Massachusetts

Yearly Operational Plan

2025

Unitil Corporation

Fitchburg Gas and Electric Light Company

357 Electric Ave

Lunenburg, MA 01462-2246

January 2025

TABLE OF CONTENTS

APPENDICES

Summary

The purpose of this Yearly Operational Plan (hereafter referred to as "YOP") is to outline the Fitchburg Gas and Electric Light Company[1] (hereafter referred to as FG&E or the Company) 2025 program for managing vegetation with herbicides on the rights-of-way. This program and YOP have been developed in compliance with 333 CMR 11.00, rights-of-way management regulations administered by the Massachusetts Department of Agricultural Resources (DAR).

In compliance with 333 CMR 11.06 and 11.07 and Chapter 85 of the Acts of 2000, the YOP notification process provides for a forty-five day public review and comment period which starts when the Department of Agricultural Resources (DAR) publishes a notice in the Environmental Monitor, a twenty-one day review period for the municipal notification letter (may run simultaneously), and a 48 hour newspaper notice. These review periods give communities an opportunity to provide information that help identify additional areas that may require specific precautions or protection.

Under the supervision of FG&E's Manager of Forestry Operations and staff, herbicide applications are made in the context of an Integrated Vegetation Management (IVM) program that also utilizes mechanical and biological controls and takes into consideration the cultural use of the landscape. This IVM program is outlined in our Five-Year Vegetation Management Plan (VMP), copies of which are available upon request or at:

https://unitil.com/energy-projects/integrated-vegetation-management-habitat-initiative

FG&E retains independent, experienced contractors to perform the treatment applications. Herbicides are only applied by trained, licensed applicators using hand-held equipment under the direct supervision of certified supervisors.

Any questions or comments on this YOP should be directed to the contact person listed in Section 9 of this YOP.

1: Introduction

In compliance with 333 CMR 11.00. Rights-of-Way Management, FG&E's YOP outlines our 2025 vegetation management program on specified (see Section 2) electric transmission rights-of-way. This YOP is consistent with the terms and procedures set forth in FG&E's 2024-2029 Vegetation Management Plan (VMP); with all pertinent clauses is Chapter 85 of the Acts of 2000; with the Massachusetts Endangered Species Act (MESA; M.G.L. chapter 131A) and its regulations, 321 CMR 10.00; and the Massachusetts Wetland Protection Act (M.G.L. chapter 132A) and its regulations, 310 CMR 10.00 of the Massachusetts Department of Environmental Protection; and with all state and federal laws and regulations that apply to right-of-way vegetation management in the Commonwealth of Massachusetts.

The purpose of 333 CMR 11.00 is to establish a statewide and uniform regulatory process which will minimize the uses of, and potential impacts from, herbicides in the rights-of-way on human health and the environment while allowing for the benefits to public safety provided by the selective use of herbicides (333 CMR 11.01).

333 CMR 11.00 (see Appendix 2) is the most comprehensive rights-of-way regulation in New England. It requires an Integrated Pest Management (in this case IVM) approach to right-of-way vegetation management; the establishment of standards and procedures to prevent unreasonable risks to humans and the environment; and a multi-layered system of public and municipal notification that requests input about environmentally and culturally sensitive areas. All of this is outlined in FG&E's VMP and annual YOP's, the vehicles for establishing and implementing IVM programs, which serve as guides for the public, state and municipal officials, vegetation management contract personnel and FG&E.

FG&E manages approximately 350 acres and 30 miles of cross-country transmission rights-of-way and 410 miles of distribution right-of-way, located primarily along roads, through the municipalities of Ashby, Fitchburg, Lunenburg and Townsend. The work is carried out over a five year maintenance cycle.

The cross-country rights-of-way traverse uplands and lowlands typical of central Massachusetts. They traverse wetlands and uplands in three municipalities: Fitchburg, Lunenburg and Townsend. These municipalities are primarily rural and suburban, though portions of Fitchburg are urban. In all locations, the rights-of-way must be kept clear of vegetation that may interfere with the safe, reliable delivery of electric service. To achieve this goal, FG&E utilizes the IVM program described in the VMP and summarized in Section 3 below.

2: Location of Proposed Herbicide Treatments

In 2025 FG&E will carry-out IVM work on sub-transmission rights-of-way, in Table 1 below;

The 06, 1309, and the 1303 Lines in Fitchburg from Sawyer Passway Substation #20 to Summer Street Substation #40. The 08/09 Lines beginning at Summer Street Substation #40 to where the lines split in Lunenburg near Chase Road. Also, the Lunenburg tap of the 08/09 Lines located near Massachusetts Ave to the Lunenburg Substation #30. The length is approximately 7 miles, with approximately 98.9 acres to be treated.

Table 1: Rights-of-Way for 2025 treatments

Fitchburg Gas and Electric Light Company Right of Way Segments				
Line Number	Voltage	Description	Miles	Acres
06/1309/1303	56 kV/ 13.8 kV	Sawyer Passway SS to RR Bridge to Summer St Sub	1.0	14.3
08/09	56 kV	Summer ST Sub #40 to 08/09 Line Jct, Near Chase Rd, Lunenburg	4.9	71.3
08/09	56 kV	Lunenburg substation #30 to 08/09 Line Junction Near Mass Ave, Lunenburg	1.1	13.3

3: Integrated Vegetation Management, Including Alternative Control Methods

The Company proposes to use all appropriate IVM methods available including: mechanical, chemical, and biological control methods. Mechanical and chemical control methods facilitate development of a low-growing plant community that in time will become the biological control over the plant community.

The primary mechanical methods will be hand cutting with chainsaws, pruning, and mowing. Chemical methods involve the use of herbicides applied in several ways including: cut-stump treatment, basal treatment and low-volume foliar treatment. All methods except mowing are applied selectively.

The Company will employ concurrent five-year maintenance cycles for both mechanical and chemical vegetation management techniques. Year 1 will include floor and sideline clearing using the appropriate mechanical methods for the site. The following year, the same lines will be treated with chemicals controls to manage the regrowth and allow biological controls to become established. This system of concurrent cycles gives the Company the option to use less invasive methods of chemical control, such as low-volume foliar, due to the small size of incompatible trees and plants following mechanical control the year before. As cycles progress, the expectation is that mechanical methods used on the right-of-way floor will decrease over time and will begin to transition from mowing to hand cutting. Mowing will not be completely eliminated however, due to restricted spray areas. Being flexible and site specific will be an important aspect of the program.

The advantage of a flexible IVM program is the ability to apply the appropriate mechanical and chemical methods to meet the conditions of individual rights-of-way. As the sole means to control vegetation, mechanical controls are a short-term solution. With the exception of most conifer species, cut vegetation re-sprouts, resulting in high density in-compatible vegetation.

Selective herbicide application methods effectively remove this vegetation that would otherwise compete with and dominate the low-growing, early successional plant communities that provide biological control.

Mechanical methods are the preferred method for non-sprouting conifer species as well as in areas where herbicides are precluded, such as the no-spray areas associated with Sensitive Areas; in visual screens, around structures, on access roads; and where large areas of high density in-compatible species exceed maximum herbicide treatment heights (12 feet). Mechanical methods are applied in combination with chemical methods for hardwoods over 12 feet tall – they are hand cut and stumps treated with herbicide.

Mechanical Methods

Hand Cutting

Hand cutting is the mechanical cutting of vegetation using chain saws, brush saws, loppers or hand pruners. Hand cutting may be conducted at any time of the year. Target species are cut as close to the ground as practical. Slash from the cutting is cut and scattered so as to lay close to the ground – not to exceed two feet in height.

Hand cutting is used to: protect environmental Sensitive Areas; around structures; gates and access roads; to control vegetation greater than 12 feet in height; where herbicide use is prohibited by regulation or easement restriction; on non-sprouting conifer species; and on sites where terrain, site sensitivity or site size makes mowing impractical.

Mowing

Mowing is the mechanical cutting of vegetation using large tree/brush mowers mounted in rubber tired tractors or tracked vehicles.

Mowing may be used at any time of the year except when deep snow prevents safe operation. Selection of specific equipment is based on terrain, vegetation size and equipment availability. Mowing is restricted by steep slopes, rocky terrain, obstructions, wet sites with deep soft soils and debris on the right-of-way.

Mowing is used on sites where herbicide use is prohibited by regulatory or easement restriction, where vegetation is tall and high density, and where terrain, site size and sensitivity permit the efficient use of the equipment.

Selective Pruning

Selective pruning is the mechanical removal of the tops or limbs of trees to prevent them from growing in to or falling on to the lines.

Selective pruning may be done at any time of the year. Pruning will be accomplished from the ground, using aerial lifts or by tree climbing crews. This method is used in maintaining trees in visual screens adjacent to yards or roads and along the edges of the rights-of-way to prune off-right-of-way trees.

Slash is the woody debris generated from pruning and cutting operations. Slash will be disposed of by dicing and cutting low to the ground, chipping, piling or removing from the site at the discretion of the Company. The

preferred method of disposal is to dice and cut low to the ground and leave to on the right-of-way to decay naturally.

Slash will not be left in waterways, trails or roads, or in such a manner that would permit it to wash into these areas. The placement of slash must comply with applicable State Fire Marshall regulations. Slash from yards or recreational sites will be chipped or removed to an adjacent area or removed. Chipping is used when dicing and cutting low to the ground are prohibited or impractical. Chips will be removed in highly sensitive sites. When left on site, wood chips will be scattered uniformly over the site at depths not exceeding four inches or piled on isolated areas. No chips will be left in wetlands.

Chemical Methods

Herbicide application include cut stump, basal and low volume foliar. Herbicides are applied as mixtures consisting of the herbicide formulation(s), adjuvants, carriers and additives. The timing of herbicide applications, materials and mix rates will be detailed in the Company's Yearly Operational Plan (YOP) and associated notices to municipal officials and newspaper notices. The Company will only use herbicides and mixes consistent with the *Sensitive Area Materials List* published by the Massachusetts Department of Agricultural Resources (DAR). The Company Forestry Operations Manager will further specify to the contractor the particular materials and mixture rates for individual rights-of-way according to conditions and timing of the treatments. Treatment crews will not deviate from the Company's specification without the approval of the Forestry Operations Manager.

Each herbicide has varying degrees of efficacy on vegetation. Seasonal variations in rainfall and date of application also effect efficacy. No herbicide is equally effective on all species and certain herbicides are more effective on some species than others. The Company selects the herbicide or combination of herbicides in conjunction with the appropriate treatment method to obtain the most effective control of the incompatible vegetation and density on each right-of-way.

Each herbicide and method of application has distinctive results with respect to "brownout" and timing of plant necrosis and environmental characteristics. Environmental characteristics such as rate of biodegradation and mobility in the soil are important to consider when prescribing their use. Some herbicide formulations are labeled for use in wetlands, others are not. The selection of herbicide or herbicide mixtures and the appropriate application method is made with equal consideration given to the visual and environmental sensitivity of a right-of-way or site within a right- of-way.

The environmental characteristics, rates of application and selectivity of the application method are critical parameters for consideration by the DAR in development of the *Sensitive Area Materials List*.

Methods of Application:

<u>Selective Low Volume Foliar Application</u>

Selective low volume foliar applications are made to fully developed leaves and stems of the incompatible vegetation. Selective low volume foliar applications are limited to the season when leaves are fully developed, typically from June through early October.

The equipment for selective low volume foliar applications includes hand-pump backpack sprayers and motorized backpack sprayers.

Applications are made as a uniform spray over the plant's entire foliage to dampen or lightly wet the vegetation, not applied to run-off. This application method minimizes the amount of herbicide applied and reduces impacts to desirable vegetation under and around the incompatible vegetation and deposition to the soil.

Selective low volume foliar applications were shown to result in the least deposition of herbicide to the soil.

Selective low volume foliar applications are used on hardwood trees and incompatible shrub species below 12 feet in height. Foliar applications are not used where landowner agreements preclude their use, within visual screens on incompatible species greater than 6 feet in height and within mechanical only sensitive areas per 333 CMR 11.04.

Foliar applications are allowed in wetland areas where no standing water is present, per the Department of Food and Agriculture Decision, dated October, 1995, concerning the wetland impact study conducted pursuant to 333 CMR 11.04(4)(c)(2).

<u>Basal Application</u>

Basal treatments are the selective application of an herbicide, diluted in specially formulated oil, to wet the lower 12 to 18 inches of the stem of incompatible plants. Application is made using a hand pump backpack sprayer. The oil carrier enables the herbicide solution to penetrate the bark tissue and translocate within the plant.

Basal applications are very selective, and when used in low incompatible species density, are applied at low rates of herbicide per acre. Optimum vegetation density is low, with average heights greater than 4 feet, within visual screens and in areas where a high degree of selectivity is necessary. The application method can be used any time of the year except in conditions that prevent access to the target stems such as seasonal standing water or deep snow. The optimum treatment time frame is in the dormant season when applications are easier due to the lack of foliage and the obstruction caused by grasses and herbaceous growth. Basal applications are not ideal in high incompatible vegetation densities due to the time and cost to apply, the likelihood of missing incompatible vegetation and resulting high level of application of herbicide per acre.

Basal applications are used on the same species and vegetation heights cited above for foliar applications. Basal applications have the advantage of extending the application season into the dormant season. They also have the advantage of not creating brownout of vegetation.

<u>Cut Stump Applications</u>

Cut stump applications are the mechanical cutting of incompatible vegetation followed by herbicide application to the phloem and cambium tissue of the stump. The cut stump mixture is diluted in water or a non-freezing liquid carrier and is ideally applied to freshly cut stumps. Application equipment includes low volume backpack sprayer, hand pump sprayer, hand held squirt bottles, paintbrushes and sponge applicators.

This application method is used where maximum selectivity is desirable and/or to reduce the visual impact of vegetation management work. It is commonly used to prevent re-sprouts when hand cutting vegetation is preparation for a foliar application, to apply herbicide to vegetation in sensitive sites where other methods are not possible, on all woody vegetation (except conifers) removed in visual screens except within environmentally sensitive areas where restrictions preclude herbicide use.

Like basal applications, cut stump applications may be used at any time of the year provided snow depth does not prevent cutting low to the ground. It is best to avoid application during the season of high sap flow, and/or moderate to heavy rain; it is not practical in moderate to heavy vegetation densities.

Tree Growth Regulators

Tree growth regulators are plant growth regulator chemicals that manage or reduce the potential growth rates of trees. This application is useful where restricted clearance to electric lines requires repetitive pruning, in high priority areas of electric lines, in difficult to access areas, or where safety is a concern, such as along railroad tracks.

Tree growth regulators can lengthen the time between pruning cycles, improve the aesthetics of street trees requiring severe pruning, and help to positively affect the tree's health. The tree growth regulator treatment creates other plant growth effects that are beneficial for tree health including increased root density, improved drought and heat resistance, and higher tolerance to insects and diseases. Tree growth regulators can be applied by either basal drench around the base of the tree, or a soil injection next to the buttress root zone.

4: Identification of Target Vegetation

The primary target on an electric utility right-of-way is woody vegetation, primarily trees that are capable of interrupting the safe delivery of energy products to our customers. Other target vegetation includes: dense woody vegetation, vines, noxious, nuisance and poisonous vegetation: all vegetation that interferes with access around structures, access roads and trails, substations; and anywhere in which vegetation prevents access to the right-of-way for inspections, maintenance, repairs and emergency access to the lines.

With few exceptions, all target species will be removed or controlled during a treatment operation. Within the cleared width of the right-of-way, all tree species, except conifers less than two feet tall, will be removed or controlled.

Tree species are identified as woody plants that mature at heights exceeding fifteen feet, These trees must be removed because they are capable of growing tall enough to grow in to or fall on to the lines.

Except in no-spray sensitive areas, (see Section 5), hardwoods over 12 feet tall are hand cut and the stumps are treated with herbicides. Hardwoods less than 12 feet tall and woody species that present safety problems are treated with herbicides using either low volume foliar or cut stump application methods. As mentioned above, Pitch Pine is the only conifer species treated with herbicides.

Trees that need to be removed will be identified visually by trained treatment crews and include, but are not limited to the following:

Ash, Aspen, Beech, Birch, Cherry, Hemlock, Pine, Poplar, Maple, Oak and Willow.

All woody vegetation (trees, shrubs, vines) on or encroaching upon existing roads or pathways or immediately adjacent to line structures or equipment will be treated by mechanical or herbicide control methods. If no access along the right-of-way exists, a pathway will be created and maintained in a suitable location by treating all woody vegetation within the selected route. Woody vegetation must be treated in these areas to ensure access to and along the right-of-way and line structures for safe and efficient inspection, maintenance and repair operations.

Other plant species to be controlled include invasive, shrub, and vine species and vegetation that because of heavy thorn growth or dermal toxicity may be hazardous including, but not limited to:

Alder, Bittersweet, Blackberry, Buckthorn, Bush honeysuckle, Burning Bush, Giant Hogweed, Japanese Barberry, Autumn Olive, Grapevines, Greenbriar, Hawthorne, Japanese Knotweed, Multiflora Rose, Poison Ivy, Sumacs, Viburnums, Virginia Creeper and Winterberry.

Not all vegetation on the right-of-way are considered targets, in fact, most species are not targets. Desirable plant species that provide the natural controls in our IVM program include, but are not limited to:

Azaleas, Button bush, Chokeberry, Common Juniper, Dogwoods, High and Low Bush Blueberries, Huckleberry, Mountain Holly, Mountain Laurel, Privet, Rhododendron, Sedges, Shadbush, Sheep Laurel, Spirea, Sumac, Sweet Fern, Sweet Pepperbush, Viburnums, Ferns, Grasses, and Herbaceous species.

5: Sensitive Areas

For the purposes of this YOP Sensitive Areas regulated by 333 CMR 11.04 are as follows:

Any areas within rights-of-way, including No-Spray and Limited Spray Areas, in which public health, environmental or agricultural concerns warrant special protection to further minimize the risks of unreasonable adverse effects. An illustration of sensitive areas and their associated no-spray and limited spray areas is included in Appendix 3 of this YOP.

Sensitive Areas include the following:

Water Supplies

- Zone I
- Zone II
- IWPA (Interim Wellhead Protection Area
- Class A Surface Water Sources
- Tributaries to a Class A Surface Water Source
- Class B Drinking Water Intakes
- Private Wells

Surface Waters

- Wetlands
- Open Water Bodies
- Rivers
- The Mean Annual High Water Line of a River
- The Outer Boundary of a Riverfront Area
- Certified Vernal Pools

Cultural Sites

- Agricultural Areas
- Inhabited Areas

Wildlife Areas:

- Certified Vernal Pool Habitat
- Priority Habitat

Protecting these environmentally sensitive sites is accomplished by defining specific sensitive areas and establishing limited spray and no-spray areas and treatment restrictions within these areas based on the sensitivity of each site and the requirement to minimize any unreasonable adverse impacts within that area.

These sensitive areas consist of no-spray areas in which herbicides use is prohibited, larger limited spray areas where herbicide use is permitted under certain conditions, general limited spray areas and areas that require special treatment recommendations.

For the purpose of identification, sensitive areas are separated into those readily identifiable in the field and not readily identifiable in the field:

1. Sensitive area readily identifiable in the field will be treated and marked according to all applicable restrictions listed in 333 CMR 11.00 and FG&E's VMP. These areas include but are not limited to rivers and streams, surface waters, wetlands, inhabited areas, agricultural areas and road buffers.

2. Sensitive areas not readily identifiable in the field are identified by the use of the data on Company maps and additional data collected in the YOP and notification processes before the time of treatment. These areas include, but are not limited to public ground water supplies, public surface water supplies and tributaries and private wells, Priority Habitats, certified vernal pools, landowner agreement areas and easement restrictions.

Sensitive areas will be identified using many resources from the following list:

1. FG&E right-of-way maps, records and institutional knowledge,
2. Massachusetts Department of Environmental Protection water supply maps and/or GIS mapping layers available through Mass GIS,
3. DAR, Municipal Board of Health maps and lists, and FG&E records of identified private wells along the right-of-way,
4. Correspondence, meetings and input from municipalities within the forty-five day YOP and twenty-one day municipal right-of-way notification letter review and comment periods and the 48 hour newspaper notification (under 333 CMR 11.06 & 11.07 and Chapter 85 of the Acts of 2000),
5. Correspondence and meetings resulting from FG&E's abutter notification procedure,
6. A crew point person who verifies identified sensitive areas and any additional areas that may require special precautions,
7. USGS topographic maps,
8. Information from the contractor's knowledge and records,
9. Information from MassGIS,
10. Confidential information from NHESP, and copy of the YOP and VMP.

As appropriate, sensitive areas will be identified and marked in the field by either FG&E personnel, trained and experienced vegetation management contract personnel and or by individuals trained in the identification of sensitive areas.

Priority Habitat of State-Listed Species

In compliance with 321 CMR 10.18, Massachusetts Endangered Species Act Regulations, Part II Exemptions, FG&E has submitted this YOP for approval by the NHESP.

Under the approval process, details about the Priority Habitats of State-listed species that our activities might affect and management recommendations are shared with FG&E under strict confidentiality agreements. Using this data and best management practices, FG&E and contract personnel will follow the appropriate vegetation management treatment methods within these sensitive areas. To identify Priority Habitats, FG&E and vegetation management contract workers are trained to recognize Priority Habitats using paper maps and/or GIS systems. Particularly sensitive State-listed species will be reviewed and identified in the field for protection by NHESP approved biologists.

Treatment in Wetlands

Pursuant to 333 CMR 11.04(4) and based upon two right-of-way wetland impact studies, the Massachusetts Department of Food and Agriculture (now DAR) in consultation with the Department of Environmental Protection and the Right-of-Way Advisory Panel, made a determination that utilities may treat target plant species, except pines, selectively with herbicides in wetlands, under the guidance of an IVM program and with sensitive area approved herbicides except within ten feet of standing or flowing water.

6: Description of Maps Locating the Rights-of-Way

YOP maps locating the rights-of-way and sensitive areas not readily identified in the field will be prepared and are attached to this YOP in Appendix 1. These YOP maps will be sent to municipal officials per notification procedures discussed in Section 5.

These maps include the most current data available at the time of printing. To insure that applicable sensitive areas are identified on the maps, FG&E is requesting municipal verification of areas currently mapped and the identification of any additional areas not mapped.

The maps are resources and a tool for the public and vegetation management contractors, therefore, they contain data needed to identify, mark and treat sensitive areas appropriately at the time of treatment. Additional sensitive area information that is collected will be added to the information utilized by FG&E's vegetation management contractors. Please note that Zone II's are included on the maps, however, FG&E only uses herbicides approved for use within this limited spray sensitive area.

7: Proposed Herbicides, Carriers, Adjuvants and Rates

The following table shows the proposed herbicides, tank mixes, application methods and estimated application rates for use by FG&E in 2024. FG&E proposes only two methods of application, cut-stump treatment and low-volume foliar treatment. Per discussion in this YOP and the Companies VMP, the herbicides, tank mixes, application rates and timing/frequency of application comply with the limited spray sensitive area requirements for all sensitive areas and will be applied on the full length and width of the companies' rights-of-way.

Proposed Herbicide Mixes

Trade Name	**EPA #**	**Active Ingredient**	**Mixture**	**Treatment**	**Estimated rate of product per acre**
Rodeo Arsenal Powerline	62719- 324 241- 431	Glyphosate Imazapyr	40-50% in water 3% to 5% in water	Stump (CST)	16 – 64 oz.
Krenite S Escort XP	352-395 432-1549	Fosamine Ammonium Metsulfuron Methyl	5% - 10% 2-4 oz. per 100 gal	Selective Foliar	32 – 64 oz 0.25 - .0.50 oz.

Krenite S Arsenal Powerline	352-395 241-431	Fosamine Ammonium Imazapyr	5% - 10% 0.125% – 0.5%	Selective Foliar	32 – 64 oz 0.25 - .0.50 oz
Rodeo Arsenal Powerline	62719-324 241-431	Glyphosate Imazapyr	3% - 5% 0.125% – 0.5%	Selective Foliar	32 – 64 oz 0.25 - .0.50 oz
Cambistat	74779-3	Paclobutrazol	8.3%	TGR (Basal)	Per tree (see application guide)
Aquaneat Aquatic Herbicide	228-365	Glyphosate Isopropylammonium	. 3% - 5% 0.125% – 0.5%	Selective Foliar	32 – 64 oz 0.25 - .0.50 oz
AquaMaster Herbicide	524-343	Glyphosate Isopropylammonium	3% - 5% 0.125% – 0.5%	Selective Foliar	32 – 64 oz 0.25 - .0.50 oz
Rodeo Arsenal Powerline Escort	62719-324 241-431	Glyphosate Imazapyr Metsulfuron Methyl	3% - 5% 0.125% – 0.5% 4 oz per 100 gal	Selective Foliar	32 – 64 oz 0.25 - .0.50 oz
Arsenal Powerline Escort	241-431 432-1549	Imazapyr Metsulfuron Methyl	3% - 5% 0.125% – 0.5% 4 oz per 100 gal	Selective Foliar	32 – 64 oz 0.25 - .0.50 oz

Footnote on carriers and adjuvants: The carrier for cut stump application will be water. Carrier for foliar applications will be water. Induce or Aqua Fac or equivalent surfactant will be added to foliar tank mix. Point Blank or equivalent anti-drift agent will be added to foliar mixes as needed.

8: Procedures and Locations for Handling, Mixing and Loading Herbicide Concentrates

The Companies' retain independent contractors to accomplish all aspects of handling, mixing and loading herbicide concentrates. As a contractual term, contractors are required to comply with all applicable laws, regulations and rules pertaining to handling, mixing and loading herbicide concentrates.

The majority of mixing, handling and loading of herbicide concentrates is done at the contractor's place of business. If it is necessary to handle, mix or load herbicide concentrates at any other location, the contractor is required to comply with herbicide label directions and 333 CMR 11 requirements regarding set-backs from sensitive areas.

FG&E requires the following standards to be followed if handling and mixing are carried out on company property or rights-of-way:

1. No handling, mixing or loading of herbicide concentrated will be done on rights-of-way within the buffer zones adjacent to any drinking water supplies or surface water or within 100 feet of any other sensitive area.
2. No water will be pumped from open sources in the field.
3. Hoses used for water will not be used to pump or mix herbicides.

9: Individuals Supervising the YOP

Overall supervision for development and implementation of the YOP will be performed by:

Chris Moultroup
Manager, Forestry Operations
Unitil Service Corp.
1 McGuire St
Concord, NH 03301

The Company Forestry Operations Manager is ultimately responsible for preparation, implementation of and compliance with this YOP. The Forestry Operations Manager's duties include: work scheduling, prescription of herbicides and application methods, procurement of necessary permits, municipal notifications, contractor selection, provision of technical expertise and liaison between Company right-of-way easement landowners, neighbors, local and state officials and other interested parties and field supervision of vegetation management contractors.

Chris Moultroup has been working in the electric utility vegetation management industry since 2005, has a degree in Forestry from the University of Vermont, and is an International Society of Arboriculture Certified Arborist and Utility Specialist.

This VMP was drafted in consultation with Sara Sankowich, Unitil's Director, Sustainability and Shared Services. It is an update from previous iterations.

10: Contractor that will Perform Herbicide Applications

Vegetation Control Services (VCS)

2342 Main St, Athol MA 01331

11: Remedial Spill and Emergency Plan

This section is offered as a general procedural guide for responding to chemical spills or related accidents (related accidents include but are not limited to fire, poisoning and vehicle accidents). The Company contracts with independent, professional, certified herbicide applicators that are responsible for the containment, clean up and reporting of chemical spills or accidents. The following is, therefore, only a guide to the information sources that *shall be* available to the treatment crew in the event of a chemical spill or emergency situation:

TYPES OF CHEMICAL SPILLS THAT REQUIRE ACTION

Chemicals include, but are not limited to the following:

- Herbicides
- Bar and Chain Oil
- Motor & Hydraulic Oil
- Diesel Fuel
- Gasoline
- Title 3 Hazmat Materials

REQUIRED SPILL RESPONSE EQUIPMENT

As a minimum, the ROW crew shall have available on the job site:

- VMP and YOP with emergency contact lists
- MSDS and product labels
- Product Fact Sheets
- Appropriate absorbent material such as “speedi dri” or “soak up”
- Shovel
- Broom
- Flagging
- Leak proof container
- Heavy-duty plastic bags

PERSONAL CONTACT

In the event of **Personal Contact** with hazardous chemicals:

- Wash affected area with plenty of soap and water
- Change clothing which has absorbed hazardous chemicals
- If necessary, contact a physician
- If necessary, contact the proper emergency services
- If necessary, follow the procedures for Major or Minor Spills as outlined below
- Avoid breathing the fumes of hazardous chemicals

REFERENCE TABLES (INFORMATION SUBJECT TO CHANGE AS NECESSARY)

Table 1: Herbicide Manufacturers

MANUFACTURER	TELEPHONE NUMBER	SPECIAL INSTRUCTIONS
BASF Corporation	800-832-4357	Arsenal
E.I. du Pont de Nemours and Company	800-441-3637	Krenite & Escort
Dow Agro Sciences	800-992-5994	Accord & Garlon
Rainbow Treecare Scientific Advancements	800-888-8372	Cambistat
Bayer CropScience	800-331-2867	AquaMaster
Nufarm Americas Inc	800-424-9300	AquaNeat & Polaris
Corteva Agriscience	800-992-5994	Vastlan

Table 2: State Agencies

STATE AGENCY	TELEPHONE NUMBER	SPECIAL INSTRUCTIONS
Massachusetts Pesticide Bureau	617-626-1700	A.S.A.P (within 48 hours)
Massachusetts Department of Environmental Protection, Emergency Response Section	Main Office: 888-304-1133 Central Region: 508-792-7650	for emergencies involving reportable quantities of hazardous materials; required info: City/town, Street address, Site name (if applicable), material
Massachusetts Poison Information Centers	800-222-1222	for medical emergencies involving suspected or known pesticide poisoning symptoms
Massachusetts Department of Public Health, Bureau of Environmental Health, Assessment Toxicology Program	617-624-5757	

Table 3: Emergency Services

EMERGENCY SERVICE	TELEPHONE NUMBER

Massachusetts State Police, Central Office	617-566-4500 or 911
ChemTrec	800-424-9300

Table 4: Fitchburg Gas and Electric Contacts

FG&E Contact	TELEPHONE NUMBER
Central Electric Dispatch (CED)	603-294-5102
Chris Moultroup- Manager, Forestry Ops	603-227-4652
David Clapham- Forestry Supervisor, FGE	978-353-3252

Table 5: Local Emergency Numbers
(to be filled out with the appropriate towns and included in the YOPs)

Municipality	Emergency Services	Board of Health	Town Hall
	911		

CLEAN-UP PROCEDURES

Education and attention will constantly be directed at accident and spill prevention; however, the following is a guideline in the even the event of a spill:

REPORTABLE SPILLS (Spills of reportable quantity of material): FOLLOW STEPS 1 – 11

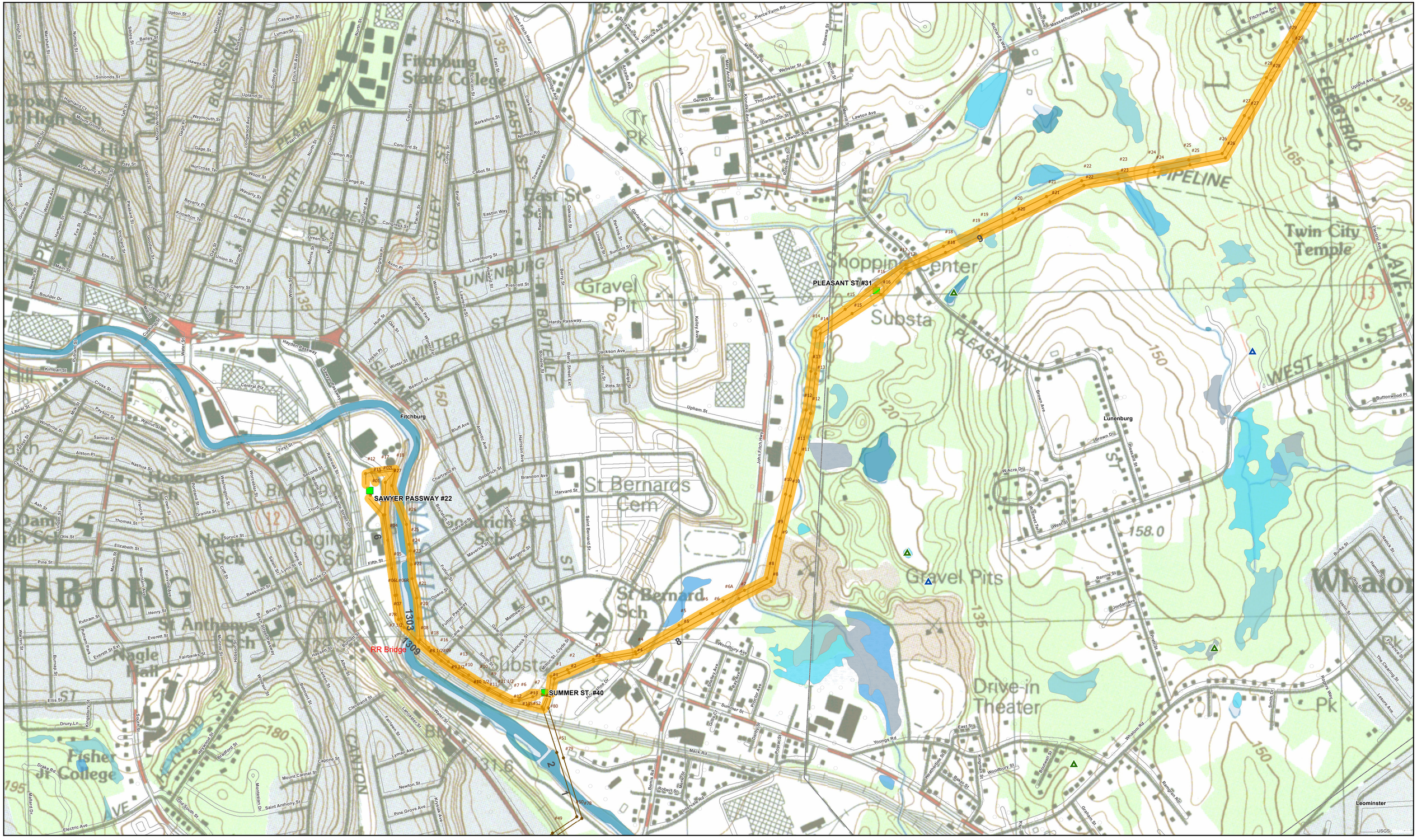
NON-REPORTABLE SPILLS: FOLLOW STEPS 1, 2, 3, 4, 8, 9, 10 & 11 and contact the Company representative.

Table 5: HERBICIDE SPILL CHECK LIST

Order	ACTION		Done (v)
1	Use any and all PPE as directed by product label or MSDS.		
2	Cordon-off spill area to unauthorized people and traffic to reduce the spread and exposure of the spill.		
3	Identify source of spill and apply corrective action, if possible stop or limit any additional amounts of spilled product.		
4	Contain spill and confine the spread by damming or diking with soil, clay or other absorbent materials.		
5	Report spills of "reportable quantity" to the Massachusetts DEP and DAR: See 310 CMR 40.00		
	Massachusetts DAR, Pesticide Bureau	617-626-1700	
	Massachusetts Department of Environmental Protection, Emergency Response Section	Main Office: 888-304-1133 Central Region: 508-792-7650	
6	If the spill cannot be contained or cleaned-up properly, or if there is a threat of contamination to any bodies of water, immediately contact any of the following applicable emergency response personnel:		
	local fire, police, rescue	911	
	FG&E: Central Dispatch	603-294-5102	
	FG&E: Environmental Dept: Tom Murphy	603-379-3829	
	FG&E: Forestry: Chris Moultroup	603-227-4652	
	Chemtrec	800-424-9300	
	additional emergency personnel		
	If there is a doubt as to who should be notified, contact State Police, Central Office	617-566-4500 or 911	
7	Remain at the scene to provide information and assistance to responding emergency clean-up crews.		
8	Refer to the various sources of information relative to handling and clean-up of spilled product.		
9	If possible, complete the process of "soaking up" with absorbent materials.		
10	Sweep or shovel contaminated products and soil into leak proof containers for proper disposal at approved location.		
11	Spread activated charcoal over spill area to inactivate any residual herbicide.		

Appendix 1

YOP Maps

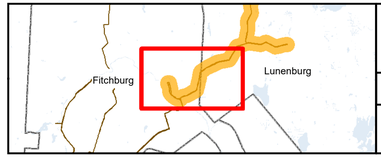


- Treatment Area
- Sub-Transmission Line
- Sub-Transmission Poles
- Street ROW
- Substation
- NHESP Priority Habitats
- NHESP Estimated Habitats of Rare Wildlife
- Potential Vernal Pools
- NHESP Certified Vernal Pools

Mass DEP Wetlands

- BOG
- DEEP MARSH
- OPEN WATER
- SALT MARSH
- SHALLOW MARSH MEADOW OR FEN
- SHRUB SWAMP
- WOODED SWAMP CONIFEROUS
- WOODED SWAMP DECIDUOUS
- WOODED SWAMP MIXED TREES

**Data Sources:
USGS Topographic Series Maps - MassGIS
NHESP Priority Habitats of Rare Species - MassGIS
NHESP Estimated Habitats of Rare Wildlife - MassGIS
Potential Vernal Pools - MassGIS
NHESP Certified Vernal Pools - MassGIS



2025 Herbicide Treatment Area
Fitchburg 1 of 3

Disclaimer: Unitil has prepared these maps based on best available information. The information provided is not warranted for accuracy and may be incomplete. Field verification is advised for all information shown on the maps.

SCALE 0 250 500 1,000 Feet

DATE 9/4/2024

Unitil

- Treatment Area
- Sub-Transmission Line
- Sub-Transmission Poles
- Street ROW
- Substation
- NHESP Priority Habitats
- NHESP Estimated Habitats of Rare Wildlife
- Potential Vernal Pools
- NHESP Certified Vernal Pools

Mass DEP Wetlands

- BOG
- DEEP MARSH
- OPEN WATER
- SALT MARSH
- SHALLOW MARSH MEADOW OR FEN
- SHRUB SWAMP
- WOODED SWAMP CONIFEROUS
- WOODED SWAMP DECIDUOUS
- WOODED SWAMP MIXED TREES

**Data Sources:
USGS Topographic Series Maps - MassGIS
NHESP Priority Habitats of Rare Species - MassGIS
NHESP Estimated Habitats of Rare Wildlife - MassGIS
Potential Vernal Pools - MassGIS
NHESP Certified Vernal Pools - MassGIS

2025 Herbicide Treatment Area
Fitchburg 2 of 3

Disclaimer: Unitil has prepared these maps based on best available information. The information provided is not warranted for accuracy and may be incomplete. Field verification is advised for all information shown on the maps.

SCALE 0 250 500 1,000 Feet

DATE 9/4/2024

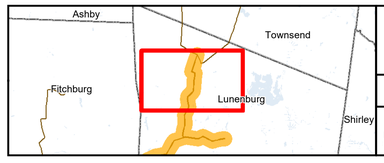
Unitil

Treatment Area
Sub-Transmission Line
Sub-Transmission Poles
Street ROW
Substation

NHESP Priority Habitats
NHESP Estimated Habitats of Rare Wildlife
Potential Vernal Pools
NHESP Certified Vernal Pools

Mass DEP Wetlands
BOG
DEEP MARSH
OPEN WATER
SALT MARSH
SHALLOW MARSH MEADOW OR FEN
SHRUB SWAMP
WOODED SWAMP CONIFEROUS
WOODED SWAMP DECIDUOUS
WOODED SWAMP MIXED TREES

**Data Sources:
USGS Topographic Series Maps - MassGIS
NHESP Priority Habitats of Rare Species - MassGIS
NHESP Estimated Habitats of Rare Wildlife - MassGIS
Potential Vernal Pools - MassGIS
NHESP Certified Vernal Pools - MassGIS



2025 Herbicide Treatment Area
Fitchburg 3 of 3

Disclaimer: Unitil has prepared these maps based on best available information. The information provided is not warranted for accuracy and may be incomplete. Field verification is advised for all information shown on the maps.

SCALE
0 250 500 1,000 Feet

DATE
9/4/2024

Unitil

Appendix 2

333 CMR 11.00

333 CMR 11.00: RIGHTS OF WAY MANAGEMENT

Section

11.01: Purpose

The purpose of 333 CMR 11.00 is to establish a statewide and uniform regulatory process which will minimize the uses of, and potential impacts from herbicides in rights-of-way on human health and the environment while allowing for the benefits to public safety provided by the selective use of herbicides. Specific goals of 333 CMR 11.00 are to:

(1) Ensure that an Integrated Pest Management (IPM) approach to vegetation management is utilized on all rights-of-way covered by 333 CMR 11.00.

(2) Establish standards, requirements and procedures necessary to prevent unreasonable risks to humans or the environment, taking into account the economic, social and environmental costs and benefits of the use of any pesticide.

(3) Ensure ample opportunity for public and municipal agency input on potential impacts of herbicide application to rights-of-way in environmentally sensitive areas.

(4) Establish a mechanism for public and municipal review of rights-of-way maintenance plans.

11.02: Definitions

For the purposes of 333 CMR 11.00, unless the context clearly requires otherwise, the following definitions shall apply:

Agricultural Area includes, but is not limited to, actively cultivated gardens, greenhouses, orchards, fields, pastures, and other areas under cultivation or agricultural management.

Applicant, any person representing any federal, state or local government or agency, utility, railroad or pipeline, that intends to maintain a right-of-way in the Commonwealth by application of herbicides.

Associated Surface Water Body, as identified on the most current available maps prepared by the Department of Environmental Protection, any body of water that is hydrologically connected to a Class A surface water source.

Ballast, the coarse gravel or crushed rock on which the ties, tracks and switching, signaling and communication devices of a railroad are laid.

Broadcast, any non-selective herbicide application technique which results in application to all vegetation within a target area.

Certified Vernal Pool, a confined basin depression, certified and mapped by NHESP pursuant to the provisions of 310 CMR 10.57(2)(a)5. and 6., which, at least in most years, holds water for a minimum of two continuous months during the spring and/or summer, and which is free of adult fish populations.

11.02: continued

Certified Vernal Pool Habitat, that vernal pool habitat which has been certified and mapped by NHESP pursuant to the provisions of 310 CMR 10.57(2)(a)5. and 6. or, in the event that such habitat has not been mapped, the area extending 100 feet horizontally outward from the boundary of any Certified Vernal Pool.

Class A Waters, waters which are designated as a source of public water supply, as defined in 314 CMR 4.05(3)(a).

Class B Drinking Water Intakes, intakes to Class B waters suitable as sources of public water supply with appropriate treatment, as defined at 314 CMR 4.05(3)(b) and as identified on the most current available maps prepared by the Department of Environmental Protection.

Department, the Department of Agricultural Resources.

FIFRA, the Federal Insecticide, Fungicide and Rodenticide Act, Public Law 92-516.

Foliar Treatment, any technique which applies herbicide to leaves of target vegetation.

Inhabited Area, any area where people generally live, work or gather, including, but not limited to, any residence, school, hospital, park or recreational facility.

Interim Wellhead Protection Area (IWPA), for public water systems using wells or well fields that lack a Department of Environmental Protection-approved Zone II, an interim wellhead protection area, as that term is defined in the Massachusetts drinking water regulations, 310 CMR 22.02, and as identified on the most current available maps prepared by the Department of Environmental Protection, shall apply. Generally, this is a ½- mile radius for sources whose approved pumping rate is 100,000 gallons per day or greater. For smaller sources, the radius in feet is determined by multiplying the approved pumping rate in gallons per minute by 32 and adding 400.

Limited Application Waiver, a waiver from the requirements of 333 CMR 11.05 and 11.06, granted at the Department's sole discretion pursuant to 333 CMR 11.03(14), when the reason for the application is emergency public health or safety or when the application is for one time only.

Limited Spray Area, any area that is both within a Right-of-Way and within:

(a) any Zone II or IWPA;
(b) a distance of between 100 feet and 400 feet of any Class A Surface Water Source;
(c) a distance of between ten and 200 feet of any tributary or associated surface water body where the tributary or associated surface water body runs outside the Zone A for the Class A surface water source;
(d) a lateral distance of between 100 and 200 feet for 400 feet upstream, on both sides of the river, of a Class B Drinking Water Intake;
(e) a distance of between 50 and 100 feet of any identified Private Well;
(f) a distance of between 10 and 100 feet of any Wetlands or Water Over Wetlands;
(g) a distance of between ten feet from the mean annual high water line of any river and the outer boundary of the Riverfront Area;
(h) a distance of between ten feet from any Certified Vernal Pool and the outer boundary of any Certified Vernal Pool Habitat; and
(i) a distance of 100 feet of any Agricultural or Inhabited Area.

Low Pressure, pressure under 60 pounds per square inch (psi).

Maps, United States Geological Survey maps of scale 1:25,000 or other maps, as determined by the Department, which are of such accuracy and scale to provide sufficient detail so that sensitive areas can be delineated.

NHESP, the Natural Heritage and Endangered Species Program within the Massachusetts Division of Fisheries and Wildlife.

11.02: continued

No-spray Area, any area that is both within a Right-of-Way and within:

(a) any Zone I;
(b) 100 feet of any Class A Surface Water Source;
(c) 100 feet of any tributary or associated surface water body where the tributary or associated surface water body runs within 400 feet of a Class A surface water source;
(d) ten feet of any tributary or associated surface water body where the tributary or associated surface water body is at a distance greater than 400 feet from a Class A surface water source;
(e) a lateral distance of 100 feet for 400 feet upstream, on both sides of the river, of a Class B Drinking Water Intake;
(f) 50 feet of any identified Private Well;
(g) ten feet of any Wetlands or Water Over Wetlands;
(h) ten feet of the mean annual high-water line of any river; and
(i) ten feet of any Certified Vernal Pool.

Person, an individual, association, partnership, corporation, company, business organization, trust, estate, the Commonwealth or its political subdivisions, administrative agencies, public or quasi-public corporation or body, or any other legal entity or its legal representatives, agent or assignee, or a group of persons.

Person Aggrieved, any person who, because of an act or failure to act by the Department may suffer an injury in fact which is different either in kind or magnitude from that suffered by the general public and which is within the scope of the interests identified in 333 CMR 11.00. Such person must specify in writing sufficient facts to allow the Department to determine whether or not the person is in fact aggrieved.

Private Well, any private drinking water supply identified by the local Board of Health, the well owner or the Department of Agricultural Resources.

Private Well Registry, a registry of private wells located within 100 feet of a right-of-way which is maintained by the Department of Agricultural Resources. Homeowners must notify the Department by completing a registration form which is available directly from the Department or online at the Department website.

Public Water Supplier, as defined at 310 CMR 22.02(1), any person who owns or operates a public water supply system.

Public Ground Water Source, a source of water for a Public Water Supply System, as that term is defined in the Massachusetts drinking water regulations at 310 CMR 22.02.

Right(s)-of-way (ROW), any roadway, or thoroughfare on which public passage is made and any corridor of land over which facilities such as railroads, powerlines, pipelines, conduits, channels or communication lines or bicycle paths are located.

Rights-of-way Advisory Panel, a panel established to advise the Department on issues relating to 333 CMR 11.00 and to fulfill specific functions as detailed within 333 CMR 11.05 and 11.11.

River, a river as defined at 310 CMR 10.04 and as identified on the most current available maps prepared by the Department of Environmental Protection.

Riverfront Area, a riverfront area as defined at 310 CMR 10.58(2) and as identified on the most current available maps prepared by the Department of Environmental Protection. In general, this term shall mean the area between the mean annual high-water line of a perennially flowing river and a parallel line 200 feet away.

Selective Application, any application of herbicides, in such a manner that the delivery to the target vegetation is optimized and delivery to non-target vegetation and the environment is minimized.

11.02: continued

Sensitive Areas, as defined in 333 CMR 11.04, any areas within Rights-of-Way, including No-Spray and Limited-Spray Areas, in which public health, environmental or agricultural concerns warrant special protection to further minimize risks of unreasonable adverse effects.

State-listed Species, any species on the Massachusetts list of Endangered, Threatened, and Special Concern Species as described in the Massachusetts Endangered Species Act (M.G.L c. 131A; 321 CMR 10.02).

State-listed Species Habitat, the Estimated Habitats of Rare Wildlife (310 CMR 10.59 and 10.37) and the Priority Habitats for State-listed Species (321 CMR 10.02) as shown on the most recent edition of the Massachusetts Natural Heritage Atlas prepared by NHESP.

Stem Treatment, any technique including, but not limited to, stump, basal, stem, injection, banding, frill, or girdle and any other technique which delivers herbicide at low pressure to the stump, base or stem of the target vegetation.

Surface Water Source, any lake, pond, reservoir, river, stream or impoundment designated as a public water supply in the Massachusetts Surface Water Quality Standards, 314 CMR 4.00, as identified on the most current available maps prepared by the Department of Environmental Protection.

Target Vegetation, any plant species which has the potential to interfere with the operation and safety of the right-of-way.

Touch-up Application, any limited application of herbicides following an initial treatment, which is necessary to achieve the desired vegetation control.

Tributary, as identified on the most current available maps prepared by the Department of Environmental Protection, any body of running, or intermittently running, water which moves in a definite channel, naturally or artificially created, in the ground due to a hydraulic gradient, and which ultimately flows into a Class A surface water source, as defined in 314 CMR 4.05(3)(a).

Vegetation Management Plan (VMP), a long term management plan for the applicant's right-of-way system which describes the intended program for vegetation control over a five year period.

Vernal Pool, *see* Certified Vernal Pool.

Water Over Wetlands, the ocean or any estuary, lake or pond as defined at 310 CMR 10.04.

Wetlands, any of the following areas as defined in 310 CMR 10.02(1)(a), (b), (c) and (f):

(a)

Any bank,		the ocean
any freshwater wetland,		any estuary
any coastal wetland,		any creek
any beach,	bordering	any river
any dune,	on	any stream
any flat		any pond
any marsh,		or any lake
or any swamp;		

(b) Land under any of the water bodies listed in 333 CMR 11.02: Wetlands(a); and

(c) Land subject to tidal action.

11.02: continued

Wetlands Determination, a written determination of the boundaries of Wetlands and boundaries of areas within 100 feet of Wetlands in accordance with the regulations of the Department of Environmental Protection (DEP) at 310 CMR 10.05(3)(a)1. and 2. 310 CMR 10.03(6)(b) requires applicants not eligible for a public utility exemption to submit these determinations with their VMPs if they will apply herbicides within 100 feet of wetlands and will not submit a Notice of Intent under M.G.L. c. 131, § 40, the Wetlands Protection Act. In order to obtain a Wetlands Determination, the applicant should submit a request to the conservation commission on maps of a scale that will enable the conservation commission or Department of Environmental Protection to find and delineate the boundaries of Wetlands and buffer zones within the vicinity of the right-of-way herbicide management area. To be considered "valid", the Wetlands Determination should be made no sooner than six months immediately prior to the submission of the Vegetation Management Plan. The Wetlands Determination shall cover the period of the Vegetation Management Plan only and shall expire at the end of the five year period of that Vegetation Management Plan.

Yearly Operational Plan (YOP), the yearly operational plan which describes the detailed vegetation management operation for the calendar year consistent with the terms of the long term Vegetation Management Plan.

Zone A, as identified on the most current available maps prepared by the Department of Environmental Protection, the protective land area for a Surface Water Source, Class A water source, Tributary, or Associated Surface Water Body defined in 310 CMR 22.02 as:

(a) the land area between the Class A surface water source and the upper boundary of the bank;

(b) the land area within a 400 foot lateral distance from the upper boundary of the bank of a Class A surface water source, as defined in 314 CMR 4.05(3)(a); and

(c) the land area within a 200 foot lateral distance from the upper boundary of the bank of a Tributary or Associated Surface Water Body.

Zone I, as identified on the most current available maps prepared by the Department of Environmental Protection and as defined at 310 CMR 22.02, the protective radius required around a public water supply well or wellfield. For public water system wells with approved yields of 100,000 gallons per day (gpd) or greater, the protective radius is 400 feet. Tubular wellfields require a 250 foot protective radius. Protective radii for all other public water system wells are determined by the following equation: Zone I radius in feet = (150 x log of pumping rate in gpd) –350.

Zone II, as identified on the most current available maps prepared by the Department of Environmental Protection and as defined at 310 CMR 22.02, the aquifer recharge area for a public water supply well or wellfield.

11.03: General Provisions

(1) No person shall use an herbicide for the purpose of clearing or maintaining a right-of-way unless appropriately certified by the Department, or licensed by the Department and working under the on-site supervision of an appropriately certified applicator.

(2) No person shall use an herbicide for the purpose of clearing or maintaining a right-of-way except in accordance with a Vegetation Management Plan (VMP) and a Yearly Operational Plan (YOP) as approved by the Department. The YOP shall be available at the work site at all times during herbicide applications and be made available to the Department and municipal officials including the Conservation Commission and Board of Health upon reasonable request.

(3) No person shall handle, mix or load an herbicide concentrate on a right-of- way within 100 feet of a sensitive area.

(4) The perimeter of any sensitive areas which are not readily identifiable on the ROW shall be identified with a clearly visible marker system, consistent with the VMP, prior to any herbicide application.

11.03: continued

(5) No foliar application of herbicides shall be used to control vegetation greater than 12 feet in height except for side trimming.

(6) No herbicide shall be applied when the wind velocity is such that there is a high propensity to drift off target and/or during measurable precipitation, and no person shall apply herbicides in such a manner that results in drift into any No-spray Area.

(7) No person shall apply herbicides by aircraft for the purpose of clearing or maintaining a right-of-way.

(8) No touch-up applications shall be carried out except under the following conditions:

(a) Touch-up applications must occur within 12 months of the initial application.

(b) All applicable public notification procedures of M.G.L. c. 132B, § 6B, as outlined in 333 CMR 11.07(1) and (3), are followed.

(c) No more than 10% of the initially identified target vegetation on the applicant's right-of-way in any municipality may be treated and the total amount of herbicide applied in any one year shall not exceed the limits specified by the label or Yearly Operational Plan.

(d) The Department may impose such additional restrictions or conditions on the use of herbicides as it deems necessary to protect public health and the environment.

(9) The Department will maintain mailing lists of individuals and groups desiring to obtain notices on various aspects of the Program.

(10) No person shall apply any herbicide identified as a Potential Ground Water Contaminant pursuant to 333 CMR 12.00 to a right-of-way.

(11) No person shall use an herbicide for the purpose of clearing or maintaining a right-of-way unless that person has obtained the most current available map of public ground water sources from the Department of Environmental Protection.

(12) No person shall use an herbicide for the purpose of clearing or maintaining a right-of-way unless that person has done one or more of the following:

(a) obtained a current list of identified Private Wells within 100 feet of the right-of-way from the Board of Health, or

(b) obtained a current list of all private wells, within 100 feet of the right of way from the Department of Agricultural Resources private well registry; or

(c) followed an alternative Private Well identification method outlined in an approved YOP.

(13) The applicator shall provide any employee of any state agency, or authority as defined in M.G.L. c. 3, § 39, when such employee is, within a right-of-way, using pesticides, supervising the use of pesticides, or present during the use of pesticides, with personal protective equipment and clothing. Applicators should note that other federal or state laws or regulations pertaining to pesticide applications may require this personal protective equipment to include protections according to Material Safety Data Sheets (MSDS's), the product label, and any other supporting technical data supplied by the manufacturer.

(14) Notwithstanding the provisions of 333 CMR 11.03(2) or other provisions of 333 CMR 11.00, the Department may, at its sole discretion, issue Limited Application Waivers to applicants wishing to apply herbicides to clear or maintain rights-of-way without VMPs or YOPs, but only under the following conditions:

(a) The applicant must demonstrate either:

1. that the application will not occur more than once in a five-year period unless a VMP and a YOP are prepared and all other requirements of 333 CMR 11.00 are met; or
2. that the application is necessary to protect public health or safety.

(b) The applicant must still adhere to all public notification requirements established at 333 CMR 11.07(1) and (3).

(c) The applicant must provide the Department with a letter establishing the concurrence of the chief elected official or board of selectmen of the municipality where the application is to be made.

11.03: continued

(d) The applicant may only use herbicides on the Department's "Herbicides Recommended for Use in Sensitive Areas List."
(e) If the application could impact Wetlands, the Department recommends that the applicant send a copy of its application for a Limited Application Waiver to the Department of Environmental Protection's Division of Wetlands and Waterways no less than 21 days before the proposed application.
(f) It should be noted that, with certain exceptions for public utilities, wetlands regulations at 310 CMR 10.03(6)(b) currently require Wetlands Determinations prior to any application within 100 feet of a Wetland.

Limited Application Waivers shall be issued solely at the Department's discretion, and the Department may impose such additional restrictions or conditions on the use of herbicides as it deems necessary to protect public health and the environment.

11.04: Sensitive Area Restrictions

(1) General. In any sensitive area:
(a) No more than the minimum labeled rate of herbicide for the appropriate site, pest, and application method shall be applied.
(b) Herbicides shall only be applied selectively by low pressure, using foliar techniques or basal or cut-stump applications, or other method approved for use by the Department.
(c) No person shall apply herbicides for the purpose of clearing or maintaining a right-of-way in such a manner that results in drift to any area within ten feet of standing or flowing water in a wetland; or area within 400 feet of a public drinking water supply well; or area within 100 feet of any Class A surface water used as a public water supply; or area within 50 feet of a Private Well.
(d) Only herbicides specified by the Department as acceptable for use in sensitive areas pursuant to the Cooperative Agreement executed between the Department of Agricultural Resources and the Department of Environmental Protection on July 1 and 2, 1987, or future amendments thereto, shall be used in sensitive areas. Applicants proposing to use an herbicide which has been registered for use on rights-of-way but has not yet been evaluated pursuant to the provisions of the Cooperative Agreement may request that such herbicides be evaluated pursuant to said provisions. For an herbicide that has been evaluated pursuant to the provisions of the Cooperative Agreement, applicants proposing to use such herbicide in a manner inconsistent with the terms and conditions of use imposed in the guidelines may request a modification or waiver of such terms or conditions. A request for such modification or waiver shall provide a detailed rationale for use, with all relevant data including but not limited to environmental fate, efficacy and human health effects of the proposed herbicide. Such herbicides and/or uses shall be subject to the evaluation standards adopted by the Departments of Agricultural Resources and Environmental Protection in the Cooperative Agreement.
Commentary. Applicants not eligible for the public utilities exemption from the Wetlands Protection Act outlined at 310 CMR 10.03(6)(a), who wish to apply pesticides registered for use in Massachusetts to rights-of-way, may choose to apply herbicides determined to be suitable for use in sensitive areas in accordance with the provisions of the Cooperative Agreement mentioned above or, alternatively, such applicants may proceed pursuant to the provisions of 310 CMR 10.00 as authorized by M.G.L. c. 131, § 40.
(e) The Department may impose such additional restrictions or conditions on the use of herbicides within or adjacent to sensitive areas as it determines necessary to protect human health or the environment. Such changes may be proposed by a municipal agency or individual during the public comment period.
(f) In the event of a question or dispute as to which setback applies to a sensitive area, the most restrictive setback shall apply.

(2) Water Supplies.
(a) Public Ground Water Sources.
1. No herbicides shall be applied within a Zone I.
2. No herbicides shall be applied within a Zone II or IWPA unless:

11.04: continued

a. A minimum of 24 months has elapsed since the last application to the site; and

b. Herbicides are applied selectively by low pressure, using foliar techniques or basal or cut-stump applications.

(b) Class A Public Surface Water Sources, Associated Surface Water Bodies, Tributaries and Class B Drinking Water Intakes.

1. No herbicides shall be applied within 100 feet of any Class A public surface water source.

2. No herbicides shall be applied within 100 feet of any tributary or associated surface water body located within the Zone A of a Class A public surface water source, or within ten feet of any tributary or associated surface water body located outside of the Zone A of the Class A public surface water source.

3. No herbicides shall be applied within a lateral distance of 100 feet for 400 feet upstream of any Class B Drinking Water Intake.

4. No herbicides shall be applied within a distance of between 100 feet from any Class A surface water source and the outer boundary of any Zone A, or within a distance of between ten feet and the outer boundary of the Zone A for any tributary or associated surface water body located outside of the Zone A of a Class A surface water source, or within a lateral distance of between 100 and 200 feet for 400 feet upstream of a Class B Drinking Water Intake, unless:

a. A minimum of 24 months has elapsed since the last application to the site; and

b. Herbicides are applied selectively by low pressure, using foliar techniques or basal or cut-stump applications.

(c) Private Wells.

1. No herbicides shall be applied within 50 feet of an identified Private Well.

2. No herbicides shall be applied within a distance of between 50 feet and 100 feet of an identified Private Well, unless:

a. A minimum of 24 months has elapsed since the last application to the site; and

b. Herbicides are applied selectively by low pressure, using foliar techniques or basal or cut-stump applications.

(3) State-listed Species Habitat.

(a) Any person proposing to apply an herbicide within any State-listed Species Habitat who does not have a current Yearly Operational Plan approved in writing by the Division of Fisheries and Wildlife pursuant to 321 CMR 10.14(12), shall submit all necessary materials required for review pursuant to 321 CMR 10.18.

(b) The management of vegetation within existing utility rights-of-way shall be exempt from the requirements of 321 CMR 10.18 through 10.23, provided that the management is carried out in accordance with a Yearly Operational Plan approved in writing by the Division of Fisheries and Wildlife, pursuant to 321 CMR 10.14(12).

(c) No person shall apply an herbicide within State-listed Species Habitat unless the application is approved by the Division of Fisheries and Wildlife pursuant to 333 CMR 11.04(3)(a) and (3)(b), and such approval is submitted to the Department.

(4) Wetlands, Waters Over Wetlands, Riverfront Areas, and Certified Vernal Pools.

(a) No herbicide shall be applied on or within ten feet of a Wetland or Water Over a Wetland, within ten feet of the mean annual high-water line of any River, or within ten feet of any Certified Vernal Pool.

(b) No herbicide shall be applied on or within a distance of between ten feet and 100 feet of any Wetland or Water Over a Wetland, within a distance of ten feet from the mean annual high-water line of any River and the outer boundary of any Riverfront Area, or within a distance of ten feet from any Certified Vernal Pool and the outer boundary of any Certified Vernal Pool Habitat unless:

1. A minimum of 12 months has elapsed since the last application to the site; and

2. Herbicides are applied selectively by low pressure, using foliar techniques or basal or cut-stump applications.

(c) Notwithstanding 333 CMR 11.04(4)(a) and (b), public utilities providing electric, gas, water, telephone, telegraph and other telecommunication services (and other applicants, if consistent with all relevant provisions of the Massachusetts Wetlands Protection Act and its regulations in effect at the time of application) may apply herbicides on or within ten feet of a Wetland in accordance with the following conditions:

11.04: continued

1. Submission of a study, the design of which is subject to prior approval by the Departments of Agricultural Resources and Environmental Protection, evaluating impacts of the proposed vegetation management program utilizing herbicides on or within ten feet of Wetlands, and comparing those impacts to those which would result if only non-chemical control methods were used in these areas. The study must detail vegetation management practices and use patterns specific to those used by the type of entity submitting the study; and

2. A finding by the Department, after consultation with the Rights-of-way Advisory Panel, that the proposed vegetation management program utilizing herbicides on or within ten feet of Wetlands will result in less impacts to the Wetlands than mechanical control.

3. Notwithstanding the above, no herbicides shall be applied on or within ten feet of any standing or flowing water in a Wetland.

(5) Inhabited and Agricultural Areas. No foliar herbicide shall be applied within 100 feet of any Inhabited Area or any Agricultural Area unless:

(a) A minimum of 12 months has elapsed since the last application to the site; and

(b) Herbicides are applied selectively by low pressure, using foliar techniques or basal or cut-stump applications.

11.05: Vegetation Management Plan (VMP)

(1) General.

(a) Unless otherwise specified by the Department, all VMPs should be submitted by the applicant no later than September 1st prior to the calendar year of the proposed first year of maintenance. All approved VMPs shall be effective for a five year period unless otherwise modified, or revoked by the Department.

(b) The VMP shall be presented on forms and/or format approved by the Department.

(2) Requirements. The VMP shall include, but not be limited to, the following:

(a) General statement of goals and objectives of the VMP.

(b) Identification of target vegetation.

(c) Intended methods of vegetation management and rationale for use, including vegetation control techniques, equipment proposed for use, timing of applications and alternative control procedures.

(d) Discussion of justification for proposed herbicide applications, including a description of the alternative control methods considered and the reasons that they were rejected.

(e) Methods, references and sources for identifying sensitive areas and control strategies proposed for sensitive areas. Applicants should note that the Department of Environmental Protection regulations at 310 CMR 10.03(6)(b) require Wetlands Determinations for applicants that are not eligible for a public utility exemption.

(f) Operational guidelines for applicators relative to herbicide use.

(g) Identification and qualifications of individuals developing and submitting a plan.

(h) A detailed description of the IPM Program, showing how it will minimize the amount and frequency of herbicide application.

(i) Description of alternative land use provisions or agreements that may be established with individuals, state, federal or municipal agencies that would minimize the need for herbicides, including the rationale for accepting or denying any reasonable request made by any individual.

(j) Description of a remedial plan to address spills and related accidents.

(k) For state agencies and authorities as defined in M.G.L. c. 3, § 39, a description of the applicant's policy to eliminate or, if necessary, reduce the use of pesticides for any vegetation management purpose along roadways, and a demonstration that, for the proposed application, the costs of non-chemical vegetation control significantly outweigh the benefits.

(3) Public Notice, Review and Comment.

(a) Upon receipt of the proposed VMP, the Department shall schedule and hold appropriate regional public hearings affording all interested parties the opportunity to comment, both at the hearings and in writing to the Department, on the proposed plan.

11.05: continued

(b) At least 21 days prior to the public hearings, the Department shall publish notice of the hearings in the Environmental Monitor and regionally located newspapers, and send notice to municipalities covered by the plan and to the appropriate mailing list. The notice will include locations where copies of the VMP can be reviewed.

(c) The public shall have no less than 45 days, starting from publication of the *Environmental Monitor* notice, to comment upon proposed VMPs, unless the Department extends the comment period for good cause.

(d) Wherever a chief elected official, Board of Health or Conservation Commission in a municipality covered by the proposed VMP requests a copy of the proposed plan, the applicant shall, at least 21 days prior to the end of the public comment period, respond to this request. The response must either include a copy of the proposed VMP, or an Internet address where the VMP may be viewed and a note that a hard copy will be provided promptly upon further request.

(4) Disposition of VMP.

(a) 25 copies of the proposed VMP shall be submitted to the Department. The Department shall distribute copies of the proposed VMP to each member of the Rights-of-way Advisory Panel. The Department may, at its sole discretion, allow electronic presentation of the VMP in *lieu* of some or all of the 25 copies that would otherwise be submitted pursuant to 333 CMR 11.05(4).

(b) Within 30 days of the end of the public comment period unless extended for good cause, the Rights-of-way Advisory Panel shall review the VMPs and recommend in writing to the Department approval, denial or modification of each VMP; if necessary, the Advisory Panel may request additional information from the applicant.

(c) Within 21 days of the end of the Rights-of-way Advisory Panel review period, unless extended by the Department for good cause, the Department will notify the applicant and the Advisory Panel in writing one of the following:

1. request for additional information or modification;
2. denial of VMP; or
3. approval of VMP.

(d) The VMP may be modified, withdrawn or amended by the applicant through a written request sent by certified mail to the Department.

(e) Resubmission of a denied VMP, updating of a VMP, or a significant amendment to an approved VMP shall be processed according to 333 CMR 11.05.

(f) The applicant must send a copy of the approved VMP, or an Internet address where the VMP may be viewed and a note that a hard copy will be provided promptly upon further request, to the chief elected official, Board of Health, and Conservation Commission in each municipality covered by the plan.

(5) Time for Action. Non-action by the Department on a VMP within the time specified in 333 CMR 11.05 does not constitute approval of the submitted plan. In the event that the Department fails to notify the applicant of a decision within the time specified in 333 CMR 11.05(4)and upon written request from the applicant, the Commissioner must issue a finding within ten days of receipt stating the reason for the delay and providing an estimated completion date.

11.06: Yearly Operational Plan (YOP)

(1) General.

(a) The applicant is responsible for the accuracy and completeness of all information submitted with the YOP. The YOP shall be consistent with the objectives of the VMP and shall describe the intended operational program for that calendar year.

(b) The YOP shall be presented on forms and in a format approved by the Department.

(2) Requirements. The YOP shall include but not be limited to the following:

(a) Maps locating the rights-of-way and sensitive areas not readily identifiable in the field;

(b) Herbicides proposed including Environmental Protection Agency (EPA) Registration numbers, application rates, carriers and adjuvants;

(c) Herbicide application techniques and alternative control procedures proposed.

(d) The name, address and phone number of the company which will perform any herbicide treatment;

11.06: continued

(e) Identification of target vegetation;
(f) The name, address and phone number of the individual representing the YOP applicant;
(g) Description of methods used to flag or otherwise designate sensitive areas on the right-of-way;
(h) Herbicide Fact Sheets as approved by the Department; and
(i) Procedures and locations for handling, mixing and loading of herbicide concentrates.

(3) Public Notice, Review and Comment.

(a) Upon submittal of the YOP for approval, the Department will publish a notice in the *Environmental Monitor*. Said notice shall be provided by the applicant and shall include the information on the municipalities through which the rights-of-way pass, a brief description of the intended program, and the procedure for public review and comment. The Department shall send notification of the publication to the applicant and the appropriate mailing list.

(b) Upon submittal of the YOP to the Department, the applicant shall provide by certified mail under separate cover to the Board of Health, Conservation Commission, chief elected municipal official, and where applicable, the Massachusetts Water Resources Authority and Massachusetts Department of Conservation and Recreation, a copy of the proposed YOP (or an Internet address where the proposed YOP may be viewed and a note that a hard copy will be provided promptly upon request) and the *Environmental Monitor* notice for the municipality or municipalities in which the herbicide treatment is proposed. Community water suppliers shall receive electronic information or a one page notification by mail which provides details about where to receive more information. The applicant shall maintain copies of the packet sent to municipalities and certified mail receipts. The applicant shall make copies of the packet, certified mail receipts, and any further correspondence regarding hard copies of YOPs in *lieu* of Internet viewing, available to the Department upon request.

(c) The Department shall allow a 45-day comment period on proposed YOPs, unless extended for good cause, commencing with the publication of the notice in the *Environmental Monitor* and receipt of the proposed YOP and *Environmental Monitor* notice by each municipality.

(d) The Department may approve, deny or modify YOPs after the 45-day comment period has expired.

(4) Disposition of YOP.

(a) The applicant shall submit the YOP to the Department at least 90 days prior to the proposed commencement of application to allow completion of the comment and review period.

(b) The Department shall review the YOP to ensure that the YOP is consistent with the approved VMP. Any inconsistencies or deficiencies will be noted by the Department and returned with the YOP to the applicant.

(c) Where practical, the Department shall approve or deny the YOP within 90 days of receipt. The Department will provide notice of the decision to the applicant, municipal agencies and commentators in writing.

(d) The approved YOP in conjunction with the VMP shall govern the application of herbicide for a period not to exceed 12 months in accordance with other laws and regulations of the State and Federal governments and impose such conditions as necessary to minimize the risk of adverse effects on human health and the environment.

(5) Time for Action. Non-action by the Department on a YOP within the time specified in 333 CMR 11.06(4) does not constitute approval of the submitted plan. In the event that the Department fails to notify the applicant of a decision within the time specified and upon a written request from the applicant, the Commissioner must issue a finding within ten days of receipt stating the reason for the delay and providing an estimated completion date.

11.07: Public Notification

(1) At least 21 days in advance of application of herbicide to a right-of-way in any city or town, the applicant shall notify the Department, the board of health, and the local public water supplier and, by registered mail, the Mayor, City Manager or Chairman of the Board of Selectman, and the conservation commission in the municipality where the right-of-way lies. The notice shall include the following information: the approximate dates on which such herbicide application shall commence and conclude, provided however, that said application shall not commence more than ten days before nor conclude more than ten days after said approximate dates; the method and locations of application; a Department-approved Herbicide Fact Sheet on the active ingredient(s) of the herbicide(s) used; the EPA registration number(s) for the herbicide(s) used; the name, title, business address and phone number of the certified commercial applicator or licensed applicator, or the contractor, employer or employees responsible for carrying out the application. Where specific information required for this notice is already contained in the current YOP that is on file with the local official, the applicant may incorporate the appropriate pages of the YOP by reference in its notice to that official, indicating that these pages are also directly available from the applicant upon request.

(2) This public notice may run concurrently with the public notice and comment period in 333 CMR 11.06(3), provided that the notice is distributed at least 21 days prior to the herbicide application, and that, prior to the herbicide application, the public notice and comment period has closed and the Department has granted YOP approval without modifications. When the Department's final approval requires modifications or application dates are selected after YOP approval, separate notice under 333 CMR 11.07(1) is required.

(3) At least 48 hours prior to the application referred to in 333 CMR 11.07(1), the applicant must publish a conspicuous notice in at least one newspaper of general circulation in the city or town where the right-of-way lies. The notice must appear in the local section of the newspaper and measure at least four by five inches in size. The notice shall contain the following information: the method and locations of pesticide application; the approximate dates on which the pesticide application shall commence and conclude, provided that the applications shall not commence more than ten days before nor conclude ten days after said approximate dates; a list of potential pesticides to be used; a description of the purpose of the application; and the name, title, business address and phone number of a designated contact person representing the applicant from whom any citizen may request further information. The notice should apply only to the calendar year in which the notice is published. Upon request the notice must be made available to the Department.

11.08: Notice of Modification and Revocation

(1) The Department may suspend approval of any VMP or YOP, by written notice to the applicant and applicator, halting the application of herbicide to that right-of-way of the YOP. After 21 days if the applicant does not request a hearing, the Department may revoke or modify the VMP and YOP, if it finds:

(a) that the terms, conditions of restrictions thereof, are being violated or are inadequate to avoid unreasonable adverse effects on the environment or on human health; or

(b) that the applicant has made a false or misleading statement or has not provided information requested by the Department or Rights-of-way Advisory Panel; or

(c) that the applicant has violated any provision of the Massachusetts Pesticide Control Act or FIFRA, or any regulations, standards, orders or license issued under either.

(2) Upon notice of revocation or modification, the applicant may modify the YOP by written request to the Department. Applications to modify the YOP shall be submitted in the manner set forth in 333 CMR 11.06 and disposed of in the manner set forth in 333 CMR 11.06. The Department may waive all or part of the requirement if it determines that the proposed changes do not significantly change the terms of the approved YOP.

11.09: Right-of-appeal

Any person aggrieved by the decision of the Department to approve, deny, modify or revoke a VMP or YOP may request an adjudicatory hearing. The request for a hearing must be received by the Department within 21 calendar days after receipt of the decision. The request should state clearly and concisely the facts of the proceeding, the reasons the decision is alleged to be inconsistent with 333 CMR 11.00 and the relief sought by the adjudicatory hearing. The adjudicatory hearing before the Pesticide Board shall be conducted in accordance with the informal rules of adjudicatory proceeding as set forth in M.G.L. c. 30A.

11.10: Penalties

Any person who violates any provision of 333 CMR 11.00 shall be subject to the criminal and civil penalties set forth in M.G.L. c. 132B, § 14.

11.11: Rights-of-way Advisory Panel

(1) A Rights-of-way Advisory Panel shall be established to advise the Department on issues relating to 333 CMR 11.00 and to fulfill specific functions as detailed within 333 CMR 11.00.

(2) The Department shall request that the following members participate on the Rights-of-way Advisory Panel: the Commissioners/Secretaries or his/her designee of the Department of Environmental Protection, the Department of Public Health, and the Executive Office of Transportation; and a representative, respectively, from each of the following, all to be appointed by the Department Commissioner: the Massachusetts Association of Conservation Commissions, the Massachusetts Association of Health Boards, the Massachusetts Department of Conservation and Recreation, and an Environmental Advocacy Organization Representative, a member of the University of Massachusetts Extension who is well versed in weed science and Integrated Pest Management of weeds, a representative of the Massachusetts Railroad Association, a representative of a utility company and a commercial pesticide applicator.

(3) Non-agency representatives shall remain on the panel for a term of five years. Any member absent from two or more consecutive meetings may be removed from the Advisory Panel at the discretion of the Commissioner of the Department, and a replacement requested from the representative agency, industry group, or association.

(4) The Advisory Panel shall meet at least once each year, and shall hold further meetings upon the request of the Department of Agricultural Resources or at the request of any two members of the Advisory Panel.

(5) All Advisory Panel members shall serve without compensation.

REGULATORY AUTHORITY

333 CMR 11.00: M.G.L. c. 132B.

NON-TEXT PAGE

Appendix 3

Sensitive Area Illustration

Vegetation Control Strategies in Sensitive Areas

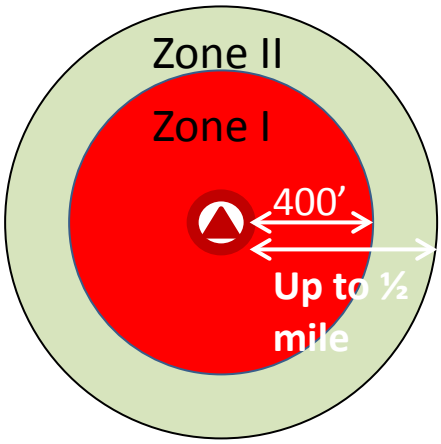
Required by 333 CMR 11.00 and/or approved Vegetation Management Program and Yearly Operational Plan

---

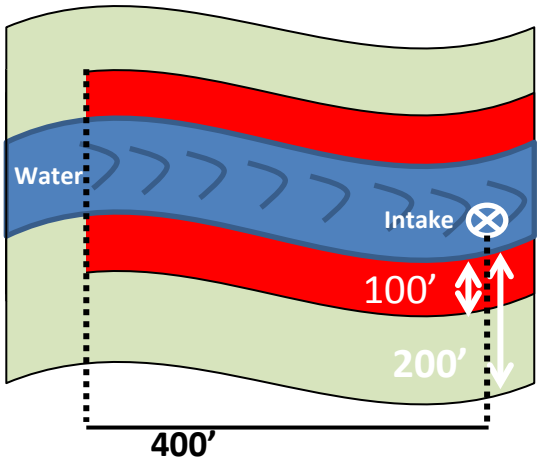
Sensitive areas not readily identified in the field:

- Mapped on electronic USGS Topographic Maps.
- Contractor will be provided electronic and hard copy of maps with which to flag the boundaries of no-herbicide zones within the right-of-way (ROW) prior to herbicide application.

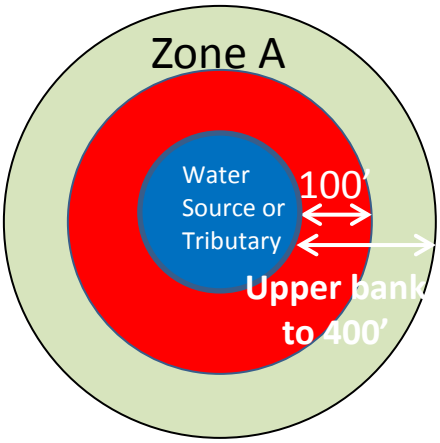
Public Ground Water Supply Well Zone I



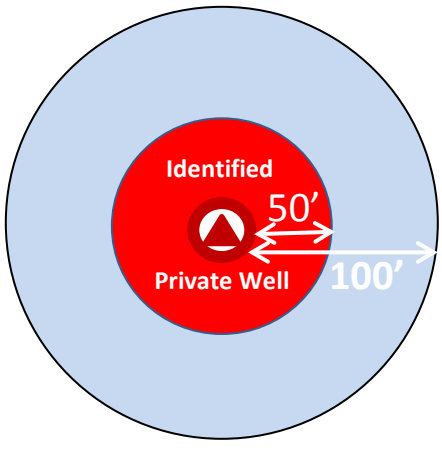
Drinking Water Intake Class B



Public Surface Water Source Class A



Identified Private Drinking Water Well

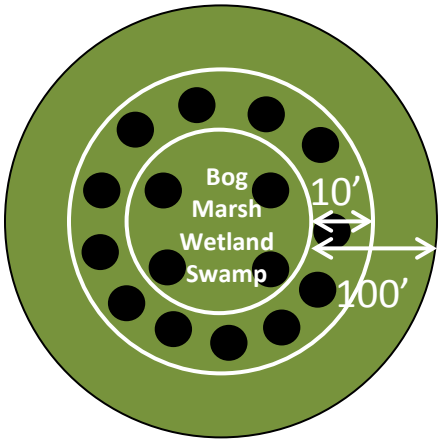


Sensitive areas readily identifiable in the field:

- Consult USGS Topographic Maps
- Contractor will be provided electronic and hard copy of maps with which to flag the boundaries of no-herbicide zones within the right-of-way (ROW) prior to herbicide application
- Contractor will mark additional areas not found on maps

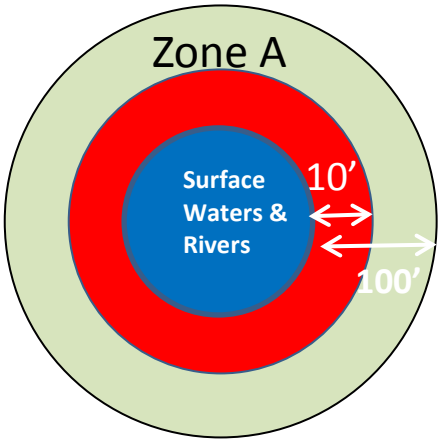
Wetlands

Defined by Chapter 131, Section 40

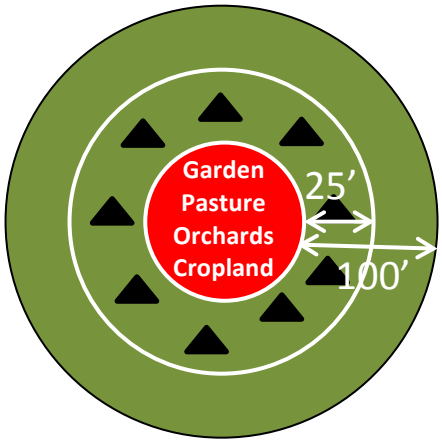


Surface Waters and Rivers

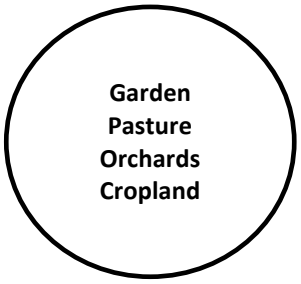
All surface water and water over wetlands. Mean high water for rivers.



Active Agricultural Areas



Inactive Agricultural



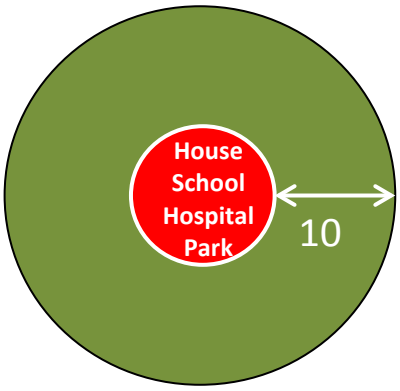
No Restrictions

Sensitive areas readily identifiable in the field: *(continued)*

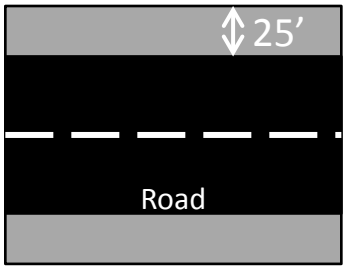
- Consult USGS Topographic Maps
- Contractor will be provided electronic and hard copy of maps with which to flag the boundaries of no-herbicide zones within the right-of-way (ROW) prior to herbicide application.
- Contractor will mark additional areas not found on maps

Inhabited Areas

Where people live, work, or gather



Road Crossings



Foliar Spray of resprout permitted

KEY

= No Herbicide Use

= Water

= Public Ground Water Supply Well or Private Well

= Limited Herbicide Use

Must adhere to the following:

1) Herbicide recommended for use in sensitive area: per (333CMR 11.04(1)(d))
2) Cut Stump, basal and low pressure foliar
3) 24 months elapsed since previous treatment
   12 months elapsed since previous treatment
4) No herbicides applied to conifer species and carriers reviewed by DAR and DEP.
5) Cut Stump Only
6) Cut Stump and Basal treatment. (foliar application to resprouts permitted) No other conditions.

Appendix 4

Herbicide Labels

Appendix 4- Herbicide Label

Accord: https://www.cdms.net/ldat/ld4TL015.pdf

AquaMaster: https://www.cdms.net/ldat/ld4BL000.pdf

AquaNeat: https://www.cdms.net/ldat/ld5NE001.pdf

Arsenal Powerline: https://www.cdms.net/ldat/ld86K002.pdf

Cambistat: https://rainbowtree.widen.net/s/sfw88flvmf/cambistat-specimen-label-2020

Escort XP: https://www.cdms.net/ldat/ldCFM002.pdf

Garlon 4 Ultra: https://www.cdms.net/ldat/ld7IN017.pdf

Krenite: https://www.cdms.net/ldat/ldB94000.pdf

Milestone: https://www.cdms.net/ldat/ld7I2005.pdf

Polaris: https://www.cdms.net/ldat/ld8KR002.pdf

Rodeo: https://www.cdms.net/ldat/ld4TN001.pdf

Stalker: https://www.cdms.net/ldat/ld01R013.pdf

Vastlan: https://www.cdms.net/ldat/ldCU2000.pdf

Appendix 5

Herbicide Fact Sheets

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
Department of Agricultural Resources
251 Causeway Street, Suite 500, Boston, MA 02114
617-626-1700 fax: 617-626-1850 www.mass.gov/agr
MDAR MASSACHUSETTS DEPARTMENT OF AGRICULTURAL RESOURCES

FOSAMINE AMMONIUM

Common Trade Name: Krenite, Krenite UT

Chemical Name: Ammonium ethyl carbamoylphosphate

CAS No.: 25954—13—6

GENERAL INFORMATION

Fosamine ammonium is usually applied to plants in the late summer and early fall. It is systemically absorbed by buds, stems and foliage. In most plants, effects of herbicide treatment are not evident until the following spring when buds fail to develop, or develop into miniature spindly leaves that do not provide adequate photosynthesis. The plant consequently dies. Although it is translocated within plants, effective treatment requires the complete coverage of all parts of woody plants. In some species of non-deciduous plants, such as pines and bindweed, leaves may turn brown immediately after application.

ENVIRONMENTAL FATE

Mobility

Fosamine ammonium is a low mobility herbicide and is not readily leached from soil. Soil adsorption coefficients (Kd) for Fosamine ammonium are reported as ranging from 0.22 (low organic sandy barns) to 350 (silt barns) (103). The organic matter adsorption coefficients are more variable and range from 20 to 62, with one adsorption coefficient reported at 7400 (103). There does not appear to be a good correlation between the soil adsorption coefficents and organic matter, clay or silt content of the soil.

In a study using soil thin layer plates to assess mobility, the Rf values (ratio of the compound mobility versus the leading edge of the water movement) for Fosamine ammonium ranged from 0.92 to 0.98 on the four soils tested (103). These Rf values indicate a high mobility pesticide, in contrast to the soil adsorption coefficients and leaching studies which indicate low mobility. This information may reflect the solubility of fosamine ammonium and not its mobility characteristics.

Fosamine arnmonium is strongly adsorbed to soil particles and it is not carried away in precipitation, in spite of its high water solubility. In a laboratory study using inclined soil flats (Fallingston sandy loam), Fosamine ammonium was applied at the rate of 15 lbs a.i/acre followed by simulated rainfall. The Fosamine ammonium remained near the surface of the soil and in the upper part of the flat, thus indicating no appreciable downward or lateral mobility (105). Field studies conducted in Florida, Delaware and Illinois have confirmed the laboratory results and indicate very little or no downward movement in soil of the herbicide or its degradation products (15, 104, 105).

Field studies indicate that Fosamine ammonium has low vertical mobility but, soils with higher adsorption capacities will tend to retard movement more than soil with lower adsorption capacities (15). However, Fosamine ammonium may move with the soil during erosion (14). Due to strong adsorption of fosamine ammonium to soil particles, there is little tendency for ground water contamination or for surface waters to become contaminated

without direct application of the material (14, 15).

In the field studies, the Delaware soil (Keyport silt loam) was the most representative soil of Massachusetts conditions. However, the Fallsington sandy loam which was used in the greenhouse studies represents a close approximation to Massachusetts soils. In these studies Fosamine ammonium exhibited slight tendency to leach in both those soils. Consequently, it is expected that fosamine ammonium will exhibit slight leaching in Massachusetts soils.

Persistence

The major route of Fosamine ammonium degradation is metabolism by soil microorganisms. Fosamine ammonium is stable to degradation by hydrolysis at pH values 5, 7, and 9; it is also stable to photodegradation (10, 14, 101, 102).

Fosamine ammonium is not considered a persistent compound in soils. Under field conditions in Florida, Delaware and Illinois, the half-life of Fosamine ammonium in soils was approximately one week following the application of 10 lbs/acre (104).

In the field, the metabolite carbamoylphosphonic acid (CPA) was found several days after initial soil treatment. All Fosamine ammonium and CPA had disappeared completely by 3 to 6 months (14, 15).

Greenhouse soil studies indicate a half-life of about 10 days, which is in close agreement with the field study half—life (15,104). In the field, Fosamine ammonium was metabolized to CPA more quickly in fine sand than in two silt barns (14, 104).

There is little persistence information in the literature for Fosamine ammonium and the only reported field degradation rates are from one study. This might be a cause for concern were it not for the close agreement in soil half-lives reported, not withstanding the varied location and soils used in the field stu-dies. Moreover, the greenhouse degradation study was also in close agreement with the reported field half-life.

It is assumed that the half-lives reported in the previous study have been obtained in spring to summer conditions, since they were not stated. The degradation of fosamine ammonium was investigated for a one year period in the previous study but, because of the short half-life complete degradation had occurred before the winter. It is expected that fosamine ammonium will be applied in summer or fall only since it must be applied to full foliage for control. Consequently, the lack of winter degradation rates is not a major concern.

With most herbicides soil characteristics and local climatic factors have a pronounced effect on soil half—life. This study suggest that degradation of Fosamine ammonium by soil microorganisms is not influenced by soil characteristics or local climate to any appreciable extent.

Due to the similar persistence of Fosamine ammonium in all locations and soils there is no most representative location. In this case, all sites represent expected persistence. Therefore, the half-life of Fosamine ammonium under Massachusetts condition is expected to be approximately one week.

TOXICITY REVIEW

Acute (Mammalian)

The oral LD5Os have been determined for both the formulated product and the formulated product plus surfactant (41.1 to 42% active ingredient (ai) in both cases). The LD5Os in the male rat were 24,400 mg (ai) (formulated product)/kg and 7,295 mg (ai) (formulated product with surfactant)/kg. Female rats had an LD50 of 5,000 (ai) mg (formulated product with surfactant)/kg. The formulated product has an LD50 of 7,380 mg(ai)/kg (formulated product) in male guinea pigs (107).

Fosamine ammonium was tested in an acute dermal study. 10 ml of the formulated product at a dose of 1,683 mg(ai)/kg resulted in no mortalities and no clinical signs of toxicity (107). The formulation plus surfactant was tested in rabbits and was not a primary eye irritant. There was mild transient erythema in tested skin. No sensitization was found in Guinea pigs (107).

The formulation plus surfactant (0.1 ml) produced transient mild corneal opacity and transient conjunctual irritation. The formulation without the surfactant was not an irritant (107).

Metabolism

The metabolism of Fosamine ammonium in the rat is rapid with 86% in feces and 11% in urine after 48 hrs (103,15). Compounds identified in the feces included 14C radiolabelled fosamine ammonium (86%) and 14C Carbamoylphosphonic Acid (CPA) diammonium salt (14%). The compnunds identified in the urine were also fosamine ammonium and CPA (103).

Subchronic and chronic feeding studies have been performed using several species, for various time periods.

The No Observable Effect Level (NOEL) for Fosamine Ammonium in diet studies for rats (90 day), dog (6 month), and sheep (90 day) were: 5,000/10,000 ppm, (286/572 mg/kg); 1,000 ppm (40 mg/kg) and 2,000/2,500 ppm highest dose tested (HDT) respectively (107). In the feeding studies the dose was increased after a certain time point when effects were not observed at the lower dose. These dose groups are written first dose/increased dose. In the six month dog study, the female dogs receiving 5000/7500/10000 ppm had increased stomach weights (107).

Oncogenicity Studies

Long term carcinogenicity studies are not available. These studies have not been required by EPA as there are no food uses proposed for Krenite.

Mutagenicity Studies

Mutagenicity testing has been done using Fosamine Ammonium formulated product. It was negative in 5 strains of the Ames assay, and negative both with and without activation in Chinese Hamster ovary point mutation assay. Chromosome damage was produced in the in vitro cytogenetic assay using Chinese Hamster ovary cells at 1.6% and 3.2 formulation (nonactivated) and 1.4, 2.8 and 5.7% formulation (activated) (107). There were no compound related increases in chromosomal aberrations in an in vivo bone marrow study and no changes in unscheduled DNA synthesis in rat hepatocytes (107).

Developmental Studies

The developmental studies that have been performed using fosamine ammonium include a one generation/two litter rat study and a rat oral teratogenicity study. The doses in the 90 day reproduction study were 0, 200, 1,000 and 5,000/10,000 ppm (0, 11, 57 and 285/570 mg/kg/d). There were no effects observed on reproduction and lactation in the reproduction study (NOEL = 5,000/10,000 ppm HOT). The doses in the teratogenicity study were 0, 200, 1,000 and 5,000/10,000 ppm (0, 11, 57 and 285/570 mg/kg/d). There were no effects observed on teratogenicity and fetoxicity at the 1,000 ppm dose level(107).

(a) In these discussions the assumptions made for conversion of ppm (diet) to mg/kg/D were:
Species Body weight (kg) Intake (kg)
Rat 0.35 0.020 Mouse 0.03 0.004 Dog 10 0.4

Avian

Unformulated Fosamine ammonium was administered to Mallard ducks and bobwhite quail by intubation in acute toxicity studies. Five birds per species-sex group received doses of 0, 312.5, 625, 1,250, 2,500, and 5,000 mg/kg. The LD50 was greater than 5,000 mg/kg in both the ducks and quail (15, 107).

Ducks and quail were also used in subacute dietary studies at doses of 0, 625, 1,250, 2,500, 5,000 and 10,000 ppm in the diet for 5 days. Basal diet was given for the last three days of the 8 day exposure. The 8 day LC50 in the diet was greater than 10,000 ppm. There was no increase in duck mortality: food consumption was depressed but body weight gain was normal. There was variable quail mortality and food consumption and body weight were decreased as compared with control (15, 107).

Invertebrates:

Fosamine ammonium toxicity has been determined for only a very few microorganisms and invertebrates. The available studies indicate that Fosamine ammonium has a very low acute toxicity to those organisms tested (15):

Fosamine ammonium salt (42% formulation): 48 hr LC5Os range from 1,524 mg/L for Daphnia to 10,000 mg/L for bees sprayed with the herbicide.

Aquatic Species (fish):

Fosamine ammonium has a very low toxicity to those fish species tested.

Fosamine ammonium salt (42% formulation): 96 hr LC5Os range from 670 mg/L for bluegill sunfish to 8,290 mg/L for coho salmon (15).

Except for the LC5O of 670 mg/L for the bluegill sunfish, reported adult fish LC5Os are all in excess of 1000 mg/L. (15) The yolk-sac fry stage in salmonids was the most sensitive to Fosamine ammonium.

Threshold-effect concentrations of Krenite for salmonids in partial life-cycle studies are less than 75 times the maximum theoretical concentration of Krenite that would be found in shallow waters due to direct overhead spray application (15).

SUMMARY

Fosamine ammonium is not persistent in the environment and is a low mobility herbicide in soil. Fosamine ammonium has a low potential to leach to groundwater or to reach surface waters from surface runoff. With acute oral LD5Os in rats of greater than 5,000 mg/kg, Fosamine ammonium is considered to be of low acute and subchronic mammalian toxicity. Subchronic exposures to Fosamine ammonium resulted in NOELS of greater than 1,000 ppm in a 6 month dog study. Mutagenicity test were negative in all but one case and there are no carcinogenicity data for this active ingredient. Fosamine ammonium is also considered to have very low aquatic and invertebrate acute toxicity.

REFERENCES

1. The Agrochemicals Handbook: 1983 Reference manual to chemical pesticides Pub. by The Royal Society of Chemistry The University, Nottingham NG7 2RD, England

10. The Herbicide Handbook: 1983 Fifth Ed. Handbook of the Weed Science Society of America Pub. by the Weed Science Society of America, Champaign, Ill.

14. GIER Generic Environmental Impact Report: 1985 Control of vegetation of utilities & Railroad Right of Way Pub. by Harrison Biotec, Cambridge, MA

15. Pesticide Background Statements: Aug. 1984 USDA Forest Service Agriculture Handbook #633 Vol. 1

100. Octanol/Water Partition Coefficient (Kow) of Fosamine Ammonium. Berus, J.S. and Breaux, E.J., DuPont Report.

101. Hydrolysis of [Carbonyl—14C] Fosamir~e Animonium. M Koeppl, Mary K., Dupon Report No. AMR-567-86.

102. Photodegradation of [Carbonyl-14C] Fosamine Ammonium on Soil. Scott, Martin T., DuPont Report No. AMR-560-86.

103. Batch Equilibrium (Adsorption/Desorption) and Soil Thin—Layer Chromatography Studies with [Carbonyl-14CJ Fosamine Ammonium. Priester, Thomas, M. and Sheftic, George D., DuPont Report No. AMR-632 -86.

104. Han, Jerry C-Y. (1979) Stability of [C] Fosamine Ammonium in Water and Soils. 3. Agr. Food Chem. 27, 3

105. TRW. (1981) Environmental Fates and Impacts of Major FOrest Use Pesticides. USEPA. Office of Pesticides and Toxic Substances. Contract No. 68-02—3174., Washington D.C.

107. Schneider, P.W. and Kaplan, A.M. (1983 Toxicological Information Fosamine Arirnonium, Dupont

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
Department of Agricultural Resources
251 Causeway Street, Suite 500, Boston, MA 02114
617-626-1700 fax: 617-626-1850 www.mass.gov/agr

GLYPHOSATE

In addition to the review that is presented below, a comprehensive review available from USDA Forest Service provides information that incorporates more recent studies and data. The US Forest Service risk assessment report is available at: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

Review conducted by MDAR and MassDEP for use in Sensitive Areas of Rights-of-Way in Massachusetts

Common Trade Name(s): Roundup, Glyphosate VMF Round Up Pro, Rodeo, Accord, Accord Concentrate,

Chemical Name: N—(phosphonomethyl)glycine—isopropylamine salt
CAS No.: 1071-83-6

GENERAL INFORMATION
Glyphosate, n-phosphonomethyl glycine, is a systemic, broad spectrum herbicide effective against most plant species, including deep rooted perennial species, annual and biennial species of grasses, sedges, and broadleafed weeds. The major pathway for uptake in plants is through the foliage, however, some root uptake may occur. The presence of surfactants and humidity increases the rate of absorption of glyphosate by plants (15).

Foliarly applied glyphosate is readily absorbed and translocated from treated areas to untreated shoot regions. The mechanism of herbicidal action for glyphosate is believed to be inhibition of amino acid biosynthesis resulting in a reduction of protein synthesis and inhibition of growth (10, 15, 101).

Glyphosate is generally formulated as the isopropylamine salt in aqueous solution (122). Of the three products containing glyphosate considered here, Roundup is sold with a surfactant and Rodeo and Accord are mixed with surfactants prior to use (15). Glyphosate has been reviewed by US Forest Service (15), FAO (122), and EPA 00W (51).

ENVIRONMENTAL FATE

Mobility
Glyphosate is relatively immobile in most soil environments as a result of its strong adsorption to soil particles. Adsorption to soil particles and organic matter begins almost immediately after application. Binding occurs with particular rapidity to clays and organic matter (l5). Clays and organic matter saturated with iron and aluminum (such as in the Northeast) tend to absorb more glyphosate than those saturated with sodium or calcium. The soil phosphate level is the main determinant of the amount of glyphosate adsorbed to soil particles. Soils which are low in phosphates will adsorb higher levels of glyphosate (14, 15).

Glyphosate is classified as immobile by the Helling and Turner classification system. In soil column leaching studies using aged (1 month) Glyphosate, leaching of glyphosate was said to be insignificant after 0.5 inches of water per day for 45 days (14).

Persistence

It has been reported that glyphosate dissipates relatively rapidly when applied to most soils (14). However, studies indicate that the soil half-life is variable and dependent upon soil factors. The half-life of glyphosate in greenhouse studies when applied to silty clay loam, silt loam, and sandy loam at rates of 4 and 8 ppm was 3, 27 and 130 days respectively, independent of application rate (14). An average half-life of 2 months has been reported in field studies for 11 soils (15).

Glyphosate is mainly degraded biologically by soil micro-organisms and has a minimal effect on soil microflora (15). In the soil environment, glyphosate is resistant to chemical degradation such as hydrolysis and is stable to sunlight (15). The primary metabolite of glyphosate is aminomethyl phosphonic acid (AMPA) which has a slower degradation rate than glyphosate (15). The persistence of AMPA is reported to be longer than glyphosate, possibly due to tighter binding to soil (14). No data are available on the toxicity of this compound.

Glyphosate degradation by microorganisms has been widely tested in a variety of field and laboratory studies. Soil characteristics used in these studies have included organic contents, soil types and pHs similar to those that occur in Massachusetts (117).

Glyphosate degradation rates vary considerably across a wide variety of soil types. The rate of degradation is correlated with microbial activity of the soils and does not appear to be largely dependent on soil pH or organic content (117). While degradation rates are likely temperature dependent, most reviews of studies do not report or discuss the dependence of degradation rate on temperature. Mueller et al. (1981 cited in 117) noted that glyphosate degraded in Finnish agricultural soils (loam and fine silt soils) over the winter months; a fact which indicates that degradation would likely take place in similar soils in the cool Massachusetts climate. Glyphosate halflives for laboratory experiments on sandy loam and loamy sand, which are common in Massachusetts, range up to 175 days (117). The generalizations noted for the body of available results are sufficiently robust to incorporate conditions and results applicable to glyphosate use in Massachusetts.

TOXICITY REVIEW

Acute (Mammalian)

Glyphosate has reported oral LD5Os of 4,320 and 5,600 mg/kg in male and female rats (15,4). The oral LD5Os of the two major glyphosate products Rodeo and Roundup are 5,000 and 5,400 mg/kg in the rat (15).

A dermal LD5O of 7,940 mg/kg has been determined in rabbits (15,4). There are reports of mild dermal irritation in rabbits (6), moderate eye irritation in rabbits (7), and possible phototoxicity in humans (9). The product involved in the phototoxicity study was Tumbleweed marketed by Murphys Limited UK (9). Maibach (1986) investigated the irritant and the photo irritant responses in individuals exposed to Roundup (41% glyphosate, water, and surfactant); Pinesol liquid, Johnson Baby Shampoo, and Ivory Liquid dishwashing detergent. The conclusion drawn was that glyphosate has less irritant potential than the Pinesol or the Ivory dishwashing liquid (120).

Metabolism

Elimination of glyphosate is rapid and very little of the material is metabolized (6,106).

Subchronic/Chronic Studies (Mammalian)

In subchronic tests, glyphosate was administered in the diet to dogs and rats at 200, 600, and 2,000 ppm for 90 days. A variety of toxicological endpoints were evaluated with no significant abnormalities reported (15,10).

In other subchronic tests, rats received 0, 1,000, 5,000, or 20,000 ppm (57, 286, 1143 mg/kg) in the diet for 3 months. The no observable adverse effect level (NOAEL) was 20,000 ppm (1,143 mg/kg) (115). In the one year oral dog study, dogs received 20, 100, and 500 mg/kg/day. The no observable effect level (NOEL) was 500 mg/kg (116).

Oncogenicity Studies
Several chronic carcinogenicity studies have been reported for glyphosate including an 18 month, mouse study; and a two year rat study. In the rat study, the animals received 0, 30, 100 or 300 ppm in their diet for 2 years. EPA has determined that the doses in the rat study do not reach the maximum tolerated dose (112) and replacement studies are underway with a high dose of 20,000 ppm (123). The mice received 1000, 5000 or 30,000 ppm for 18 months in their diets. These studies were non-positive (112,109). There was a non-statistically significant increase in a rare renal tumor (renal tubular adenoma (benign) in male mice (109). The rat chronic study needs to be redone with a high dose to fill a partial data gap (112). The EPA weight of evidence classification would be D: not classified (51).

Mutagenicity Testing
Glyphosate has been tested in many short term mutagenicity tests. These include 7 bacterial (including Salmonella typhimurim and B. subtilis) and 1 yeast strain Sacchomyces cerevisiae as well as a mouse dominant lethal test and sister chromatid exchange. The microbial tests were negative up to 2,000 mg/plate (15), as were the mouse dominant lethal and the Chinese hamster ovary cell tests. EPA considers the mutagenicity requirements for glyphosate to be complete in the Guidance for the Registration of Pesticide Products containing glyphosate (112).

The developmental studies that have been done using glyphosate include teratogenicity studies in the rat and rabbit, three generation reproduction studies in the rat, and a reproduction study in the deer mouse. (15)

Rats were exposed to levels of up to 3,500 mg/kg/d in one rat teratology study. There were no teratogenic effects at 3,500 mg/kg/d and the fetotoxicity NOEL was 1,000 mg/kg/d. In the rabbit study a fetotoxicity NOEL was determined at 175 mg/kg/d and no teratogenic effects were observed at 10 or 30 mg/kg/d in one study and 350 mg/kg/d in the other study (15). No effects were observed in the deer mouse collected from conifer forest sprayed at 2 lbs active ingredient per acre (15).

Tolerances & Guidelines
EPA has established tolerances for glyphosate residues in at least 75 agricultural products ranging from 0.1 ppm (most vegetables) to 200 ppm for animal feed commodities such as alfalfa (8).

U.S. EPA Office of Drinking Water has released draft Health Advisories for Glyphosate of 17.50 mg/L (ten day) and 0.70 mg/L (Lifetime)(51).

Avian
Two types of avian toxicity studies have been done with glyphosate: ingestion in adults and exposure of the eggs. The species used in the ingestion studies were the mallard duck, bobwhite quail, and the adult hen (chickens). The 8 day feeding LC5Os in the mallard and bobwhite are both greater than 4,640 ppm. In the hen study, 1,250 mg/kg was administered twice daily for 3 days resulting in a total dose of 15,000 mg/kg. No behavioral or microscopic changes were observed (15).

Invertebrates
A variety of invertebrates (mostly arthropods) and microorganisms from freshwater, marine, and terrestrial ecosystems have been studied for acute toxic effects of technical glyphosate as well as formulated Roundup. The increased toxicity of Roundup compared with technical glyphosate in some studies indicates that it is the surfactant (MONO 818) in Roundup that is the primary toxic agent (117). Acute toxicity information may be summarized as follows:

Glyphosate (technical): Acute toxicity ranges from a 48 hr EC5O for midge larvae of 55 mg/L to a 96 hr TL5O for the fiddler crab of 934 mg/L (15).

Roundup: Acute toxicity ranges from a 48 hr EC5O for Daphnia of 3 mg/L to a 95 hr LC5O for crayfish of 1000 mg/L (15).

Among the insects tested, the LD50 for honeybees was 100 mg/bee 48 hours after either ingestion, or topical application of technical glyphosate and Roundup. This level of experimental exposure is considerably in excess of exposure levels that would occur during normal field applications (15).

Aquatic Species (Fish) Technical glyphosate and the formulation Roundup have been tested on various fish species. Roundup is more toxic than glyphosate, and it is the surfactant that is considered to be the primary toxic agent in Roundup:

Glyphosate (technical):
Acute 96 hr LC5Os range from 24 mg/L for bluegill (Dynamic test) to 168 mg/L for the harlequin fish (15).

Roundup: Acute lethal toxicity values range from a 96 hr LC5O for the fathead minnow of 2.3 mg/L to a 96 hr TL5O for rainbow trout of 48 mg/L (15).

Tests with Roundup show that the egg stage is the least sensitive fish life stage. The toxicity increases as the fish enter the sac fry and early swim up stages.

Higher test temperatures increased the toxicity of Roundup to fish, as did higher pH (up to pH 7.5). Above pH 7.5, no change in toxicity is observed.

Glyphosate alone is considered to be only slightly acutely toxic to fish species (LC5Os greater than 10 mg/L), whereas Roundup is considered to be toxic to some species of fish, having LC5Os generally lower than 10 mg/L (15,118).

SUMMARY
Glyphosate when used as recommended by the manufacturer, is unlikely to enter watercourses through run-off or leaching following terrestrial application (117). Toxic levels are therefore unlikely to occur in water bodies with normal application rates and practices (118).

Glyphosate has oral LD5Os of 4,320 and 5,600 in male and female rats respectively. The elimination is rapid and very little of it is metabolized. The NOAEL in rats was 20,000 ppm and 500 mg/kg/d in dogs. No teratogenic effect was observed at doses up to 3,500 mg/kg/d and the fetotoxicity NOELS were 1,000 mg/kg/d in the rat and 175 mg/kg/d in the rabbit.

The evidence of oncogenicity in animals is judged as insufficient at this time to permit classification of the carcinogenic potential of glyphosate. The compound is not mutagenic.

REFERENCES

1. The Agrochemicals Handbook: 1983 Reference manual to chemical pesticides, Pub. by the Royal Society of Chemistry. The University, Nottingham NG7 2RD, England

4. RTECS Registry of Toxic Effects of Chemical Substances: 1982 NIOSH, US Dept. of Health and Human Services Ref QV 605 T755 Vol. l, 2,&3 1981-1982

6. The FDA Surveillance Index and Memorandum: Aug. 1981 and up Review and recommendations of the US Food & Drug Admin. Pub. by NTIS, US Dept. of Commerce

7. NTP Technical Report Series U.S. Dept. of Health and Human Services Pub. by The National Institute of Health

8. BNA Chemical Regulation Reporter: starts 1977 A weekly view of activity affecting chemical users and manufacturers. Pub. by The Bureau of National Affairs, Inc. 0148-7973

9. Dept. of Justice - Drug Enforcement Administration Memo dated September 26, 1985

10. The Herbicide Handbook: 1983 Fifth Ed. Handbook of the Weed Science Society of America. Pub. by the Weed Science Society of America, Champaign, Ill.

14. GEIR Generic Environmental Impact Report: 1985 Control of Vegetation of Utilities & railroad Rights of Way. Pub. by Harrison Biotec, Cambridge, MA

15. Pesticide Background Statements: Aug. 1984 USDA Forest Service Agriculture Handbook #633 Vol. 1

51. Office of Drinking Water Health Advisories, USEPA

101. IUPAC Advances In Pesticide Science (1978) V—2 p. 139.

106. Hietanen, E., Linnainma.a, K. and Vainco, H. (1983) Effects of Phenoxyherbicides and Glyphosate on the Hepatic and Intestinal Biotransformation Activities in the Rat Acta Pharmacol et Tox 53 p. 103—112.

109. Dept. of Justice - Drug Enforcement Administration Memo dated September 26, 1985.

112. Guidance for the Re-regjstration of Pesticide Products Containing Glyphosate, June 1986

115. Monsanto-Memo-Rat Feeding Study 3 Month.

116. Monsanto-Memo-RE: Day 1 year oral

117. The Herbicide Glyphosate Grossbard E. and Atkinson, D. (19)

118. Non:Target Impacts of the Herbicide Glyphosate Mammal Pest Management, LTD.

120. Maibach, H.I. (1986) Irritation, Sensitization, Photo Irritation and Photosensitic assays with Glyphosate Herbicide. Contact Dermititis 15 152—156.

122. Pesticide Residues in Food - 1986 FAQ Plant Production and Protection Paper 77.

123. Personal communication with Bill Heydens of Monsanto 2/16/89

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
Department of Agricultural Resources
251 Causeway Street, Suite 500, Boston, MA 02114
617-626-1700 fax: 617-626-1850 www.mass.gov/agr

IMAZAPYR

In addition to the review that is presented below, a comprehensive review available from USDA Forest Service provides information that incorporates more recent studies and data. The US Forest Service risk assessment report is available at: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

Review conducted by MDAR and MassDEP for use in Sensitive Areas of Rights-of-Way in Massachusetts

Common Trade Name(s): Arsenal

Chemical Name: Imazapyr!
2-(4-isopropyl-4-methyl--5-oxy-2-imidazolin-2-yl)
nicotinic acid with isopropyl amine (2)

CAS No.: 81510-83-0

GENERAL INFORMATION

Imazapyr is effective against and provides residual control of a wide variety of annual and perennial weeds, deciduous trees, vines and brambles in non—cropland situations. It also provides residual control and may be applied either pre or postemergence. Postemergence is the preferred method especially for the control of perennial species. Imazapyr is readily absorbed by the foliage and from soil by the root systems. Imazapyr kills plants by inhibiting the production of an enzyme, required in the biosynthesis of certain amino acids, which is unique to plants (10, 100).

ENVIRONMENTAL FATE

Mobility

There are few studies which have investigated the mobility of Imazapyr in soil, but available reports indicate that Imazapyr does not leach and is strongly absorbed to soil (100). Imazapyr has a high water solubility (1 — 1.5%) which could generally indicate a high leaching potential, but as with other organic acids Imazapyr is much less mobile than would normally be expected (100). No soil partition coefficients have been reported, but they may be expected to be quite high (100).

One field study investigated Imazapyr mobility in a sandy loam soil (0.9% organic matter, 8.0% clay; 38.8% silt). Imazapyr did not leach below the 18—21 inch layer after 634 days and 49.6 inches of rain. The levels found below the 12 inch layer were just above the 5 ppb detection limit. In addition, this study investigated the off—target mobility of Imazapyr and found no residues further than 3 inches from the sprayed area after 1 year (102).

Although low levels of Imazapyr did move to the 18 to 21 inch layer this was only after nearly 2 years and fifty inches of rain. This indicates that imazapyr is relatively non-mobile and does not leach through the soil profile. Imazapyr remains near the soil surface and heavy precipitation may cause some off target movement from surface erosion of treated soils.

Persistence

The main route of Imazapyr degradation is photolysis. In a study of photodegradation in water, the half—life of Imazapyr was calculated as 3.7, 5.3 and 2.5 days in distilled water, pH 5 and pH 9 buffers respectively (101). A soil photolysis study for Arsenal on sandy loam calculated a half—life of 149 days (101).

Studies have investigated the persistence of Imazapyr in soil under aerobic and anaerobic conditions. The half-life of Imazapyr in soil has been reported as varying from 3 months to 2 years (100). A laboratory study found the half-life to be 17 months (101). Detectable residues were found in a field study in all soil layers to 21 inches at 634 days (102). Vegetation was sprayed with radio-labelled Imazapyr at a rate of 1 lb. a.i./acre. The soil was a sandy loam (0.9% organic matter) which received 49.6 inches of rain during 634 days. The highest level of radioactivity (0.234 ppm Imazapyr) was found in the top 3 inches of soil at 231 days after application and there were detectable levels in the 9-12 inch layer. The concentrations in the top layer increased steadily from day 4 to 231 when they reached their maximum (0.234 ppm) and then declined. At day 634 the level in the top layer (0-3 inch) was 0.104 ppm (102). These data indicate that Imazapyr is persistent in soil and, most importantly, that Imazapyr is translocated within plants from the plant shoots back to the roots and released back into soil. Very little of the Imazapyr actually reached the soil during application. The soil residues may be due to the decay of plant material containing Imazapyr in the soil (102).

TOXICITY REVIEW

Acute (Mammalian)

The acute oral LD5O in both male and female rats was greater than 5000 mg/kg using technical Imazapyr. The acute dermal LD5O in male and female rabbits was greater than 2000 mg/kg. The compound was irritating to the rabbit eye but recovery was noted 7 days after application of 100 mg of the test substance. It was classified as mildly irritating to the rabbit skin following application of 0.5 grams of the material on abraded or intact skin (103).

Arsenal product formulation was tested in a similar battery of tests. The rat oral LD5O value was greater than 5000 mg/kg and the rabbit dermal LD5O was greater than 2148 mg/kg. The irritation was observed following installation of 0.5 ml of the test substance in the skin study and 0.1 ml in the eye study (104).

Technical Imazapyr was administered to rats as an aerosol for four hours at a concentration of 5.1 mg/L. There were ten rats per sex and the animals were observed for 14 days after treatment before they were sacrificed. Slight nasal discharge was seen in all rats on day one but disappeared on day two (105).

The inhalation LC5O is greater than 5.0 mg/L for both the formulation and the technical product (105,106). Technical Imazapyr was applied dermally at the following dosages: 0, 100, 200 and 400 mg/kg/day (109). Arsenal was used at 0, 25, 50 and 100% of the formulated solution in sterile saline. Each dose group consisted of 10 male and 10 female rabbits and the test substance was applied to either intact or abraded skin and occluded for 6 hours each day.

The result of the dermal studies with Imazapyr as well as Arsenal were non remarkable with regard to body weights, food consumption, hematology, serum chemistry, clinical observations, necropsy observations and histopathology. It was noted that Arsenal, undiluted, was locally irritating (109).

Subchronic and Chronic Studies (Mammalian)

In the subchronic tests a NOEL for systemic toxicity with dermal administration in rabbits was 400 mg/kg/d (2,109). After dietary administration for 13 weeks in the rat, there was no effect at 10,000 ppm (571. mg/kg/d) which was the highest dose tested (141).

A bioassay is currently underway to evaluate the potential oncogenicity of technical Imazapyr. Groups of 65 rats per sex per dose group have received 0, 1000, 5000 or 10,000 ppm in the diet. Hematology, clinical chemistry and urinalysis tests were conducted at 3, 6 and 12 months and will also be done at 18 months and at study termination. At the 12 month sacrifice the only effect noted was a slight increase in mean food consumption in all treated female groups. Most of the increases were statistically significant, but they did not always exhibit a dose response. The oncogenicity test is due to be submitted to the EPA in the spring of 1989 (115).

Oncogenicity Studies

Chronic bioassays as discussed in the subchronic/chronic section are underway.

Mutagenicity Testing

Five different bacterial strains of Salmonella typhimurium (TA1535, TA98, TAlOO, TA1537, and TA1538) and one of Escherichia coli (WP-2 uvrA-) were used to evaluate the mutagenicity of Imazapyr. It is unclear whether the compound used was technical or formulated Imazapyr. Dose levels up to 5000 micrograms/plate were used and each strain was evaluated both in the presence or absence of PCB—induced rat liver 5—9 microsomes. Negative results were noted in all assays. The six tester strains were designed to detect either base-pair substitutions or frameshift mutations (113).

Developmental Studies (Mammalian)

Two teratology studies have been done and both of these studies evaluated technical Imazapyr. One study used rats as the test species and the other utilized rabbits (111,112).

Pregnant rats received dosages of 0, 100, 300 or 1000 mg/kg/d of Imazapyr during days 6—15 of gestation. There were 22 rats in the control group and 24, 23 and 22 in the low, mid and high dose groups. All doses were administered orally by gavage. Salivation was noted only during the dosing period in 6 of the 22 females in the highest dose group (1000 mg/kg). No other adverse observations were noted in the treated dams (111). Fetal body weight and crown-rump length data for the treated groups were comparable to controls. Fetal development (external, skeletal and visceral) “revealed no aberrant structural changes which appeared to be the result of the exposure to Imazapyr” (111). The NOEL for maternal toxicity was 300 mg/kg and the NOEL for teratogenicity and fetoxicity was 1000 mg/kg (116).

Four groups of 18 pregnant rabbits were exposed on days 6-18 of gestation to doses of 0, 25, 100, 400 mg/kg/d Imazapyr. There was no statistically significant difference between control and treated groups at any dose (112).

Avian

Acute oral LD5Os of Imazapyr in bobwhite quail and mallard duck were 2150 mg/kg. The 8 day dietary LC5O in the bobwhite quail and mallard duck were greater than 5000 ppm (101).

Invertebrates

The dermal honey bee LD5O for Imazapyr is greater than 100 mg/bee (101). The LD5O (48 hr) was greater than 100 mg/L for the water flea (100).

Aquatic

The LC50s of Imazapyr in the rainbow trout, bluegill sunfish and channel catfish were greater than 100 mg/L (101).

SUMMARY

Imazapyr is a relatively immobile herbicide in the soil profile even when used in sandy and low organic content soils. It is also persistent in soils. The low mobility and persistence may result in off-target movement of Imazapyr from surface erosion of treated soils.

The atypical soil—plant flux characteristics of Imazapyr and delayed maximum soil concentrations indicate that repeated annual applications may result in build—up of Imazapyr in soil. Consequently, an interval is required to allow for the degradation of soil residues before a repeated application is made.

The oral LD5O of Imazapyr in rats is greater than 5000 mg/kg and the derrnal LD5O is greater than 2000 mg/kg in rabbits. The oncogenicity bioassay is currently underway and the only effect reported in the interim study was an increase in food consumption in the treated females. No mutagenic effects were observed.

The acute oral LD5Os of Imazapyr and the Arsenal formulation are greater than 5000 mg/kg. In the subchronic 13 week rat study there was no effect observed at the highest dose tested 10,000 ppm. The oncogenicity study is currently underway.

REFERENCES

2. Farm Chemicals Handbook: 1985 Dictionary, buyer's guide to trade names and equipment. Pub. by Meister Pub. Co.

101. American Cyanamid Arsenal Herbicide Environmental and Toxicological Data Summary.

102. AC 243,997 [2—(4-isopropyl-4—methyl-5-oxo-2-imidazolin-2-71)nicotinic acid): Weed & Soil Metabolism in a field plot. American Cyanamid Company, POM Vol. 23-32. 1986 (Confidential Information).

103. Acute Toxicology of AC 243,997 to Rats and Rabbits. American Cyanamid Company, A83-24.

104. Acute Toxicology of AC 252,925 22.6% to Rats and Rabbits. American Cyanamid Company, A83-67.

105. Acute Inhalation Toxicity of AC 243,997 in Sprague-Dawley Rats. Food and Drug Research Laboratories, Inc. Study No. 7624.

106. Acute Inhalation Toxicity of AC 252,925 in Sprague-Dawley Rats. Food and Drug Research Laboratories, Inc. Study No. 7607.

107. Evaluation of the Sensitization Potential of AC 243,997 in Guinea Pigs. Toxicology Pathology Services, Inc. Study No. 186A—201-231-83.

108. Evaluation of the Sensitization Potential of AC 252,925 in Guinea Pigs. Toxicology Pathology Services, Inc. Study No. 186A—201-231-83.

109. Twenty-one Day Dermal Toxicity Study with AC 243,997 in Rabbits. Toxicology Pathology Services, Inc. Study No. 186B—301-230-83.

110. Twenty—one Day Dermal Toxicity Study with AC 252,925 in Rabbits. Toxicology Pathology Services, Inc. Study No. 187B-230-83.

111. Teratology Study in Albino Rats with AC 243,997. ToxiGenics Study No. 450-1222.

112. Teratology Study in Albino Rabbits with Ac 243,997. ToxiGenics Study No. 450-1224.

113. Bacterial/Microsome Reverse Mutation (Ames) Test on CL 243,997. American Cyanamid Company GTOX Volume 3, Number 13.

114. Herbicide AC 243,997: The Absorption, Excretion, Tissue Residues and Metabolism of Carboxyl Carbon—14 Labeled AC 243,997 Nicotinic acid, 2-(4—isopropyl—4-methyl—5—oxo—2-imidzolin—2-yl) in the Rat. American C~anamid Company Report No. PD-M Volume 20—3.

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS
Department of Agricultural Resources
251 Causeway Street, Suite 500, Boston, MA 02114
617-626-1700 fax: 617-626-1850 www.mass.gov/agr

METSULFURON METHYL

In addition to the review that is presented below, a comprehensive review available from USDA Forest Service provides information that incorporates more recent studies and data. The US Forest Service risk assessment report is available at: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

Review conducted by MDAR and MassDEP for use in Sensitive Areas of Rights-of-Way in Massachusetts

Common Trade Names: Escort, Escort XP (2)

Chemical Name: Methyl 2 E[C[(4-Methoxy—6-methyl-l,3,5-Triazifl—
2-yl) aminolcarbonyl] amino] sulfonyl.]benzoate] (9)

CAS NO.: 74223-64-6

GENERAL INFORMATION

Metsulfuron methyl is a sulfonyl urea herbicide initially registered by E.I. DuPont in 1986. It is a foliar herbicide registered for use on wheat and barley and non-cropland sites such as Right of Way (9).

ENVIRONMENTAL FATE

Mobility

Metsulfuron methyl is a relatively new herbicide. The studies reviewed here have been provided by the registrant, EI DuPont.

The soil water partition coefficients (Kd) of Metsulfuron Methyl have been determined in four different soils: Cecil sand, Flanagan silt loam, Fallsington silt loam, and keyport silt loam. The Kd values range from 0.36 for Cecil sand to 1.40 for Flanagan silt loam, and Kom values ranged from 29 for Fallsington silt loam to 120 for Cecil sand (100). The values for Kd and Kom indicate that metsulfuron methyl is not adsorbed well to soil and that the organic content of the soil is not the only adsorption component. The silt and clay contents appear to influence adsorption, but there are probably other factors also involved.

The previous study also determined the Rf values for soil. Thin layer chromatography was performed on four soils for metsulfuron methyl. The Rf values ranged from 0.64 to 1.00; only one value was less than 0.90 (100). This result confirms the validity of the Kd values, indicating that metsulfuron methyl is mobiie and that the organic matter content of the Soil is a significant component of adsorption.

Metsulfuron methyl was applied to tops of 12 inch columns [containing four different soils], and eluted with 20 inches of water in 20 hours. Following the percolation of the total volume of water, 106% of the metsulfuron

methyl was eluted from the Fallsington sandy loam, 96% from the Flanagan silt loam, 81% for Keyport silt loam and 93% for Myakka sand (100). The breakthrough volumes for the Fallsington, Flangan, Keyport and Myakka soils were 6.5, 4.5, 6.9 and 5.8 inches of water respectively (101).

Metsulfuron methyl is relatively mobile in most soils, but will be retained longer in soils with higher percentages of organic matter.

Persistence

There are two studies which have reviewed the persistence of metsulfuron methyl in the soil. One study was conducted in the southern United States and the second was in the northern United States and Canada. The results of the studies indicate a somewhat contradictory picture of the persistence of metsulfuron methyl.

The soil half-lives in Delaware, North Carolina, Mississippi and Florida were 1 week, 4 weeks, 3 weeks and 1 week respectively following an application in mid to late summer (102). The results are varied and indicate that either climatic or soil factors determine the persistence. The climate is sufficiently similar to be able to discount that as a factor. However, both of the locations where the shortest half-lives were observed had the highest organic matter content in the soils. Furthermore, the half—lives correspond with the organic matter content.

The half—lives following spring applications were 4 and 56 weeks for two sites in Colorado, 6 weeks in North Dakota and 28 weeks in Idaho (103). In contrast to the southern United States study there does not appear to be any correlation with climatic or soil characteristics. There appears to be a slightly shorter half—life in acidic soils in the same location.

Metsulfuron methyl was also applied in the fall and the half-lives determined in two sites in Colorado, North Dakota and Idaho. These half—lives were 8 weeks, 12 weeks, 42 weeks and 28 weeks respectively. As was expected there were longer half—lives following fall applications in North Dakota (6 weeks vs. 42 weeks) however, in Idaho there was no change at all, which is unexpected.

In Canada following spring applications the reported half-lives were 10 weeks, 4 weeks, 4 weeks and 6 weeks for Alberta, 2 locations in Saskatchewan and Manitoba (103). One would expect longer half lives in Northern locations due to the effects of temperature on degradation rates. The results from Canada are generally shorter than those in the U.S. locations, which is unexpected.

Therefore, the half-life of Metsulfuron methyl in the soil is variable and dependent on the location. It is shorter when applied in the spring but appears independent of other environmental factors in most locations.

TOXICITY REVIEW

Acute (Mammalian)

The toxicology database for Metsulfuron methyl has been reviewed and accepted by the EPA (9). DuPont supplied excerpts from their monograph on Ally herbicide (112). Summaries of studies were supplied by DuPont for subchronic, chronic and reproductive studies.

Technical metsulfuron methyl has been tested in two acute oral LD50 studies in Crl:CD Rats. In the first study the LD5O was greater than 5,000 mg/kg and in the second it was greater than 25,000 mg/kg (the maximum feasible dose) (112). Clinical signs included salivation, chromodacryorrhea, stained face, stained perineal area and weight loss (112).

In a 10—dose subacute study using male rats, a single repeated dose of 3,400 mg/kg/day for 10 days over a 2 week period was administered. This was followed by a two week recovery period. No deaths occurred and slight weight loss was the only clinical sign observed. In addition, no gross or microscopic changes were observed (112). The dermal LD50 is greater than 2,000 mg/kg in male and female rabbits (112). Technical metsulfuron methyl caused mild erythema as a 40% solution in guinea pigs. There was no reaction observed at the 4% concentration. No response occurred when treated animals were challenged (112).

In rabbits, moderate areas of slight corneal clouding and severe to moderate conjunctivitis were observed in both washed and unwashed eyes following treatment with technical metsulfuron methyl. The unwashed eyes were

normal in 3 days and the washed eyes in 14 days (112).

Metabolism
Elimination of metsulfuron methyl in the rat is rapid, with 91% of a radioactive dose excreted over 96 hours (9). The routes of elimination were not specified within the report.

Subchronic/Chronic (Mammalian)
Ninety day feeding studies have been done with metsulfuron methyl in rats and mice. The rat study was done in conjunction with a one generation reproduction study (see Developmental Study Section). In this study rats received 0, 100, 1000, or 7500 ppm (0, 5.7, 57, 428 mg/kg/d) (a) in their diets. Effects observed at the high dose were: a decrease in body weight and an increase in total serum protein in the females, and a decrease in liver weight and a decrease in cytoplasmic clearing of hepatocytes in the males the NOEL in this study was 1000 ppm (104).

The 90 day mouse study was done in conjunction with the 18 month mouse study. Groups of 90 mice per sex per dose received 0, 5, 25, 500, 2500 or 5000 ppm (0, 0.66, 3.3, 66.6, 333.3, 666.6 mg/kg/d) in their diets. Clinical evaluations were made at 1, 2, 3, 6, 12 and 18 months. Ten animals per group were sacrificed at the 90 day time point for pathological evaluation. The 2500 ppm group was sacrificed at 12 months. Sporadic effects were observed on the body weight, food consumption, and organ weights. These were not dose related, resulting in a NOEL of 5000 ppm in diet for mice (111).

In the twenty-one day dermal rabbit study, the intact skin of male and female New Zealand White Rabbits received doses of 0, 125, 500 and 2,000 mg/kg for 6 hrs/day for 21 days. Clinical signs observed were sporadic weight loss and diarrhea in a few rabbits. These effects were not dose related. Non dose related histological effects were observed in male rabbits. This effect was characterized as mild testicular atrophy occurring sporadically at all doses (112, 108).

Feeding studies in dogs have been done with purebred beagles. The animals received metsulfuron methyl in diets at dose levels of 0, 50, 500 and 5000 ppm (0, 0.2, 2, 20 mg/kg/d) for one year. There was a decrease in food consumption in the high dose males. There was a decrease in serum lactate dehydrogenase in all groups of both sexes at two or more doses these values were within the historical controls. The NOEL was 500 ppm in the males and 5000 ppm in females (112).

In a chronic feeding study in rats, the animals received metsulfuron methyl at doses of 0, 5, 25, 500, 2500 or 5000 ppm (0, 0.28, 1.4, 28.6, 143 or 286 mg/kg/d. Interim sacrifices were done at 13 and 52 weeks (105).

At the 13 week sacrifice there was a decrease in body weight in the 2500 and 5000 ppm groups; there was a decrease in absolute liver weight at 2500 and 5000 ppm males. There was a decrease in the relative liver weights in the 2500 and 5000 ppm females.

(a) In these discussions the assumptions made for estimated conversion of ppm (diet) to mg/kg/D were:
Species Body weight (kg) Intake (kg)
Rat 0.35 0.020 Mouse 0.03 0.004 Dog 10 0.4
When data were presented as ppm, the dose was estimated in mg/kg and is presented in parenthesis.

Findings at the 52 week sacrifice included increase in kidney weight (2500 ppm males) and increased absolute brain weights (at doses of 25, 500, 2500 and 5000 ppm) in males and at doses of 2,500 and 5000 ppm in females. There was an increase in absolute heart weight at 2500 ppm in males and at 2500 and 5000 ppm in females. The absolute organ weights were back to normal at termination. Relative brain weights of the 2500 and 5000 ppm groups were increased (105)

Oncogenicity Studies
There were no gross or histopathological changes observed in mice receiving up to 5000 ppm metsulfuron methyl in their diets (112. 111). Similar results were obtained in the 104 week rat study; there were no histopathological changes observed which were attributable to metsulfuron methyl (105, 112). EPA concludes that there were no

oncogenic effects in rats or mice at the highest dose tested; 5000 ppm in both cases (9).

Mutagenicity Testing

Metsulfuron methyl was negative in the unscheduled DNA synthesis assay; in vivo bone marrow cytogenic assay in rats (doses were 500, 1,000, and 5,000 mglkg bw); CHO/HGPRT Assay; Salmonella typhimurium reverse mutation assay four strains with and without S9 metabolic activation; and also in the in vivo mouse micronucleus assay at doses of 166, 500, 1666, 3000 and 5000 mg/kg (112). 'T¶e only positive mutagenicity assay was in the in vitro assay for chromosome aberrations in Chinese Hamster Ovary at high doses (greater than 2.63 mM, 1.0 mg/mL)). In this assay no increases in structural aberrations were observed at 0.13 or 1.32 mM(0.05 or 0.5 mg/mL) (112).

Developmental Studies

Several studies have been done to investigate the effects of Metsulfuron methyl on reproduction and development in rats and rabbits.

Pregnant Cr1: COBS CD(SD) BR rats received metsulfuron methyl at doses of 0, 40, 250 or 1000 mg/kg by the oral route on days 5 to 14 of gestation. There were 25 rats per group. Maternal toxicity was observed at doses of 250 and 1000 mg/kg/d. The maternal toxicity NOEL was 40 mg/kg/d. There was no evidence of "teratogenic" response or embryo fetal toxicity (112).

In the rabbit study, New Zealand white rabbits received 0, 25, 100, 300 or 700 mg/kg/d on days 6 to 18 gestation. There was a dose related increase in maternal deaths; 1, 2 and 12 deaths at doses of 100, 300 and 700 mg/kg respectively. The maternal toxicity NOEL was 25 mg/kg/d and there was no evidence of teratogenic or embryolethal effects observed in this study (112).

Several multigenerational studies have been done with Metsulfuron methyl. A four litter reproduction study was done concurrently with the chronic bioassay. Rats from each treatment were separated from the main study and bred. The doses were 0, 5, 25, 500, 2500, and 5000 ppm (0, 0.28, 1.4, 28.6, 143 and 286 mg/kg/d). There was a dose dependent decrease in body weight in the parental (P1) generation at doses of 25 ppm and greater in males and females. This effect was not present in dams during gestation or lactation (106).

Overall fertility in the P1 and filial (Fl) matings was low in both control and treated groups with no apparent cause. There was a decrease in pup size in the Fla but not the Flb, F2a, or F2b litters. The gestation index was 100% for all groups in both filial generations with the exception of F2a when it was 90%. On the basis of the lower body weights and lower growth rates, the NOEL was 25 ppm for this study (106).

In a 90 day, 2 generation 4 litter protocol, rats received 0, 25, 500 or 5000 ppm (0, 1.4, 28.6, 286 mg/kg/d) Metsulfuron methyl in their diets for 90 days prior to mating. In this protocol the parental generation was bred twice first to produce the Fla and then the FiB. The FiB rats were then fed the appropridte diet for 90 days (after weaning). There was a decrease in litter size in the 5000 ppm group in the F2a generation, but not in any other generation. The NOEL for this study was 500 ppm (107).

In a 90 day feeding, one generation rat study, 16 male and 16 female rats received 0, 100, 1000 or 7500 ppm in their diet prior to mating. There were no differences observed in reproduction and lactation performance or litter survival among groups. There was an overall low fertility in the control and treated groups. This result made the effects of metsulfuron methyl on fertility difficult to assess from this study (104).

Tolerances and Guidelines

Tolerances have been set for metsulfuron methyl in barley wheat (from 0.05 to 20 ppm, depending on the commodity) and in meat and meat byproducts (0.1 ppm). The tolerance in milk is 0.05 ppm (8, 9). The acceptable daily intake is 0.0125 mg/kg/d based on a one year dog NOEL of 1.25 mg/kg/d using a safety factor of 100 (9).

Avian

Metsulfuron methyl has been tested in two species of birds, the mallard duck and the bobwhite quail. The acute oral LD5O is greater than 2150 mg/kg in the duck. Two, 8 day dietary studies have been done. The 8 day LC5O is greater than 5620 ppm in both the duck and the quail (9).

Invertebrates

The 48 hour LC5O for Daphnia is greater than 150 ppm and the acute toxicity in the honeybee is greater than 25 mg/bee (9).

Aquatic

Metsulfuron methyl has acute LC5O of greater than 150 ppm in both the rainbow trout and the bluegill sunfish (9).

Summary

Metsulfuron methyl has a moderate to high mobility in the soil profile and is relatively persistent in the environment, especially when applied in the fall. These factors would be of concern under most circumstances. However, metsulfuron methyl is applied at very low rates (3-4 ozs./A) and therefore the amounts which reach the soil are quite low. Consequently, Metsulfuron methyl should not impact groundwater as a result of leaching or migrate from the target area. Metsulfuron methyl has low toxicity (EPA Toxicity Category III) for acute dermal exposure and primary eye irritation and is category IV for all other acute exposures. The chronic studies indicate no oncogenicity response and the systemic NOEL's are 500 ppm in rats and 5000 ppm in mice. There was no evidence of teratological effects in the rat or the rabbit at the highest dose tested in both species. While there was evidence of maternal toxicity at 40 mg/kg/d in the rat and 100 mg/kg/d in the rabbits.

REFERENCES

2. Farm Chemicals Handbook: 1985
Dictionary, buyer's guide to trade names and equipment. Pub. by Meister Pub. Co.

9. EPA Pesticide Fact Sheet Metsulfuron methyl: 1986 Collection of pesticide chemistry
Pub. by US Government Printing Office 461-221/24041

100. DuPont Soil Column Leaching Studies with [14C] DPX-T6376] (AMR 82-82).

101. DuPont Adsorption of 14C DPX-T6376 on Soil (AI'IR-66-82).

102. DuPont Field Soil Dissipation Study of DPX-T6376 in Delaware, North Carolina, Florida, and Mississippi (AMR 66—82).

103. DuPont Field Soil Dissipation of [Phenyl (U) - 14C] Metsulfuron Methyl on United States and Canadian Soils (AMR 476-86).

104. DuPont HL 180-82; 90 day feeding one generation Reproduction Study in Rats.

105. DuPont HLO-61-85; Chronic Feeding Study with Concurrent Two Generation Reproduction Study in Rats - Chronic.

106. DuPont HLO-65-85 Chronic Feeding Reproduction Phase.

107. DuPont HLR-524-84 Two generation, Four Litter Reproductive Study in Rats.

108. DuPont HLR 137-83 Subchronic Dermal Study (21 Days) in Rabbits.

111. DuPont HLR 463-84 Ninety-Day and Long Term Feeding Study in Mice.

112. Ally Herbicide Product Monograph

THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY AND ENVIRONMENTAL AFFAIRS

Department of Agricultural Resources
251 Causeway Street, Suite 500, Boston, MA 02114
617-626-1700 fax: 617-626-1850 www.mass.gov/agr

Paclobutrazol

Review Conducted by MDAR and MassDEP for Use in Sensitive Areas of Rights-of-Way in Massachusetts

January 2012

Massachusetts Department of Environmental Protection

Massachusetts Department of Agricultural Resources

Active Ingredient Paclobutrazol:

Review Conducted by MDAR and MassDEP for Use in Sensitive Areas of Rights-of-Way in Massachusetts

January 2012

Table of Contents

1. INTRODUCTION

The review presented here was initiated by the request for the addition of Cambistat® (EPA Reg. No. 74779-3), containing the active ingredient paclobutrazol, to the Massachusetts Rights-of-Way Sensitive Area Materials List. Paclobutrazol is a tree growth regulator that provides a tool for utility arborists to limit the size and growth of trees and shrubs in power line and utility rights-of-way corridors. Tree growth regulator products such as Cambistat® are regularly applied in high visibility locations such as parks, historic downtowns, residential areas and other areas where trees have a cultural value (Paul Sellers, NSTAR, pers. comm.). The utility industry is seeking approval of Cambistat® for use in sensitive areas in order to have the ability to use this product in the same locations that happen to be located within areas of rights-of-way that are regulated by 333 CMR 11.00.

The regulations specified in 333 CMR 11.00 provide standards, requirements and procedures for the use of herbicides in vegetation management in areas of rights-of-way, while minimizing the potential impacts to human health and the environment. Specific restrictions exist for sensitive areas within rights-of-way, including the list of herbicides that have been specified as acceptable for use in these sensitive areas. The herbicides included on the Sensitive Area Materials List have been evaluated to further scrutinize potential risks to sensitive receptors in these areas. The review presented here is the evaluation of the active ingredient paclobutrazol and products for use in sensitive areas of rights-of-way.

Paclobutrazol (PBZ) was first registered by U.S. EPA in 1985. At the time of preparation of this review in 2011, PBZ was undergoing registration review by U.S. EPA to determine whether it continues to meet the FIFRA standard for registration (U.S. EPA, 2007A). As part of the registration review process, a summary document was issued (U.S. EPA, 2007B). This document includes a factsheet describing the use of this active ingredient, the status of human health and ecological risk assessments, and the problem formulation and scope of work necessary to support the registration review at U.S. EPA.

Additional information was obtained from documents issued by the European Food Safety Authority (EFSA) that evaluated PBZ for use as a plant growth regulator on winter oilseed rape. The evaluation data package of the EFSA assessment included various documents describing data summaries, scientific evaluations, risk assessments, and conclusions of the peer review. The documents consulted for the review presented here included the Draft Assessment Report (DAR) (EFSA, 2006), the Additional Report to the DAR (EFSA, 2010A) and the Conclusion of the Peer Review (EFSA, 2010B).

The secondary review documents generated by the regulatory agencies U.S. EPA and EFSA are primarily based on the consideration of registrant-submitted studies in support of product registration. These studies are generally classified as Confidential Business Information (CBI) and therefore not available for review outside of these agencies. Additional information from scientific publications and other government documents was also considered, when available and as needed, for the assessment described in this review.

This document describes a review of the chemical and physical properties, product use characteristics, environmental fate characteristics and toxicity data. Environmental concentrations of PBZ were estimated using screening-level simulation models and calculation

methods. The risks to classes of organisms that are most likely to be exposed, including aquatic organisms and soil invertebrates, were characterized. The exposure to groundwater resources was also assessed.

The review described herein was conducted according to the established procedures and criteria for review of herbicide products for use within sensitive areas of Rights-of-Way (ROW) (MDAR, 2011). These review procedures and criteria address both the herbicide active ingredients as well as the “inert” or “other” ingredients, more specifically the surfactants.

2. CHEMICAL AND PRODUCT IDENTITY AND PROPERTIES

2.1. Chemical Identity and Properties

- Common Chemical Name: Paclobutrazol (***PBZ*** *acronym will be used*)
- IUPAC name: 2*RS*,3*RS*-1-(4-chlorophenyl)-4,4-dimethyl-2-(1*H*-1,2,4-triazol-1-yl) pentan-3-ol
- CAS No.: 76738-62-0

Paclobutrazol (PBZ) is a plant growth regulator belonging to the triazole chemical class (U.S. EPA, 2007B). The nomenclature is summarized in Table A1.1 in Appendix 1. PBZ is a racemic mixture of the (2R, 3R) and (2S, 3S) enantiomers. Chemical and physical properties are listed in Table A1.2 in Appendix 1.

2.2. Formulated Product

The product considered in this review, Cambistat®, is a suspension concentrate containing 22.3% PBZ. The MSDS document (Rainbow Treecare, 2011) for this product indicates that the formulation also contains propylene glycol at an unspecified concentration. No other ingredients were specified in the MSDS document (Rainbow Treecare, 2011).

Propylene glycol (PG) is a colorless, odorless liquid which is generally recognized as safe (GRAS) by the U.S. Food and Drug Administration (FDA) in 21 CFR § 184.1666 for use as a direct food additive under the conditions prescribed. It is approved by the U.S. FDA for certain indirect food additive uses. PG has a wide range of practical applications such as antifreezes, coolants and aircraft deicing fluids; solvents; food; flavors and fragrances; cosmetics and personal care products; pharmaceuticals; chemical intermediates; plasticizers; and thermoset plastic formulations (DOW, 2006). PG is not acutely toxic (single dose, high exposure). It is essentially non-irritating to the skin and mildly irritating to the eyes. Available data indicate that propylene glycol is not a skin sensitizer or a carcinogen. PG is not volatile and is miscible with water. It is not expected to bioaccumulate and it is not acutely toxic to water organisms except at very high concentrations (OECD/SIDS, 2001). Given the characteristics and regulatory status of this ingredient, propylene glycol was not further evaluated for this review.

Proprietary information on the other formulation ingredients was obtained. Two of the proprietary ingredients can be classified as surfactants. One of the surfactants belongs to a class of surfactants that has been approved for use in sensitive areas of rights-of-way in Massachusetts (MDAR, 2010A and B). Consequently, this ingredient did not have to undergo additional review and passed the surfactant policy portion of the review process for the sensitive area materials list. Nevertheless, both surfactants were included in the evaluation of proprietary ingredients.

The proprietary ingredients were evaluated as part of the review process for addition to the Sensitive Area Materials List, but cannot be disclosed here for proprietary reasons. In most cases, a quantitative or semi-quantitative evaluation was conducted based on available toxicity

endpoints and estimates for maximum soil, surface water and ground water concentrations. In some cases, only a qualitative evaluation was possible. Based on these evaluations, it was concluded that these compounds are of a nature and/or present at levels in the product such that use of it as directed would not cause unreasonable adverse effects to human health and the environment.

2.3. Mode of Action

PBZ is a cell elongation and internode extension inhibitor that retards plant growth by inhibition of gibberellins biosynthesis. Gibberellins stimulate cell elongation. When gibberellin production is inhibited, cell division still occurs, but the new cells do not elongate. The result is shoots with the same numbers of leaves and internodes compressed into a shorter length. Reduced growth in the diameter of the trunk and branches has also been observed. Another response of trees to treatment with PBZ is increased production of the hormone abscisic acid and the chlorophyll component phytol, both beneficial to tree growth and health. PBZ may also induce morphological modifications of leaves, such as smaller stomatal pores, thicker leaves, and increased number and size of surface appendages, and increased root density that may provide improved environmental stress tolerance and disease resistance (Chaney, 2005). PBZ also has some fungicidal activity due to its capacity as a triazole to inhibit sterol biosynthesis (Chaney, 2005; U.S. EPA, 2007B; BCPC, 2000).

3. USE PATTERN AND APPLICATION CHARACTERISTICS

3.1. Use as Tree Growth Regulator

The use pattern of PBZ considered in this review is as a tree growth regulator, more specifically as a tree growth retardant (TGR). PBZ was one of the three active ingredients that were used by utility arborists in the 1980s. The products were applied by trunk injection as a formulation containing alcohol solvents. Due to problems associated with trunk injection of these products (e.g., tree injury and wood discoloration) there was a decline of the use of TGRs. In 2005, PBZ was the only remaining TGR for use on trees. Modifications in formulations and application methods, satisfactory performance as a TGR and benefits to overall tree health resulted in a rebound in the use of PBZ. Current formulations of PBZ TGRs such as Cambistat® for TGR use, such as Cambistat®, are applied as a water suspension by soil injection or basal drench (Chaney, 2005).

PBZ is also registered for use on ornamental plants grown in containers in nurseries, greenhouses and interior landscapes. It is also used on turf to control annual grasses and broadleaf weeds, to reduce the mowing frequency and to increase turf density.

3.2. Application Methods and Rates

PBZ formulated as Cambistat® is applied by soil injection or application as a basal drench. The species-specific dose rate is determined by measuring the tree diameter at breast height (DBH). Based on the dose rate information on the product label, it can be calculated that the dose rate of active ingredient is in the range of 4.1 g (0.009 lbs) to 202.5 g (0.446 lbs) PBZ per individual tree. Dose rates may be reduced by 25 to 30% based on consideration of canopy size and structure, stressed or declining tree status, or the presence of a confined or compromised root system. Given the use pattern of treating individual trees, the application rate expressed in mass use per acre has not been established. The water suspension of PBZ can be injected approximately 2-6 inches deep at 50 to 200 psi as close to the tree trunk as possible. Alternatively, the water suspension can be poured into a shallow trench around the tree. Retreatment may be done every 3 years or until the effects from the previous application subside (Rainbow Treecare, 2011).

4. ENVIRONMENTAL FATE OF PACLOBUTRAZOL

4.1. Environmental Fate Parameter Summary

The environmental fate properties of PBZ are summarized in Table A2.1 in Appendix 2. The mobility and persistence characteristics are described in more detail in the following two sections.

4.2. Mobility

PBZ has been characterized as a compound with a moderate potential for mobility in soil and water environments (U.S. EPA, 2007B). The summary document for registration review prepared by U.S. EPA (2007B) documents that laboratory batch equilibrium studies indicated that PBZ has the capacity to be mobile under certain conditions. Studies with nine US soils ranging in texture from sand to silt loam indicated values for the soil adsorption coefficient K_D in the range from 1.3 to 23.0 ml/g. Adsorption appeared to increase with an increase in soil organic matter content and a decrease in soil pH. In the draft assessment report prepared by the United Kingdom (EFSA, 2006) adsorption data for 13 soils are summarized that show K_D values in the range of 0.8 – 21.3 ml/g with a geometric mean of 4.3 ml/g. The ketone metabolite showed on average a slightly higher affinity for adsorption to soil with K_D values in the range of 2.1 – 13.5 with a mean of 8.0 across 6 soils.

Results from laboratory soil column leaching experiments summarized in U.S. EPA (2007B) indicated low mobility in the experiments using methine-labeled PBZ in soils ranging in texture from sand to clay-loam. The experiments using triazole-labeled PBZ showed low mobility in columns of sand and sandy loam soils, and mobility in loamy sand and clay loam soils. In all cases, the majority (58.6 – 90.7%) of applied PBZ aged residue did not leach out of the upper 10 cm of the treated soil columns.

An issue noted in the draft assessment report (EFSA, 2006) was the identification in a column leaching study of the degradate hydroxyl triazole at a concentration of 12 μg/L in the leachate. Even though this degradate was not detected in the soil metabolism experiments, the observation in the column leaching experiment raised concerns for risks to groundwater and a data gap was identified. This data gap was addressed in the additional report to the DAR (EFSA, 2010A). Groundwater exposure modeling using additional soil degradation and adsorption data for the degradate hydroxyl triazole showed a maximum concentration of the degradate in groundwater (80^{th} percentile annual average concentration in leachate leaving the top 1 m soil layer) did not exceed 0.1 μg/L except in one of the six scenarios, where it was modeled at a concentration of 0.1192 μg/L. The modeling study concluded that the potential for the degradate hydroxyl triazole to reach groundwater at high concentrations is low.

PBZ is unlikely to volatilize to any significant extent owing to a low estimated vapor pressure. The octanol-water partitioning coefficient (log K_{OW}) of 3.2 indicates a potential for this chemical to bioaccumulate in fish. A fish bioaccumulation study, which was only conducted for 14 days, showed BCF factors of 20x for edible tissues (day 3), 248x for non edible tissues (day 3), and 44x for whole fish (day 10) (U.S. EPA, 2007B).

Although characterized as moderately mobile in laboratory studies, no significant movement of PBZ was detected in field studies in agricultural soils. In the orchard studies, PBZ residues (parent plus degradate) were detected at 10% or less of total applied in soils with depths of 48 inches in the California study, 24 inches in West Virginia study, and 48 inches in the Florida study. These depths are the maximum depths sampled at each study. No information was provided on the nature or type of soils in the summary document. The PBZ ketone metabolite was predominately detected in the subsurface soil layers, also at insignificant levels (U.S. EPA, 2007B).

A scientific publication by Baris et al. (2010) provided information regarding the potential of PBZ to impact groundwater from its use on turf areas. PBZ was included in a comprehensive evaluation of water quality monitoring data and assessment. This evaluation considered water quality data for a large number of turf-related pesticides from 44 studies involving 80 golf courses in the US over a 20-year period. PBZ was found in 3/440 groundwater samples, with the highest detection at 4.2 μg/L.

4.3. Persistence

PBZ has been characterized as an environmentally stable compound in soil and water environments (U.S. EPA, 2007B). Laboratory studies with US loam and silt-loam soils indicated that PBZ degraded with a half-life of more than 1 year under both aerobic and anaerobic conditions.

Summaries of laboratory half-lives, normalized to 20 °C with moisture content at field capacity, show values in the range of 43 to 618 d with a mean of 183 d (6 soils) (EFSA, 2006). Data from field studies in the UK and Italy indicated dissipation half-lives of 58 to 389 d with a mean of 114 d. Field accumulation studies conducted for a period of 4 to 8 years with annual applications of PBZ showed no apparent build up of PBZ residues except in one of the 7 sites.

The degradation pathway of PBZ, described in EFSA (2006), occurs via the ketone analog, (2RS)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1,2,4-triazol-1-yl)-pentan-3-one, which was detected in the aerobic soil metabolism study at approximately 18% of total applied and at less than 10% in other soil studies. The ketone analog is degraded via separation of the 1-H-1,2,4-triazole moiety. The 1,2,3-triazole moiety was only observed at a maximum of 3%. Degradation of the 1,2,4-triazole proceeds via triazole acetic acid and hydroxyl triazole. Hydroxy triazole was identified in a soil column leaching study but was not observed in any of the soil metabolism studies (EFSA, 2006).

The major ketone-metabolite is less persistent than the PBZ parent with half-lives of 23 – 90 d (mean of 54 d) in an aerobic degradation study with 3 soils. A minor metabolite 1,2,4-triazole is even less persistent as indicated by its half-life of 6.3 – 12.3 d (mean 9.5 d) in aerobic soil degradation studies.

Field dissipation studies from the US showed PBZ residues that were persistent and relatively mobile. Half-lives of PBZ residues ranged from 450-950 days for orchard soils in California,

West Virginia, Florida and 25 weeks to 36 weeks in agricultural soils in Mississippi, North Carolina, and Illinois.

Laboratory studies indicated that PBZ is relatively stable to degradation by hydrolysis. More than 94 percent of PBZ was still present after 30 d in pH 4, 7 and 9 solutions, respectively (U.S. EPA, 2007B). PBZ did not undergo appreciable photolysis in water when exposed to light in pH 7 buffer. More than 96 percent of PBZ was still present after 10 d of exposure (U.S. EPA, 2007B). In the presence of light, degradation of PBZ in soil was slightly accelerated with a calculated half-life of 188 d. It was concluded that soil photolysis is unlikely to be a significant route of dissipation (EFSA, 2006).

Degradation in a water-sediment system was reported in EFSA (2006). The data indicate a low degradation rate in both the water and the whole system. The half-life determined for the whole system was 164 d, with most of the PBZ remaining in the water phase.

5. MAMMALIAN TOXICITY

With regard to the existing toxicological data of PBZ, the work plan for registration review by U.S. EPA (2007B) makes reference to RfD/Peer Review reports from 1986 and 1994 among the primary resources for the status update. A more recent review and evaluation of toxicological information was organized by the European Food Safety Authority (EFSA) as part of the peer review of the pesticide risk assessment of PBZ in European Community. The more up-to-date information available in the EFSA-organized peer review documents was the primary source of information for review presented here. The EFSA-organized review was initiated in 2006 (EFSA, 2006), subsequently withdrawn, and then resubmitted along with additional toxicological information, and was completed in 2010 (EFSA, 2010A and B). Information on the mammalian toxicology from registrant-submitted studies considered in these review documents is summarized below.

Acute toxicity, irritation and sensitization

PBZ exhibits moderate acute toxicity by the oral route in the species tested. The LD_{50} is 1954 mg/kg in male rats and 1336 mg/kg in female rats; 490 mg/kg and 1219 mg/kg in male/female mice, respectively; 542 mg/kg and 400-640 mg/kg in male/female guinea pigs, respectively; and 835 mg/kg and 937 mg/kg in male/female rabbits, respectively. New data for rats indicated an oral LC_{50} > 2000 mg/kg.

Acute dermal LC_{50} values are greater than 2000 mg/kg in rats and greater than 1000 mg/kg in rabbits. Overall, PBZ is of low acute toxicity by the dermal route.

Acute inhalation studies showed a 4h-LC_{50} value of greater than 2 mg/L particulate to rat indicating moderate toxicity by inhalation.

Skin irritation studies with rats (5 repeated applications) and with rabbits (single application) indicated that PBZ is slightly irritating to skin. Eye irritancy studies with rabbits indicated mild irritancy to the eye. PBZ is not a skin sensitizer based on the results of studies with guinea pigs.

Overall, the acute toxicity data indicate that PBZ is of moderate acute toxicity by the oral and inhalation routes and of low acute toxicity by the dermal route. PBZ is slightly irritating to skin and eye and is not a skin sensitizer.

Toxicokinetics

In the rat, absorption was rapid and extensive (88-95%) and did not show saturation at a high dose. Absorbed material was readily oxidized to PBZ diol, which was subject either to excretion or to further oxidation to the carboxylic acid. Biotransformation was limited to the tertiary butyl moiety, with no metabolism detected in either the triazole or chlorinated phenyl rings. Male rats oxidized a greater proportion of PBZ to the carboxylic acid than did female rats.

A small proportion of radioactivity equilibrated into the tissues and was subsequently eliminated. The highest concentrations of radioactivity were seen in the liver after a high or low dose. There was no evidence of bioaccumulation.

Excretion at a low dose was relatively rapid with more than 70% of radioactivity excreted within 48 hours. The delay in excretion in the high dose animals (>70% excretion not achieved until 72 hours after dosing) and the significant amount of radioactivity in faeces (well beyond normal transit time) were due to significant enterohepatic recirculation. In cannulated rats, biliary excretion at a low dose represented >50% and 70% of the administered dose in females and males, respectively. In cannulated rats, 5% was excreted as unchanged parent.

In the dog, following a single oral low dose, radioactivity was rarely absorbed reaching peak concentrations in plasma and blood within 1 hour and declining below the limits of detection by 72 hours. Most of the radioactivity was associated with plasma. Elimination was faster than for rats with >75% of radioactivity eliminated in urine and faeces within 24 hours. At 168 hours after dosing, there was almost a complete absence of radioactivity in all tissues examined (with the exception of the liver in one animal). There was no evidence of bioretention of PBZ or its metabolites in dogs.

Short-term toxicity

The short-term toxicity of PBZ was investigated by the oral route in rats (90 days) and dogs (90 days and 1 year), and by the dermal route in rabbits (21 days).

The liver is the target organ of PBZ oral toxicity in the rat. Signs of liver toxicity (clinical chemistry changes, increased weight and marginal increases in hydropic and fatty changes) were observed in males and females at 1250 ppm (93 and 107 mg/kg/day in males and females, respectively). These effects were accompanied by decreases in food consumption and body weight gain. There were no effects at 250 ppm (20 mg/kg/day). An overall short-term NOAEL of 20 mg/kg/day was identified for the rat from this subchronic study.

Similar findings were observed in the dog. Liver toxicity (clinical chemistry changes, increased weight, enzyme induction and ballooned hepatocytes), accompanied by decreases in food consumption and body weight gain, was observed from a dose of 75 mg/kg/day (in the 1-year study). There were no effects at 15 mg/kg/day (1-year study). Therefore, an overall short-term NOAEL of 15 mg/kg/day was identified for the dog from the chronic study.

A repeat dose dermal toxicity study in rabbits showed no signs of systemic toxicity up to 100 mg/kg bw/day.

No short-term studies in the mouse were available; however, results from the mouse carcinogenicity study do not indicate that the mouse was more sensitive to PBZ than rats or dogs.

Genotoxicity

The mutagenic, clastogenic, and aneugenic potential of PBZ was studied in several *in vitro* test systems using bacteria and mammalian cells and *in vivo* test systems in rats and mice. PBZ was negative in an *in vitro* bacterial reverse mutation assay and an *in vitro* gene mutation test in mouse lymphoma cells. No clastogenic effects were seen in an *in vitro* human lymphocyte cytogenetics test, two *in vivo* rat cytogenetics tests and two *in vivo* mouse micronucleus tests. No evidence of DNA damage or repair was noted in an *in vivo* UDS assay. PBZ had no effect on

either fertility or dominant lethality in mice in a dominant lethality test. Based on these *in vitro* and *in vivo* mutagenicity tests, it was concluded that PBZ is not genotoxic.

Long-term toxicity and carcinogenicity

The chronic toxicity and carcinogenicity of PBZ was investigated in two standard dietary studies in rats and mice.

The liver is the target organ of PBZ oral chronic toxicity in the rat. Signs of liver toxicity (decreases in plasma triglycerides in females and increases in plasma BUN levels in females, increased liver weights in males and females and increased incidence of hepatocyte steatosis/hypertrophy in males and females) were seen at the top dose of 1250 ppm. These were accompanied by decreases in body weight gain and food consumption in females. At 250 ppm, body weight gains were still significantly reduced in females and liver steatosis was still significantly increased in males. There were no toxicologically significant effects at 50 ppm (2.2 and 2.8 mg/kg bw/day in males and females, respectively).

In mice, the target organ of PBZ oral chronic toxicity was also the liver (and related fat metabolism), as indicated by increased liver weights, increased severity of steatosis in males and reduced serum cholesterol in males and triglyceride levels in females at the top dose level of 750 ppm. There were no toxicologically significant effects at 125 ppm (14 and 16 mg/kg bw/day in males and females, respectively).

There was no evidence of carcinogenic effect of PBZ in rats or mice.

Reproductive and developmental toxicity

The reproductive toxicity of PBZ has been investigated in a 2-generation study in the rat and in pre-natal developmental toxicity studies in rats and rabbits.

In the 2-generation study, dietary administration of PBZ caused general toxicity in the parental animals at the top dose of 1250 ppm, observed as increased incidence of chromocryorrhea and thickened eyelids and increases in liver weights and associated histopatology (centrilobular fatty changes). PBZ also caused adverse effects in the young F_1 and F_2 offspring at the top dose of 1250 ppm, observed as a reduction in pup bodyweight gains, increased incidence of chromodacryorrhea, thickened eyelids, dental malocclusion and twisted snout and increases in liver weights and associated histopatology (centrilobular fatty changes). However, fertility mating performance, litter size and pup survival were not affected by treatment. Accordingly, on the basis of this study, it can be concluded that PBZ is not a specific hazard to fertility and reproductive performance, as no effects were seen up to the top dose of 1250 ppm (117 mg/kg/day in males and 124 mg/kg/d in females). Classification for effects on fertility was not required. However, a NOAEL of 250 ppm (23 mg/kg/day in males and 25 mg/kg/day in females) was identified for general parental toxicity and for effects on the offspring.

New information confirmed the increased incidence of dental malocclusion and twisted snout observed in the F1 and F2 offspring is unlikely to be a developmental effect of PBZ. As the same finding was detected in the treated adult animals of the F_O generation with a similar incidence, it

was considered that, at most, it represents a generalized, unspecific toxic effect of PBZ to pups and adult animals.

Two developmental toxicity studies in the rat are available. In the first study, a NOAEL for maternal toxicity of 100 mg/kg bw/day was identified on the basis of reduced food consumption and deaths at the next dose level of 250 mg/kg bw/day (top dose). Developmental toxicity was limited to delayed ossification of a number of bones. A no-effect level for developmental effects could not be established because a statistically significant, dose-related increase in partially ossified 7th transverse process was apparent at all dose levels (from 40 mg/kg bw/day = LOAEL). There was also an increased incidence of cleft palate (1.28% vs 0% in concurrent and historical controls) at the highest dose which may have been the consequence of maternal toxicity (including lethality); however a direct teratogenic effect could not be ruled out.

In a second study, conducted to determine a no-effect level for developmental toxicity, there were no effects on the dams up to the top dose tested (100 mg/kg bw/day = NOAEL for maternal toxicity). Developmental toxicity was limited to an increased incidence of partial ossification of the transverse processes of the 7th cervical vertebra and extra 14th rib at 40 and 100 mg/kg bw/day. There were no developmental effects at 10 mg/kg bw/day (NOAEL for developmental toxicity).

In two separate developmental toxicity studies in the rabbit, there was no evidence of developmental effects up to the top dose tested of 125 mg/kg bw/day at which maternal toxicity (reduced body weight gain and food consumption) was observed. Additional information confirmed that the reported skeletal variants are chance findings unrelated to treatment and that PBZ is not a developmental toxicant in the rabbit up to maternally toxic dose levels.

Overall, therefore, PBZ causes developmental toxicity in rats, manifested as a low incidence of cleft palate (1.28% affected foetuses vs 0% in concurrent and historical controls), seen in a preliminary study at 240 mg/kg bw/day and in one of the two definitive studies at the top dose of 250 mg/kg bw/day. The lack of the observation in the second definitive study is consistent with the findings of the other studies as the highest dose tested in the second study was only 100 mg/kg bw/day. Although the cleft palate occurred in the presence of severe maternal toxicity (including lethality), there is no evidence that the finding is a secondary non-specific consequence of maternal toxicity. PBZ also causes small changes in the incidences of common skeletal variants in the rat (partial ossification of the transverse processes of the 7th cervical vertebra and extra 14th rib). Although these occurred both in the absence of observable maternal toxicity and in the presence of maternal toxicity, they were observed in isolation, did not show a consistent pattern and were not accompanied by any effects on other foetal parameters, such as body weight. Nevertheless, as cleft palate toxicity is very rare in the rat and is not considered to be a secondary non-specific consequence of maternal toxicity, classification for developmental toxicity in a category representing substances with possible risk of harm to the unborn child was considered to be appropriate.

Tolerances and other guidelines

Since there are no food uses of PBZ, no maximum residue levels for PBZ have been established for agricultural commodities in the US (U.S. EPA, 2007A). A drinking water standard is also not

established in the US. The derivation of a maximum allowable concentration in drinking water of 66 μg/L is described in EFSA (2010A). This value is based on an allowable daily intake of 0.022 mg/kg/day.

In the context of the evaluation water quality data and assessment of pesticide impacts, Baris et al. (2010) calculated a lifetime health advisory level following procedures used by U.S. EPA and reported a value of 460 μg/L for PBZ.

6. ECOTOXICITY

Data on the ecotoxicity of PBZ were available in EPA's summary document for registration review (U.S. EPA, 2007B), in the draft assessment report (EFSA, 2006), and in the additional report to DAR (EFSA, 2010A). The toxicity data considered in these regulatory reviews were primarily obtained from registrant-submitted data. Summaries of these studies are available in review documents generated by EFSA (2006 and 2010A). The ecotoxicity information is described below. A data summary table is included in Appendix 3.

6.1. Acute and Chronic Toxicity of Paclobutrazol

Avian

PBZ is slightly toxic to practically non-toxic to avian species based on acute oral toxicity data (see Appendix 3) ranging from >2100 to >7913 mg/kg b.w. and the ecotoxicity categories as defined by U.S. EPA (2011A). The sub-acute dietary toxicity data indicate that PBZ is slightly toxic to mallard and bobwhite quail. The no-observed-effect-concentration (NOEC) corresponded to a daily dose of 3106 mg/kg/d for mallard and 101 mg/kg/d for bobwhite quail, respectively. A reproductive toxicity effect study with mallard ducks indicated a NOEC that corresponded to a daily dose of 38.8 mg/kg bw/d.

Aquatic Species

The acute toxicity data for bluegill sunfish, rainbow trout, mirror carp and sheepshead minnow listed in Appendix 3 show a range of LC_{50} values from 23.6 to 27.8 mg/L. These data indicate that PBZ is slightly acutely toxic to fish. Aquatic-phase amphibian toxicity data were available from a study with toad tadpoles that indicated a slight toxicity of PBZ with a LC_{50} value of 11 mg/L.

Chronic toxicity data for rainbow trout indicated a NOEC of 3.3 mg/L. The endocrine activity was studied in zebra fish (*Danio rerio*). No activity was found at levels up to and including the mean measured concentration of 3.2 mg/L. No NOEC could be established. However, statistically significant reductions in vitellogenin levels were observed at all test concentrations in male fish, while non-significant decreases were observed in top dose levels in female fish. Fish gonadal screening assays for endocrine activity in zebra fish showed no histopathological treatment-related effect on the gonads, liver, and kidneys.

Bioaccumulation

Bioaccumulation factors in bluegill sunfish were approximately 44 in whole fish, 20 in muscle, and 248 in viscera. During the depuration period the accumulated residues were rapidly eliminated, with ^{14}C-residue concentrations returning to background levels within 7 days.

Aquatic invertebrates

The toxicity data for aquatic invertebrates, including water fleas (*Daphnia magna*), mysid shrimp (*M. bahia*), and Pacific oyster larvae (*C. gigas*), indicate that PBZ is slightly toxic to this class of organisms with LC_{50} data in the range of >9 to 35 mg/L. Chronic toxicity data for water fleas (*D. magna*) indicated a 22-d NOEC value of 0.32 mg/L based on effect on *D. magna* length.

Aquatic plants

For non-vascular aquatic plants, the toxicity of PBZ to green algae (*Selenastrum capricornutum*) the 96-hr E_bC_{50} and E_rC_{50} [1] for PBZ were 7.2 mg/L and >15.2 mg/L, respectively. For blue-green algae (*Anabaena flos-aquae*) these values were estimated to be greater than 23.2 mg/L. PBZ is more toxic to vascular aquatic plants. The data for duckweed (*Lemma gibba*) 7-d E_bC_{50} and E_rC_{50} for PBZ were 8.2 μg/L (0.0082 mg/L) and 28.3 μg/L (0.0283 mg/L), respectively.

Terrestrial Vertebrates

Mammalian toxicity was presented in Section 5. The reader is referred to that section for information relative to the ecotoxicity for terrestrial invertebrates.

Bees

Honey bees (*Apis hellifera*) exposed to PBZ by contact with doses in the range of 2 to 40 μg per bee and orally by dosing at 2 μg per bee indicated contact and oral LD_{50} values that were determined to be >40 μg/bee and >2 μg/bee, respectively.

Earthworms

Clitelate adult earthworms (*Eisenia foetida*) were exposed at a single test concentration of 1000 mg/kg soil for 14 days. The 14 d LC_{50} value was >1000 mg/soil. No deaths, abnormalities in behavior or external condition were observed at the test concentration. There was a statistically significant 20% reduction in body weight. The 14 d LC_{50} value for the ketone degradate was also determined to be >1000 mg/soil.

6.2 Acute and Chronic Toxicity of Metabolites

Metabolites that are considered relevant for ecotoxicological risk assessment are the ketone analog of PBZ, 1,2,4,-triazole and hydroxyl triazole (EFSA, 2006 and 2010). The available toxicity data for these metabolites are listed in Table 6.1. The data for PBZ are included for comparison.

[1] The EbC50 value is the concentration at which 50% reduction of biomass is observed; the ErC50 is the concentration at which a 50% inhibition of growth rate is observed (Bergtold and Dohmen, 2011).

Table 6.1. Comparison of acute (LC_{50}/EC_{50}) and chronic (NOEC) ecotoxicity data of paclobutrazol and its metabolites ketone, 1,2,4-triazole, and hydroxy-triazole (EFSA, 2006 and 2010).

Species	Paclobutrazol (mg/L)	Ketone (mg/L)	1,2,4-triazole (mg/L)	Hydroxy-triazole (mg/L)
ACUTE				
Fish (*O. mykiss*, 96-h LC_{50})	23.6	-	498	-
Invertebrates (*D. magna*, 48-h EC_{50})	27.8	-	>100	-
Algae (*P. subcaptitata*, 72-h EC_{50})	7.2	-	12	-
Aquatic plants (*L. gibba*, 7-d EC_{50})	0.0283	0.57		>100
CHRONIC				
Fish (*O. mykiss*, NOEC)	3.3		100	

The data in Table 6.1 show that the metabolites are less toxic than the parent compound PBZ. In the case of the ketone metabolite, only aquatic plants have been tested. Such an approach was considered acceptable in the review by EFSA (2006) as this group of organisms is considered more sensitive to the parent compound than the other aquatic organism groups tested and the ketone is closer in structure to the parent and is formed higher up in the metabolic pathway.

7. EXPOSURE ASSESSMENT

In order to perform an ecological risk assessment, the exposure assessment is needed to estimate the environmental concentrations associated with the application of PBZ. Given the application method of PBZ as tree growth regulator by soil injection around the base of a tree, the exposure assessment was done for the environmental compartments surface water, ground water, and the soil in and immediately adjacent to the injection area. Potential off-site migration routes that are likely to be relevant for the applied product include runoff and leaching through the soil toward surface water and groundwater. Off-target migration through spray drift is not considered given that the application method is by soil injection.

7.1 Surface Water Exposure

The exposure to surface water was estimated using a Tier I screening-level exposure model that is used by the Environmental Fate and Effects Division of U.S. EPA's Office of Pesticide Programs (EFED-OPP) to assess the risk of a pesticide product to the environment. This Tier I model is designed as a coarse screen and estimates expected concentrations from several basic chemical and environmental fate parameters, and application information. This GENeric Expected Environmental Concentration Program (GENEEC) uses a candidate chemical's soil/water partition coefficient and degradation half-life values to estimate runoff from a ten hectare field into a one hectare by two meter deep pond. GENEEC is a program to calculate both acute and chronic generic expected environmental concentration values. It considers reduction in dissolved pesticide concentration due to adsorption of pesticide to soil or sediment, incorporation into the soil, degradation in soil before wash-off to a water body, direct deposition of spray drift into the water body, and degradation of the pesticide within the water body. It is designed to mimic the more sophisticated PRZM-EXAMS model simulation (Tier II model in EFED-OPP) (U.S. EPA, 2011B).

The model requires input values for parameters associated with application and the characteristics of the active ingredient. An application rate for Cambistat expressed in amount of product or active ingredient per acre has not been established because of its use pattern of treating individual trees. The application rate for the model input was set at 3 lbs per acre for a single application. This application rate was based on the annual maximum rate as for applications on turf (4 application per year of 0.75 lbs PBZ per acre = 3 lbs PBZ per acre) as was used with the exposure modeling described in U.S. EPA (2007B). This rate can be considered a reasonable high-end estimate of a per-acre rate considering the use pattern of treating individual trees. Since the product is injected into the soil, the option of granular application was selected in order to not simulate aerial spray drift. The incorporation depth of 6.0 inches was selected to be representative of the recommended injection depth used with the application of this product.

The values of the chemical and environmental fate properties were a K_D of 2.7 (lowest non-sand value in EFSA (2006), soil half-life of 437 days (according to GENEEC manual instructions for selecting conservative parameter value), aquatic half-life of 164 d, and photolysis half-life of 365 d (stable). The GENEEC input and output for this scenario are included in Appendix 4.

The model output shows that the simulated peak generic environmental concentration was 19.98 µg/L (0.01998 mg/L), the maximum concentration was 19.34 µg/L at 21 d and 17.35µg/L at 90

days. It is important to note that the GENEEC model simulates conservative pesticide concentrations for aquatic ecological exposure assessments.

7.2. Groundwater Exposure Assessment

The exposure of herbicides to groundwater was evaluated by using the SCI-GROW model simulations. SCI-GROW (***S***creening ***C***oncentration ***I***n ***GRO***und ***W***ater) is a screening model which the Office of Pesticide Programs (OPP) in EPA frequently uses to estimate pesticide concentrations in vulnerable ground water (U.S. EPA, 2011C). The model provides an exposure value which is used to determine the potential risk to the environment and to human health from drinking water contaminated with the pesticide. The SCI-GROW estimate is based on environmental fate properties of the pesticide (aerobic soil degradation half-life and linear adsorption coefficient normalized for soil organic carbon content), the maximum application rate, and existing data from small-scale prospective ground-water monitoring studies at sites with sandy soils, low organic matter content (on average <1%) and shallow ground water (on average 14 ft).

Pesticide concentrations estimated by SCI-GROW represent conservative or high-end exposure values because the model is based on ground-water monitoring studies which were conducted by applying pesticides at maximum allowed rates and frequency to vulnerable sites (i.e., shallow aquifers, sandy, permeable soils, and substantial rainfall and/or irrigation to maximize leaching). In most cases, a large majority of the use areas will have ground water that is less vulnerable to contamination than the areas used to derive the SCI-GROW estimate.

The input parameters for SCI-GROW include the application rate, soil degradation (soil half-life value) and a soil mobility parameter (soil organic matter-water partitioning coefficient (K_{OC}). Following the instructions for input value selection, the annual application rate used was 3 lbs PBZ per acre (as described with surface water assessment), the soil half-life was 285 days (see surface water assessment), and the K_{OC} was 106 mL/g (determined from the lowest non-sand K_D value used above with surface water and the corresponding organic carbon content of 2.5%: K_{OC} = K_D/ fraction OC).

The SCI-GROW simulated screening-level groundwater concentration using the selected input values as described above was 14.3 µg/L(see also Appendix 5).

7.3. Soil Exposure at the Application Site

The exposure of PBZ in the soil following the injection of the product in a band around the trunk base of a tree was estimated by considering the amount of product applied according to label instruction to a tree with an assumed trunk diameter and assumed dimensions of a soil band around the trunk base of the tree that would received the initial application of the product. Details on the calculation of the PBZ concentration in the soil of the treated area around a tree are shown in Appendix 6. The initial peak concentration of PBZ in the treated soil band was calculated to be 150 mg/kg dry soil.

8. RISK CHARACTERIZATION

8.1 Ecological Risk Assessment

Ecological risk characterization integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. For most ecological risk assessments, U.S. EPA uses a deterministic approach or the quotient method to compare toxicity to environmental exposure. In the deterministic approach, a risk quotient (RQ) is calculated by dividing exposure estimates by ecotoxicity values, both acute and chronic. RQ values are then compared to established levels of concern (LOCs). The LOCs are criteria used by U.S. EPA to indicate potential risk to non-target organisms. The RQ ratio is a screening-level method that identifies high- or low-risk situations (U.S. EPA, 2011D).

As pointed out earlier, the environmental compartments that are most likely to be exposed to the products or residues thereof are the soil in and adjacent to the treatment area, and surface and ground water. The ecological risk assessment will therefore consider the risk to aquatic organisms and earthworms. Based on the localized application of product in the soil of tree rooting area it can be expected that the exposure to terrestrial vertebrates and birds is going to be minimal. The groundwater is not considered as a relevant environmental compartment for ecological risk, but will be addressed separately for a drinking water assessment.

The RQ values for the groups of organisms considered in this ecological risk assessment are listed in Table 8.1 along with the corresponding toxicity endpoint and EEC data. The RQ are compared with the established LOCs (U.S. EPA, 2011D).

Table 8.1. Ecological risk assessment data for paclobutrazol.

Species	Toxicity Endpoint	Endpoint Value	EEC	RQ	LOC[1]
AQUATIC INVERTEBRATES		(mg/L)	mg/L	EEC/ Endpoint	
Daphnia magna	Acute 96-h LC_{50}	35	0.01998	0.0006	0.5
Mysid Shrimp	Acute 96-h LC_{50}	>9	0.01998	>0.0022	0.5
Pacific oyster larvae	Acute 48-h EC_{50}	>10	0.01998	>0.0020	0.5
Daphnia magna	Chronic NOEC	0.32	0.0173	0.0541	1
FISH					
Bluegill sunfish	Acute 96-h LC_{50}	23.6	0.01998	0.0008	0.5
Rainbow trout	Acute 96-h LC_{50}	27.8	0.01998	0.0007	0.5
Mirror Carp	Acute 96-h LC_{50}	26.0	0.01998	0.0008	0.5
Sheepshead minnow	Acute 96-h LC_{50}	24.3	0.01998	0.0008	0.5
Rainbow trout	Chronic 22-d NOEC	3.3	0.01735	0.0053	1

Species	Toxicity Endpoint	Endpoint Value	EEC	RQ	LOC[1]
AMPHIBIAN (aquatic phase)					
Bufo bufo (toad)	Acute 72-h LC_{50}	11	0.01998	0.0018	0.5
AQUATIC PLANTS					
Green algae	Growth E_bC50	7.2	0.01988	0.0028	1
	Growth E_rC50	15.2	0.01988	0.0013	1
Blue-green algae	Growth E_bC50	>23.2	0.01988	>0.0009	1
	Growth E_rC50	>23.2	0.01988	>0.0009	1
Duck weed	Growth E_bC50	0.0082	0.01988	**2.4244**	1
	Growth E_rC50	0.0283	0.01988	0.7025	1
EARTHWORMS		mg/kg soil	mg/kg soil		
Eisenia foetida	Acute 14-d LC_{50}	>1000	150	0.15	0.5

[1] LOC values established by U.S. EPA, 2011D.

Comparison of the RQ values with the established LOCs indicates that all are well below the established LOCs, except for duckweed. The low RQ values indicate low potential for adverse effects on most aquatic organisms. The RQ value for growth effects on duckweed biomass indicates that there is some potential for adverse effects for vascular aquatic plants. This can be expected from exposure of plants to a growth retardant compound. Given the slight exceedance of the LOC and that the effect is on growth, it is not expected that the impact would be detrimental for this group of organisms. In addition, the estimated surface water concentration is a screening-level assessment that is based on conservative assumptions. The screening-level concentration can be considered to be representative of a high-end exposure and will not occur in most situations.

Earthworms are organisms that could be exposed to PBZ following a soil injection application around the perimeter of a tree trunk. However, the level of exposure associated with such an application would not exceed the LOC for this group of organisms. PBZ soil concentration and associated exposure by earthworms would also decrease over time as the PBZ is gradually taken up by the tree.

Acute and chronic risk to mammals from potential exposure to PBZ residues in food was assessed in the review by EFSA (2006). The exposure assessment was based on the application rate of 0.0557 lbs PBZ per acre as proposed for use on an oil seed crop. The food intake rate considered was for a medium-sized herbivorous mammal and residue characteristics were

representative for application to a leafy crop. The estimated theoretical exposure was 2.18 mg PBZ/kg bw/d (acute) and 0.51 mg PBZ/kg bw/d (chronic). The toxicological endpoints used in this risk assessment were the LD_{50} for male mouse (490 mg PBZ/kg bw) and developmental toxicity NOAEL of 10 mg/kg bw in rat. A developmental end-point was used as this was the lowest longer-term end-point and therefore considered to represent the worst-case scenario. Using this information, EFSA calculated a toxicity exposure ratio (TER) of 224.8 for acute risk and 19.6 for chronic risk. Based on comparison with the levels of concern (TER values of greater than 10 for acute risk and greater than 5 for chronic risk are not of concern), EFSA concluded that the acute and chronic risks to mammals were not a concern.

It should be pointed out that the developmental endpoint is toxicologically not considered a long-term or chronic endpoint. Developmental exposure is typically viewed as being of intermediate exposure. The evaluation of chronic toxicity using a toxicity value based on intermediate exposure is not protective.

Alternative long-term toxicological end-points for mammalian species identified by EFSA were the NOAEL of 23.2 mg/kg bw/d for parental toxicity and 108 mg/kg bw/d for reproductive toxicity. Evaluation of chronic risk based on these endpoints results in TER values of 45 (parental) and 212 (reproductive) which can be considered protective. Given that there was no estimated theoretical exposure of medium duration generated in the EFSA evaluation, it is not possible to properly evaluate the developmental endpoint, (i.e., the most sensitive endpoint) based on the available information. It is likely that if an exposure estimate of intermediate exposure were to be generated, that it would indicate that developmental effects would not be of concern—however, such a conclusion cannot be drawn based on the current information.

The risk to earthworm-eating mammals was assessed by considering the residue estimates in earthworms that were based on estimated bioconcentration factors and concentrations of PBZ in soil. The residue estimates were converted to a daily dose that had a value of 0.18 mg PBZ/kg bw/d. Compared to the long-term NOAEL of 10 mg/kg bw/d, the toxicity exposure ratio was 55.6. This value exceeds the trigger value (level of concern) of 5 (a TER value greater than 5 for chronic risk is not of concern) and therefore it was concluded that the risk to earthworm-eating mammals was not a concern.

The risk assessments described above were done assuming an application scenario representative for the use of PBZ on oilseed crops, which includes broadcast foliar applications resulting in residues that mostly occur on above ground plant material. The use scenario for tree treatments, in contrast, is by soil injection around the tree trunk perimeter, which results in a much more localized application of the material in the soil. It is likely that tree trunk application results in higher concentrations of PBZ occur in soil compared to soil concentrations associated with broadcast foliar applications. However, it is unlikely that small mammals would feed exclusively and permanently in a treated tree trunk area. It is therefore unlikely that the exposure of mammals to PBZ in a tree trunk treatment scenario would exceed the exposure levels as described above in the broadcast oil seed crop scenario. The risks to mammals from PBZ exposure associated with tree trunk applications is not expected to be significant.

8.2 Comparison of Estimated Groundwater Concentration with Drinking Water Standards

The screening-level groundwater concentration of 14.3 ppb is below the maximum allowable concentration in drinking water of 66 µg/L reported in EFSA (2010A). This screening-level concentration is also below the lifetime health advisory level of 460 µg/L calculated by Baris et al. (2010).

With the consideration of the risk to groundwater it is important to consider that the screening-level concentrations generated by the SCI-GROW model represent conservative or high-end exposure. In most cases, the use areas will have ground water that is less vulnerable to contamination than the areas used to derive the SCI-GROW estimate. In addition, the model does not consider buffer zones around a drinking water well as is required by ROW regulations.

9. RISK MITIGATION AND USE PRECAUTIONS

The product label (Rainbow Treecare, 2011) offers a number of precautionary practices that may be taken to mitigate potential risks to non-target organisms. Given that the product is a plant growth inhibitor, non-target plants have the highest potential to be affected by PBZ exposure through off-site movement of applied product. This potential risk to non-target plants is addressed by warning and precautionary language on the label:

Localized stunting or injury of turfgrass or other non-target plants immediately adjacent to the treatment site may occur if the product flows off of the application site.

Avoid basal drench applications on inclines and other areas where treated soil is likely to be washed away from the base of the tree by rainfall or irrigation.

Shrubs and/or herbaceous ornamentals next to treated trees may be affected if their roots extend into the treatment zone.

The risk to aquatic organisms is addressed by language that states that the product should not be applied directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark.

Other label language addresses the treatment of trees that produce products for human consumption such as maple trees, and fruit and nut trees.

10. REFERENCES

Baris, R.D, S.Z. Cohen, N. L. Barnes, J. Lam, Q. Ma., 2010. Quantitative analysis of over 20 years of golf course monitoring studies. Env. Toxicol. Chem. 29:1224-1236.

Bergtold, M. and Dohmen, G.P., 2011. Biomass or growth rate endpoint for algae and aquatic plants: relevance for the aquatic risk assessment of herbicides. Integr Environ Assess Manag. 7(2):237-47.

British Crop Protection Council (BCPC), 2000. The pesticide manual, 12th ed., C.D.S. Tomlin (Edt.).

Chaney, W.R., 2005. Growth retardants: A promising tool for managing urban trees. Purdue Extension document FNR-252-W. Accessed on May 11, 2011 at: http://www.extension.purdue.edu/extmedia/FNR/FNR-252-W.pdf

DOW, 2006. Product Safety Assessment: Propylen glycol. Accessed at: http://msdssearch.dow.com/PublishedLiteratureDOWCOM/dh_0074/0901b80380074c91.pdf?filepath=productsafety/pdfs/noreg/233-00248&fromPage=GetDoc

EFSA, 2006. Paclobutrazol Draft Assessment Report (DAR). Report and proposed decision of the United Kingdom made to the European Commission. Available at: http://dar.efsa.europa.eu/dar-web/provision

EFSA, 2010A. Additional Report to the DAR. Risk Assessment provided by rapporteur Member State the United Kingdom for the existing active substance paclobutrazol upon resubmission in the framework of the accelerated procedure in accordance with Commission Regulation (EC) No 33/2008. Available at: http://dar.efsa.europa.eu/dar-web/provision

EFSA, 2010B. Conclusion on the peer review of the pesticide risk assessment of the active substance paclobutrazol. European Food Safety Authority (EFSA), Parma, Italy. Available at: http://www.efsa.europa.eu/en/efsajournal/pub/1876.htm

MDAR, 2010A. Herbicide Evaluation Technical Update No. 1: Methods for the evaluation of herbicides for use in sensitive areas of rights-of-way. Available at: http://www.mass.gov/agr/pesticides/rightofway/sensitive-area-review-process.htm

MDAR, 2010B. Herbicide Evaluation Technical Update No. 2: List of Approved Surfactants for Use in Sensitive Areas on Rights-of-Way, June 2010. Available at: http://www.mass.gov/agr/pesticides/rightofway/sensitive-area-review-process.htm

MDAR, 2011. Herbicide review process for sensitive areas in rights-of-way. Available at: http://www.mass.gov/agr/pesticides/rightofway/sensitive-area-review-process.htm

OECD/SIDS, 2001. 1,2-Dihydroxyproane SIDS Initial Assessment Profile. UNEP Publications, SIAM 11. Available at: http://www.chem.unep.ch/irptc/sids/OECDSIDS/57-55-6.pdf

Rainbow Treecare Scientific Advancements, 2011. Cambistat® label and MSDS. Available at: http://www.treecarescience.com/msds

U.S. EPA, 2011A. Technical Overview of Ecological Risk Assessment Analysis Phase: Ecological Effects Characterization. Accessed at: http://www.epa.gov/oppefed1/ecorisk_ders/toera_analysis_eco.htm

U.S. EPA, 2007A. Paclobutrazol Final Work Plan for Registration Review. Available in docket number EPA-HQ-EPA-2006-0109 at regulations.gov. Docket link: http://www.regulations.gov/#!docketDetail;D=EPA-HQ-OPP-2006-0109

U.S. EPA, 2007B. Paclobutrazol summary document for registration review: Initial Docket. Case Number 7002. Available in docket number EPA-HQ-EPA-2006-0109 at regulations.gov.

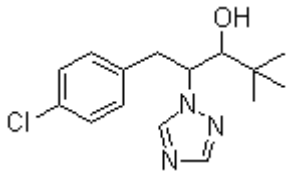
U.S. EPA, 2011B. GENEEC model description. Available at: http://www.epa.gov/oppefed1/models/water/geneec2_description.htm

U.S. EPA, 2011C. SCI_GROW model information and background. Available at: http://www.epa.gov/oppefed1/models/water/scigrow_description.htm

U.S. EPA, 2011D. Technical Overview of Ecological Risk Assessment Risk Characterization. Available at: http://www.epa.gov/oppefed1/ecorisk_ders/toera_risk.htm#Deterministic

Appendix 1

Table A1.1. Paclobutrazol structure and nomenclature

Paclobutrazol	
Structure	
Molecular Formula	$C_{15}H_{20}ClN_3O$
IUPAC Name	(2*RS*,3*RS*)-1-(4-chlorophenyl)-4,4-dimethyl-2-(1*H*-1,2,4-triazol-1-yl)pentan-3-ol
CAS name	(a*R*,ß*R*)-*rel*-ß-[(4-chlorophenyl)methyl]-a-(1,1-dimethylethyl)-1*H*-1,2,4-triazole-1-ethanol
CAS Number	76738-62-0
PC Code	125601

Source: U.S. EPA, 2007B

Table A1.2. Physical and chemical properties of paclobutrazol

Parameter	Value	Source
Molecular Mass	293.8	EFSA, 2006[1)]
Melting/Boiling point	164 °C/ 384 °C	EFSA, 2006
Density	1.23 g/cm^3 (20 °C)	EFSA, 2006
Vapor Pressure	1.9 × 10^{-6} Pa (very slightly volatile)	EFSA, 2006
Volatility from water (Henry's constant	2.39 × 10^{-5} Pa m^3 mol^{-1}	EFSA, 2006
Solubility in water	26 mg/L (20 °C)	BCPC, 2000[2)]
Octanol-water partitioning constant (Log P)	3.2	BCPC, 2000

1) EFSA, 2006, Section B.2.1; [2)] British Crop Protection Council, 2000 (The Pesticide Manual).

Appendix 2

Table A2.1. Environmental fate properties for mobility and persistence of paclobutrazol

Parameter	Value	Source
Hydrolysis	Stable: <6% degradation after 30 d at pH 4,7, and 9	U.S. EPA, 2007B
Photolysis in water	Stable: < 5% degradation after 10 d at pH 7	U.S. EPA, 2007B
Aerobic soil metabolism (half-life)	> 1 yr 43 – 618 d (mean 183 d)	U.S. EPA, 2007B EFSA, 2006 [1)]
Anaerobic soil metabolism (half-life)	> 1 yr	U.S. EPA, 2007B
Field dissipation (half-life)	450-950 d in orchard US soils 175 – 252 d in agricultural US soils	U.S. EPA, 2007B EFSA, 2006 [1)]
Aquatic metabolism (half-life)	164 d	EFSA, 2007B
Soil Adsorption Coefficient (K_D) mL/g	1.3 – 23.0 0.8 – 21.3 (mean of 4.3)	U.S. EPA, 2007B EFSA, 2006 [1)]

[1)] EFSA, 2006: Volume 3, Annex B, Section 8.

Appendix 3

Table A3.1. Summary of ecotoxicity data for paclobutrazol. Data were obtained from U.S. EPA (2007B), EFSA (2006) and EFSA (2010).

Species	Toxicity	Endpoint	Values
AVIAN			(mg/kg b.w.)
Mallard	Acute Oral[1]	LD50	>7913
Japanese Quail	Acute Oral	LD50	>2100
Mallard	Sub-acute dietary[2]	LD50	>3106
		NOEC	3106
Bobwhite Quail	Sub-acute dietary	LD50	>2791
		NOEC	101
Mallard	Long-term/ Reproductive[3]	NOEC	38.8
AQUATIC INVERTEBRATES			mg/L
Daphnia magna (flea)	Acute	48 hr EC50 static	35
Mysid Shrimp	Acute	96 hr EC50 semi- static	>9
Pacific oyster larvae	Acute	48 hr EC50 static	>10
Daphnia magna	Chronic	22-d NOEC semi-static	0.32
FISH			mg/L
Bluegill sunfish	Acute	96 hr EC50 semi- static	23.6
Rainbow trout	Acute	96 hr EC50 semi- static	27.8
Mirror Carp	Acute	96 hr EC50 semi- static	26.0
Sheepshead minnow	Acute	96 hr EC50 static	24.3
Rainbow trout	Chronic	28-d NOEC	3.3
AMPHIBIAN (aquatic phase)			mg/L
Bufo bufo (toad)	Acute	24-h LC50	11
VERTEBRATES (terrestrial)			mg/kg
Rat	Acute Oral[1]	LD50	1954 (male) 1336 (female)
Mouse	Acute Oral	LD50	490 (male) 1219 (female)
Guinea Pig	Acute Oral	LD50	542 (male) 400-640 (female)

Species	Toxicity	Endpoint	Values
Rabbit	Acute Oral	LD50	835 (male) 937 (female)
BEES			µg/bee
Honey bee *(Apis mellifera)*	Acute	48-hr LD50	>40 (contact) >2 (oral)
EARTHWORMS			mg/kg soil
Eisenia foetida	Acute	14-d LC50	>1000
AQUATIC PLANTS			mg/L
Green algae	Growth	96-h E_bC50 96-h E_rC50	7.2 15.2
Blue-green algae	Growth	96-h E_bC50 96-h E_rC50	>23.2 >23.2
Duck weed	Growth	7-d E_bC50 7-d E_rC50	0.0082 0.0283

[1] Exposed by a single oral dose

[2] Exposed by diets containing PBZ for 5 d

[3] Exposed by diets containing PBZ for 21 wks

Appendix 4

GENEEC Surface Water Model Input and Output:

```
RUN No.**** FOR Paclobutrazol  ON  Trees     * INPUT VALUES *
  ---------------------------------------------------------------------
  RATE (#/AC)  No.APPS &  SOIL SOLUBIL  APPL TYPE NO-SPRAY INCORP
  ONE(MULT)  INTERVAL   Kd  (PPM )  (%DRIFT)  ZONE(FT) (IN)
  ---------------------------------------------------------------------
 3.000( 3.000)  1  1    2.7  26.0  GRANUL(  .0)  .0  6.0


  FIELD AND STANDARD POND HALFLIFE VALUES (DAYS)
  ---------------------------------------------------------------------
  METABOLIC DAYS UNTIL HYDROLYSIS  PHOTOLYSIS  METABOLIC COMBINED
  (FIELD)  RAIN/RUNOFF  (POND)   (POND-EFF)  (POND)   (POND)
  ---------------------------------------------------------------------
  437.00    2     N/A  365.00-45260.00  164.00  163.41


  GENERIC EECs (IN MICROGRAMS/LITER (PPB))   Version 2.0 Aug 1, 2001
  ---------------------------------------------------------------------
    PEAK   MAX 4 DAY   MAX 21 DAY  MAX 60 DAY  MAX 90 DAY
    GEEC   AVG GEEC    AVG GEEC   AVG GEEC   AVG GEEC
  ---------------------------------------------------------------------
    19.98    19.88     19.34     18.17     17.35
  ---------------------------------------------------------------------
```

Appendix 5

SCI_GROW model input and output for Paclobutrazol:

```
             SCIGROW
            VERSION 2.3
     ENVIRONMENTAL FATE AND EFFECTS DIVISION
        OFFICE OF PESTICIDE PROGRAMS
      U.S. ENVIRONMENTAL PROTECTION AGENCY
           SCREENING MODEL
       FOR AQUATIC PESTICIDE EXPOSURE

SciGrow version 2.3
chemical:Paclobutrazol
time is 6/13/2011 16:34:39
-------------------------------------------------------------------------
Application   Number of    Total Use  Koc   Soil Aerobic
rate (lb/acre) applications  (lb/acre/yr) (ml/g)  metabolism (days)
-------------------------------------------------------------------------
  3.000      1.0      3.000   1.06E+02   285.0
-------------------------------------------------------------------------
groundwater screening cond (ppb) =  1.43E+01
*************************************************************************
```

Appendix 6

Estimation of Paclobutrazol concentration in soil band around tree trunk:

Assumptions:

- Diameter of trunk at breast height of 50 inches
- Mass of applied PBZ is 202.5 g (calculated from information on Cambistat Label)
  (833 ml product x 1.09 g/ml x 22.3 % PBZ = 202.5 g PBZ)
- Diameter trunk at ground level is 60 inches
- Soil band treated begins 2 inches from trunk resulting in an inside diameter of soil band of 64 inches
- A 1-foot wide band will initially be exposed to product: Outside diameter of band is 76 inches
- Treatment reaches initially a depth of 1 ft
- Dry bulk density of soil to be 1.3 g/ml

Conversions:	Inside diameter:	64 inches =	162.56	cm
	Outside diameter:	76 inches =	193.04	cm
	Depth	12 inches =	30.48	cm

Calculations:

Area of treated soil band: Calculated by subtracting the areas of the circles with outside and inside diameters:

	Outside diameter:	Inside diameter:		
Circle areas (cm^2):				
(πR^2)	117069.7	83018.95		
Difference between circle areas is band area:			34050.74	cm^2
Volume of treated soil band: (area x depth):			1037867	cm^3
Mass of dry soil is volume x bulk density:			1349227	g
			1349.227	kg
Mass of applied PBZ in band area of soil:			202.5	g
Concentration of PBZ in soil (mg/kg or ppm)			150.086	ppm