and *S. secundum*) and both flowers after exposure to 0.09 lb a.i./acre.	Kaeser and Kirkman (2010)

Monocots Oat (*Avena sativa*) Corn (*Zea mays*) Purpletop (*Tridens flavus*) Big blue stem (*Andropogon gerardi*) Dicots Carrot (*Daucus carota*) Soybean (*Glycine max*) Tomato (*Solanum Lycopersicon*) Tall goldenrod (*Solidago canadensis*) Nodding smartweed (*Polygonum lapathifolium*) Calico aster (*Symphyotrichum lateriflorum*) 6 plants/dose	Formulated sulfometuron methyl product (Oust 75DF, assuming 75% a.i.) and 0.25% v/v nonionic surfactant (Preference™). Application rate: 0.052, 0.104, 0.52, and 5.2 g a.i./ha (equivalent to 0.000046, 0.00009, 0.00046, and 0.0046 lb a.i./acre), with negative and surfactant controls (field application rate: 52 g a.i./ha). Greenhouse experiment: Applied to plants via overhead trolley sprayer; 14-day vegetative vigor test. Location: Oregon	**Most sensitive monocot:** Oat (plant height and shoot dry weight) EC_{25}: 0.00001 NOAEL: 0.000046 lb a.i./acre Corn (plant height and shoot dry weight) EC_{25}: 0.00001 NOAEL: <0.000046 lb a.i./acre Purpletop (plant height) EC_{25}: 0.0005 NOAEL: 0.00046 lb a.i./acre **Most sensitive dicot:** Carrot (plant height and shoot dry weight) EC_{25}: 0.000007 lb a.i./acre NOAEL: <0.000046 lb a.i./acre Soybean (plant height and shoot dry weight) EC_{25}: 0.00001 NOAEL: <0.000046 lb a.i./acre Tomato (plant height and shoot dry weight) EC_{25}: 0.00001 NOAEL: 0.000046 lb a.i./acre Goldenrod (plant height) EC_{25}: 0.00007 NOAEL: <0.000046 lb a.i./acre Nodding smartweed (plant height and shoot dry weight) EC_{25}: 0.00002 NOAEL: 0.000046 lb a.i./acre	Olszyk et al. (2008)

Species	Exposure	Response	Reference
		Calico aster (plant height and shoot dry weight) EC_{25}: 0.0004 NOAEL: 0.000046 lb a.i./acre No significant effects for height or biomass were observed in big bluestem. All tested applications produced some degree of leaf injury in all species tested.	

Species	Exposure	Response	Reference
Pea (*Pisum sativum*) 6 plants/dose	Formulated sulfometuron methyl product (Oust, 75% a.i.) and 0.25% v/v nonionic surfactant (Preference™). Application rate: 0.053, 0.106, 0.53, and 5.3 g a.i./ha (equivalent to 0.000047, 0.000095, 0.00047, 0.0047 lb a.i./acre), with negative and surfactant controls (field application rate: 53 g a.i./ha). Greenhouse experiment: Applied to plants via overhead trolley sprayer at the vegetative stage (~14 days after emergence (DAE)) or at flowering (~20 DAE). Evaluated plant height and leaf injury 14 days post-exposure. Seed and plant dry weight were measured after seed harvest, 35-41 DAE. "Experiment 1" was conducted in the spring, and "Experiment 2" was conducted in the summer. Location: Oregon	NOAEL: <0.000047 lb a.i./acre LOAEL: 0.000047 lb a.i./acre EC_{25}: 0.000003 lb a.i./acre LOAEL is based on significant reduction in seed dry weight across both experiments compared to controls ($p<0.05$). For stem height, the NOAEL was 0.000047 lb a.i./acre for plants treated at 14 DAE and 0.00047 lb a.i./acre for planted treated 20 DAE. Leaf injury was not significantly affected during Experiment 1, but the NOAEL for leaf injury in Experiment 2 was 0.000095 lb a.i./acre. Plant (stem) dry weight was not significantly affected by treatment across both experiments.	Olszyk et al. (2009)

Species	Exposure	Response	Reference
Potato (*Solanum tuberosum*) 6 plants/dose	Formulated sulfometuron methyl product (Oust, 75% a.i.) and 0.25% v/v nonionic surfactant (Preference™). Application rate: 0.029, 0.166, 0.94, and 5.2 g a.i./ha (equivalent to 0.00003, 0.00015, 0.00084, and 0.00046 lb a.i./acre), with negative and surfactant controls (field application rate: 52 g a.i./ha). Greenhouse experiment: Applied to plants via overhead trolley sprayer approximately 14 DAE and harvested 42 DAE. Plant height and leaf injury were evaluated 14 DAT, and tuber fresh weight and shoot dry weight were evaluated 28 DAT. Location: Oregon	NOAEL: 0.00015 lb a.i./acre LOAEL: 0.00084 lb a.i./acre EC25: 0.00007 lb a.i./acre LOAEL is based on significant reduction in tuber fresh weight and plant height compared to control ($p<0.05$). EC_{25} is based on tuber fresh weight. The percentage of healthy leaf area was significantly reduced in plants treated with 0.00046 lb a.i./acre compared to negative controls ($p<0.05$).	Olszyk et al. (2010a)

Species	Exposure	Response	Reference
Turnip (*Brassica rapa*) 6 plants/dose	Formulated sulfometuron methyl product (Oust, 75% a.i.) and surfactant (not specified). Application rate: 0.029, 0.17, 0.95, and 5.3 g a.i./ha (equivalent to 0.00003, 0.00015, 0.00085, and 0.0047 lb a.i./acre), with negative and surfactant controls (field application rate: 53 g a.i./ha). Greenhouse experiment: Applied to plants via overhead trolley sprayer approximately 14 DAE and evaluated for seed dry weight, number of siliques (seed pods), shoot dry weight, and height at 21 DAT, 35 DAE, or 39 days after pollination. Location: Oregon	NOAEL: 0.00003 lb a.i./acre LOAEL: 0.00015 lb a.i./acre EC_{25}: 0.000007 lb a.i./acre (seed dry weight) LOAEL is based on significant reduction in seed dry weight, seed pod number and flower height ($p<0.05$). NOAEL for shoot dry weight was 0.00015 lb a.i./acre.	Olszyk et al. (2010b)

Species	Exposure	Response	Reference
Potato (*Solanum tubersum*)	Formulated sulfometuron methyl product (Oust, 75% a.i.). Application rate: 0.0294, 0.168, 0.95, or 5.25 g a.i./ha (equivalent to 0.00003, 0.00015, 0.00084, and 0.0047 lb a.i./acre), with negative and carrier controls (field application rate: 52.5 g a.i./ha). Field study: Applied to plants via sprayer at 14 or 28 DAE and evaluated for tuber yield and weight 125 days after planting, and plant height and foliar injury 14 DAA. Location: Oregon	NOAEL: <0.00003 lb a.i./acre LOAEL: 0.00003 lb a.i./acre EC_{25}: 0.000033 lb a.i./acre LOAEL is based on significant reduction in yield of tubers ≥4 oz with no defects (US No. 1 tubers based on USDA potato grading criteria) and mean tuber weight compared to controls ($p<0.05$). EC_{25} is based on 4-6 oz tuber yield. The NOAEL was 0.00015 lb a.i./acre for plant height, and 0.00003 lb a.i./acre for percent visual foliar injury.	Pfleeger et al. (2008)

Species	Exposure	Response	Reference
Potato (*Solanum tuberosum*), Soybean (*Glycine max*), and Pea (*Pisum sativum*) 6 plants/dose	Formulated sulfometuron methyl product (Oust, 75% a.i.) and 0.25% v/v surfactant (Preference™). Application rate: 0.0294, 0.168, 0.95, 5.25, and 52.5 g a.i./ha (equivalent to 0.00003, 0.00015, 0.00084, 0.0047, and 0.047 lb a.i./acre), with carrier controls (field application rate: 52.5 g a.i./ha). Greenhouse and field experiments: Applied to plants via spray chamber at 14 or 28 DAE for potatoes, and 14 DAE or first or second flower opening for soybeans and peas. Evaluated plant height, foliar injury, biomass dry weight, and yield. Location: Oregon	**Potato**: LOAEL: 0.00003 lb a.i./acre EC_{25}: 0.00043 lb a.i./acre LOAEL is based on significant difference in total tuber yield fresh weight, percent height change, percent injury, total tuber number, and mean tuber weight compared to controls ($p<0.05$). EC_{25} is based on change in height. **Pea**: LOAEL: 0.000047 lb a.i./acre EC_{25}: 0.000005 lb a.i./acre LOAEL is based on significant decrease in pea fresh and dry weight, mean pod number, mean pea number, and shoot dry weight compared to controls ($p<0.05$). EC_{25} is based on fresh weight, dry weight, and number. **Soybean**: LOAEL: 0.000047 lb a.i./acre EC_{25}: 0.00005 lb a.i./acre LOAEL is based on significant decrease in soybean pod number and height after 7 and 14 d of exposure compared to controls ($p<0.05$). EC_{25} is based on height 7 and 14 DAT.	Pfleeger et al. (2011)

Species	Exposure	Response	Reference
American chestnut (*Castanea dentata*) 5 seedlings/dose	Formulated sulfometuron methyl product (Oust, 75% a.i.). Application rate: 0, 0.026, 0.053, 0.105, 0.158, and 0.210 kg a.i./ha (equivalent to 0, 0.023, 0.047, 0.094, 0.141, and 0.187 lb a.i./acre). Field experiment: Applied to soil in pots via handheld wand sprayer 10 days before chestnut seedlings were planted. Seven months after planting, chestnut plants were evaluated for height, root collar diameter, and root volume and length, as well as photosynthesis, stomatal conductance, and leaf transpiration. Location: Moscow, Idaho	NOAEL: 0.047 lb a.i./acre LOAEL: 0.094 lb a.i./acre LOAEL is based on significantly decreased root length compared to controls (64% less than controls; $p<0.05$). At the highest dose of 0.187 lb a.i./acre, treated seedlings exhibited a 55% reduction in height ($p=0.133$), a 71% reduction in root volume ($p<0.0001$), and an 82% reduction in net photosynthesis ($p=0.027$) compared to untreated controls. No significant effects of treatments were observed on root collar diameter.	Robertson and Davis (2011)

Western larch (*Larix occidentalis*), Interior Douglas-fir (*Pseudotsuga menziesii* var. *glauca*), and Western white pine (*Pinus monticola*) 8 seedlings/dose/trial	Formulated sulfometuron methyl product (Oust, 75% a.i.). Application rate: **Trial 1:** 0, 0.026, 0.053, 0.105, 0.158, and 0.210 kg a.i./ha (equivalent to 0, 0.023, 0.047, 0.094, 0.141, and 0.187 lb a.i./ha) **Trial 2:** 0, 0.079, and 0.158 kg a.i./ha (equivalent to 0, 0.07, and 0.141 lb a.i./acre). Field experiment: Applied to pots via handheld wand sprayer 1 month before seedlings were planted. In Trial 1 (with varying soil moisture), 4 months after planting, changes in seedling height, root-collar diameter, root volume, and mortality were evaluated, as well as photosynthesis, stomatal conductance, and leaf transpiration. In Trial 2 (with a range of pH), seedlings were measured after 35 growing days. Location: Moscow, Idaho	**Western larch:** NOAEL: <0.023 lb a.i/acre LOAEL: 0.023 lb a.i./acre LOAEL is based on significantly decreased seedling height compared to controls (55% reduction in height; $p<0.05$). Root collar diameter was significantly less than in controls at the 0.094 lb a.i./acre dose, and root volume was significantly less in seedlings exposed to 0.047 lb a.i./acre than in negative controls ($p<0.05$). No significant effects were seen on net photosynthesis, though stomatal conductance and transpiration were significantly reduced compared to controls at concentrations of 0.047 and 0.094 lb a.i./acre. **Interior Douglas fir:** NOAEL: <0.07 lb a.i/acre LOAEL: 0.07 lb a.i./acre LOAEL is based on significant decrease in root volume compared to controls (56% reduction; $p<0.05$). No significant effects were noted for root collar diameter, net photosynthesis, stomatal conductance, and leaf transpiration. LOAELs for significantly decreased plant height compared to controls was 0.141 lb a.i./acre. **Western white pine:** NOAEL: <0.023 lb a.i/acre LOAEL: 0.023 lb a.i./acre LOAEL based on significantly decreased root volume compared to controls (58% reduction; $p<0.05$); stomatal conductance and transpiration were also significantly lower than controls at lowest dose (trial 1). LOAELs for significantly decreased plant height, root collar diameter, and net photosynthesis compared to controls were 0.141, 0.047, and 0.047 lb a.i./acre, respectively.	Robertson and Davis (2012)

Species	Exposure	Response	Reference
Eucalyptus (*Eucalyptus macarthurii*) 3 plots (30 ft x 100 ft)/treatment	Formulated sulfometuron methyl product (Oust XP, 75% a.i.). Application rate: **Trial: newly planted trees**: 0.38, 0.75, 1.13, and 1.50 oz a.i./acre (equivalent to 0.024, 0.047, 0.07, and 0.094 lb a.i./acre), along with negative control. **Trial: second-year trees**: 1.50, 2.25, and 3.00 oz a.i./acre (equivalent to 0.094, 0.14, and 0.19 lb a.i./acre), along with negative control. Field study: Applied via backpack-mounted CO_2-powered sprayer. Tree condition was evaluated 2 and 6 months after treatment, and tree height was measured 8 months after treatment (MAT). Location: Louisiana	**Trial: newly planted trees:** NOAEL: 0.07 lb a.i./acre LOAEL: 0.094 lb a.i./acre LOAEL based on significant change in tree condition score compared to controls 2 months after treatment ($p<0.05$). **Trial: second-year trees:** NOAEL: <0.094 lb a.i./acre LOAEL: 0.094 lb a.i./acre LOAEL is based on significant change in tree condition score compared to controls 6 months after treatment and significantly decreased tree height growth compared to controls (50% reduction; $p<0.05$).	Blazier et al. (2012)

Species	Exposure	Response	Reference
Cotton (*Sorghum bicolor*)	Formulated sulfometuron methyl product (Oust, 75% a.i.). Application rate: 750 g a.i./kg Bench experiment: Applied via a motorized sprayer. Concentrations used were not specified. Root length was measured 3-6 days after sowing and effects were reported as I_{50} (concentration causing 50% growth inhibition). Location: Israel	IC_{50}: 0.004 µM (0.001 mg a.i./L) IC_{50} based on root length.	Nadler-Hassar and Rubin (2003)

Species	Exposure	Response	Reference
Eucalyptus (*Eucalyptus urograndis*) 4 plants/treatment	Formulated sulfometuron methyl product (Curavial®, % a.i. not reported). Application rate: 0.9 and 1.2 g a.i./ha, as reported by study authors (equivalent to 0.0008 and 0.0011 lb a.i./acre), along with a negative control. Field experiment: Applied using a backpack sprayer to plants with average height and stem diameter of 40 cm and 4.5 cm, respectively. Height and stem diameter were evaluated 7, 14, 21, 28, 35, and 42 DAA. Total leaf area and total, leaf, and stem dry mass were also evaluated on 42 DAA. Location: São Paulo, Brazil	NOAEL: 0.0011 lb a.i./acre LOAEL: >0.0011 lb a.i./acre There was no significant adverse effect on plant height, stem diameter, leaf area, leaf dry mass, stem dry mass, or total dry mass.	Pires et al. (2013)

Species	Exposure	Response	Reference
Longleaf pine (*Pinus palustris*) 40 seedlings/ treatment	Formulated sulfometuron methyl product (Oust, 75% a.i.). Application rate: 0.21 and 0.42 kg a.i./ha (equivalent to 0.19 and 0.37 lb a.i./acre), along with a negative control. Field study: Applied using a backpack sprayer to seedlings. Seedling survival was evaluated 1, 8, and 20 MAT. Root collar diameter and height were evaluated at 8 and 20 MAT. Net photosynthesis, stomatal conductance, and leaf transpiration were measured 6 MAT. Location: Florida	NOAEL: 0.37 lb a.i./acre LOAEL: >0.37 lb a.i./acre There was no significant adverse effect on seedling survival, and treatment resulted in several non-adverse outcomes, including increased root collar diameter, increased photosynthesis, increased stomatal conductance, and increased transpiration.	Ramsey and Jose (2004)

Species	Exposure	Response	Reference
Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), and western red-cedar (*Thuja plicata*) 30 seedlings/ treatment	Formulated sulfometuron methyl product (Oust®, purity: 75% a.i.). Application rate: 0.16 kg a.i./ha (equivalent to 0.14 lb a.i./acre), along with a negative control. Field study: Applied using a backpack sprayer to seedlings at three sites representing a range of elevation and soil types. Seedling height, root collar diameter, root length, and root depth were measured 9 months after application (MAA). Location: Oregon	NOAEL: <0.14 lb a.i./acre LOAEL: 0.14 lb a.i./acre LOAEL is based on decreased root length and depth in all three conifer species.	Burney and Jacobs (2009)

Species	Exposure	Response	Reference
Cotton (*Gossypium hirsutum*), bell pepper (*Capsicum annuum*), soybean (*Glycine max*), squash (*Cucurbita pepo*), tobacco (*Nicotiana tabacum*), and tomato (*Solanum lycopersicum*)	Formulated sulfometuron methyl product (Oust XP, purity: 75% a.i.). Application rate: 0 and 4 g a.i./ha (equivalent to 0.0036 lb a.i./acre). Greenhouse experiment: Sprayed both pre-emergence (48-hours after seeding or transplanting) and post-emergence. Plant injury was evaluated 18, 35, and 70 DAT, and height and biomass (dry weight) were measured 70 DAT. Location: Raleigh, North Carolina	**Plant injury (cotton, pepper, soybean, squash):** NOAEL: <0.0036 lb a.i./acre LOAEL: 0.0036 lb a.i./acre Plant injury ranged from 25-74% 70 DAT for pre- or post-emergence application. Plant injury was <20% for tobacco and tomato. **Plant height (cotton, pepper, soybean, squash):** NOAEL: <0.0036 lb a.i./acre LOAEL: 0.0036 lb a.i./acre Plant height was reduced 22-77% 70 DAT for pre- or post-emergence application. Plant height reduction was <20% for tobacco and tomato. **Dry weight biomass (cotton, pepper, soybean, squash, tobacco, tomato):** NOAEL: <0.0036 lb a.i./acre LOAEL: 0.0036 lb a.i./acre Dry weight biomass was reduced by 20-89% 70 DAT for pre- or post-emergence application (reduction was 18% for pre-emergence application in tomato).	Jeffries et al. (2014)

Abbreviations: a.i. = active ingredient; cm = centimeter; d = days; DAE = days after emergence; DAT = days after treatment; EC_{25} = 25th percentile effects concentration; g = gram; ha = hectare; HHERA = Human Health and Ecological Risk Assessment; I_{50} = concentration causing 50% inhibition; kg = kilogram; L = liter; lb = pound; LOAEL = lowest-observed-adverse-effect level; MAT = months after treatment; mg = milligram; NOAEL = no-observed-adverse-effect level; ppt = parts per trillion; USDA = United States Department of Agriculture; v = volume; WAT = weeks after treatment

Table 4-3. Studies of Toxicity to Fish of a Formulated Sulfometuron Methyl Product Published Since the 2004 HHERA

Study Basis	Species	Exposure	Response	Reference
Acute	Fathead minnow (*Pimephales promelas*), 2-10 days old (30 fish/ concentration)	Formulated sulfometuron methyl product (Oust XP, 75% a.i.). Nominal concentrations: 0 (negative control), 6.25, 12.5, 25, 50, and 100% (assuming solutions are % a.i., equivalent to 62.5, 125, 250, 500, and 1000 mg a.i./L. Mean measured concentrations were not reported, but mean % recovery at the end of the exposure period was 52%; therefore, time-weighted concentrations over the course of the exposure period were lower than nominal concentrations. 96-hour test under flow-through conditions. Evaluated for mortality.	**96-hour mortality:** LC_{50}: >76.3 mg a.i./L	Tatum et al. (2012)

Study Basis	Species	Exposure	Response	Reference
Acute	Zebrafish (*Danio rerio*)	Technical-grade sulfometuron methyl (purity >98%). Nominal concentrations: 0, 10, 20, and 40 mg a.i./L (measured concentrations not reported by authors). Exposure period was 5.5 to 72 hrs post-fertilization. Evaluated for mortality, hatching success, immune response, locomotor behavior, oxidative stress, and cell apoptosis.	**Developmental endpoints:** NOAEC: <10 mg a.i./L LOAEC: 10 mg a.i./L LOAEC based on significant decrease in hatching rate (~76% in treatment group versus ~98% in negative control; p<0.001). Percent survival from 24-96 hrs post fertilization decreased with increasing treatment level. **Immune system endpoints:** NOAEC: <10 mg a.i./L LOAEC: 10 mg a.i./L LOAEC based on significant decrease in number of neutrophils (~64 in treatment group sample versus ~140 in negative control sample; p<0.001). Exposure was also found to increase the total distance, average speed, and maximum acceleration of zebrafish larvae compared to negative controls; to increase acetylchloinesterase activity compared to controls; to increase oxidative stress; and to induce cell apoptosis at embryonic stages.	Yuan et al. (2021)

Abbreviations: a.i. = active ingredient; HHERA = Human Health and Ecological Risk Assessment; hrs = hours; LC_{50} = median lethal concentration; L = liter; LOAEC = lowest-observed-adverse-effect concentration; mg = milligram; NOAEC = no-observed-adverse-effect concentration

Table 4-4a. Studies of Toxicity to Aquatic Invertebrates of Technical-Grade Sulfometuron Methyl Published Since the 2004 HHERA

Type	Species	Exposure	Response	Reference
Technical-grade sulfometuron methyl	Aquatic bacteria (*Photobacterium phosphoreum*)	Technical-grade sulfometuron methyl (purity >98.2%) in seawater. Nominal concentration: 10 mg a.i./L. After 15 minutes exposure, luminescence was measured using a MicroTox® analyzer.	NOAEC: 10 mg a.i./L LOAEC: >10 mg a.i./L Treatment did not inhibit bioluminescence.	Shao et al. (2022)

Abbreviations: a.i. = active ingredient; ha = hectare; HHERA = Human Health and Ecological Risk Assessment; kg = kilogram; L = liter; lb = pound; LOAEC = lowest-observed-adverse-effect concentration; µg = microgram; mg = milligram; NOAEC = no-observed-adverse-effect concentration

Table 4-4b. Studies of Toxicity to Aquatic Invertebrates of Formulated Sulfometuron Methyl Published Since the 2004 HHERA

Type	Species	Exposure	Response	Reference
Formulated sulfometuron methyl product	Water Flea (*Ceriodaphnia dubia*) <24 hours old (20/concentration)	Formulated sulfometuron methyl product (Oust XP, 75% a.i.). Nominal concentrations: 0 (negative control), 6.25, 12.5, 25, 50, and 100% Oust XP, (assuming solutions are % a.i., equivalent to 62.5, 125, 250, 500, and 1000 mg a.i./L). Measured concentrations not reported. 48-hour acute toxicity test. Evaluated for mortality.	**48-hour mortality**: LC_{50}: >76.3 mg a.i./L	Tatum et al. (2012)
Formulated sulfometuron methyl product	Aquatic invertebrates (predominantly midges, mosquitos, predaceous diving beetles, physid snails, water fleas, and aquatic worms)	Formulated sulfometuron methyl product (Oust XP, purity: 75% a.i.). Application rate: 0.053 kg a.i./ha (equivalent to 0.047 lb a.i./acre, along with untreated reference catchments. Maximum measured concentrations in runoff, measured during the first storm event that occurred 1 DAA, were 23-24 µg/L for treated catchments. Field study: Aquatic invertebrates were sampled 12 days prior to application, 13 DAA, and 7 WAA; identified and quantified; and evaluated for taxa richness and abundance. Location: South Carolina	NOAEC: 0.047 lb a.i./acre No effect on aquatic invertebrate family richness or total invertebrate abundance was observed in treated catchments compared to reference areas. Abundances of individual taxa in treated areas were also not significantly different from controls.	Michael et al. (2006)

Abbreviations: a.i. = active ingredient; ha = hectare; HHERA = Human Health and Ecological Risk Assessment; kg = kilogram; L = liter; lb = pound; LOAEC = lowest-observed-adverse-effect concentration; µg = microgram; mg = milligram; NOAEC = no-observed-adverse-effect concentration