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Chlorpyrifos Summary Document Registration Review: Initial Docket March 2009

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Case # 0100

Approved by:

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Date: 3/12/09

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Please Note

This Preliminary Work Plan (PWP) and Fact Sheet summarize the Environmental Protection Agency's current position based on the following supporting documents:

1 Registration Review – Preliminary Problem Formulation for the Ecological Risk and Environmental Fate, Endangered Species, and Drinking Water Assessments for Chlorpyrifos (PC Code 059101; DP Barcode D355212). November 25, 2008.

2 Chlorpyrifos. Human Health Assessment Scoping Document in Support of Registration Review. February 9, 2009.

3 Chlorpyrifos 059101 Screening Level Usage Analysis (SLUA). February 7, 2008.

4 Appendix A: Food/Feed and Non-food/Non-feed Uses Considered in Registration Review Work Planning for Chlorpyrifos (059101) Case No. 0100. May 16, 2008.

5 Updated Review of Chlorpyrifos Incidents Reports. October 15, 2008.

Additional supporting documents for chlorpyrifos may be found in the docket, EPA-HQ-OPP-2008-0850, at www.regulations.gov.

I. Preliminary Work Plan—Chlorpyrifos

Introduction

The Food Quality Protection Act (FQPA) of 1996 mandated the registration review program. All pesticides distributed or sold in the United States generally must be registered by the U.S. Environmental Protection Agency (EPA or the Agency), based on scientific data showing that they will not cause unreasonable risks to human health (including occupational and non-occupational exposures) or the environment when used as directed on product labeling. The registration review program is intended to make sure that, as the ability to assess risk evolves and as policies and practices change, all registered pesticides continue to meet the statutory standard of no unreasonable adverse effects. Changes in science, public policy, and pesticide use practices will occur over time. Through the registration review program, the Agency periodically reevaluates pesticides to make sure that as change occurs, products in the marketplace can be used safely. Information on this program is provided at www.epa.gov/oppsrrd1/registration_review/.

The Agency is implementing the registration review program pursuant to FIFRA Section 3(g) and will review each registered pesticide every 15 years to determine whether it continues to meet the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) standard for registration. Where assessments indicate risks above the Agency's level of concern, the Agency will consider benefits information and data as required by FIFRA. The public phase of registration review begins when the initial docket is opened for each case. The docket is the Agency's opportunity to state what it knows about the pesticide and what additional risk analyses and data it believes are needed to make a registration review decision. After reviewing and responding to comments and data received during this initial comment period, the Agency will develop and commit to a final work plan and schedule for the registration review of chlorpyrifos.

Chlorpyrifos (case # 0100) is an organophosphate (OP) insecticide, acaricide, and miticide used to control a variety of insects. It was first registered in 1965 for control of foliage and soil-borne insect pests on a variety of food and feed crops. Currently, registered uses include food and feed crops, golf course turf, greenhouses, non-structural wood treatments (such as utility poles and fence posts), ant bait stations, and as an adult mosquitocide. Chlorpyrifos acts through inhibition of acetylcholinesterase. Chlorpyrifos has been the subject of a petition by the Natural Resources Defense Council (NRDC) and Pesticide Action Network of North America (PANNA) to revoke all chlorpyrifos tolerances and cancel all chlorpyrifos registrations. The Agency will address the issues raised in the petition during registration review. For further details on the petition, please see the section of the fact sheet titled "Recent Actions."

Chlorpyrifos-methyl (case # 0100) shares the same registration review case number as chlorpyrifos and is scheduled to begin in registration review in 2011. Chlorpyrifos-methyl is a general use OP insecticide registered in 1985 for use on stored grains.

Anticipated Risk Assessment and Data Needs

The Agency anticipates that comprehensive human health and ecological risk assessments will be needed for chlorpyrifos. The ecological risk assessment will include

an endangered species assessment for chlorpyrifos. Additional data that the Agency anticipates needing to complete these assessments are specified below.

Environmental fate and ecological risk:

- The most recent ecological risk assessment was completed in October 1999, and later revised in March and June 2000, in support of the 2002 Interim Reregistration Eligibility Decision (IRED) and 2006 final Reregistration Eligibility Decision (RED) for chlorpyrifos.

- The primary environmental concerns identified in the 1999 and 2000 ecological risk assessments were acute and chronic risks to birds, mammals, terrestrial invertebrates, fish, and aquatic invertebrates.

- Acute toxicity data suggest that the major degradation product of chlorpyrifos, 3,5,6-trichloro-2-pyridinol (TCP), is no more toxic to birds, mammals, and freshwater and estuarine/marine fish and invertebrates than chlorpyrifos. As a result, exposure to TCP will not be included in the ecological risk assessment.

- Chlopyrifos-oxon, a minor degradate of chlorpyrifos, was not considered in the 1999 and 2000 ecological risk assessments. However, preliminary review of toxicity test data indicates that chlorpyrifos-oxon may be more toxic than the parent compound, chlorpyrifos. Additional aquatic and terrestrial toxicity data for the chlorpyrifos-oxon are expected to be required to reduce the uncertainty in the ecological risk assessment.

- Currently, no terrestrial plant toxicity data are available to assess the potential risk of chlorpyrifos to terrestrial plants, even though phytotoxic effects (i.e., plant kills) have been demonstrated in the field. Non-target phytotoxicity studies with chlorpyrifos are expected to be required to assess the effect of the chemical on terrestrial plants.

- The Agency is initiating development of an endangered species assessment evaluating the potential effects of chlorpyrifos on several species consistent with court orders and settlements *(Center for Biological Diversity v. Johnson, et al.*, No. 02-1580 (N.D. Cal., October 20, 2006) [addressing the California red-legged frog (CRLF)] (see: http://www.epa.gov/oppfead1/endanger/litstatus/effects/redleg-frog/index.html). The Agency will consider any prudent measures or risk assessment considerations that may be included in the Services' future responses to the Agency's requests for consultation.

- The Agency has completed endangered species assessments evaluating the potential effects of chlorpyrifos on several species, which were part of court orders and litigation settlements *(Washington Toxics Coalition, et al. v. EPA,* No. C01-132C (W.D. Wash., July 2, 2002) [addressing 26 Pacific salmonid Evolutionarily Significant Units (ESUs)] (see: http://www.epa.gov/oppfead1/endanger/litstatus/effects/#chlorpyrifos). On November 18, 2008, the National Marine Fisheries Service (NMFS) issued their biological opinion, which finds use of chlorpyrifos will result in jeopardy to 27 Evolutionarily Significant Units (ESUs) and is likely to adversely affect but not jeopardize, 1 ESU. The opinion further finds that use of chlorpyrifos will adversely

modify designated critical habitat of all but 1 ESU (see: http://www.nmfs.noaa.gov/pr/pdfs/pesticide_biop.pdf). The Agency is currently evaluating how it will respond to the biological opinion and notes that action may need to be taken prior to completion of registration review.

- While the environmental fate database for chlorpyrifos is largely complete and there are numerous data available to characterize the effects of chlorpyrifos on aquatic and terrestrial organisms, additional data are needed for the chlorpyrifos-oxon to allow the Agency to assess potential risks from exposure to this degradate. The Agency anticipates needing the following data on environmental fate and effects to conduct a complete ecological risk assessment for chlorpyrifos, including an endangered species assessment:

  - GLN: 850.4100 Anaerobic Soil Metabolism (Chlorpyrifos Oxon)
  - GLN: 850.1230 Adsorption/Desorption (Batch Equilibrium) (Chlorpyrifos Oxon)
  - GLN: 850.1075 Fish Acute Toxicity Test, Freshwater (Chlorpyrifos Oxon)
  - GLN: 850.1010 Freshwater Invertebrate Acute Toxicity Test (Chlorpyrifos Oxon)
  - GLN: 850.2100 Avian Acute Oral Toxicity Test (Chlorpyrifos Oxon)
  - GLN: 850.2200 Avian Acute Dietary Toxicity Test (Chlorpyrifos Oxon)
  - GLN: 850.8100 Field Volatility (Chlorpyrifos and Chlorpyrifos Oxon)
  - GLN: 835.2370 Photodegradation in Air (Chlorpyrifos)
  - GLNs: 850.4100 and 850.4150 Non-target Area Phytotoxicity (Tier 1) Seedling Emergence and Vegetative Vigor (Chlorpyrifos Typical End-use Product)

- The Agency has not conducted a risk assessment that supports a complete endangered species determination. The ecological risk assessment planned during registration review will allow the Agency to determine whether chlorpyrifos' use has "no effect" or "may affect" federally listed threatened or endangered species (listed species) or their designated critical habitats. When an assessment concludes that a pesticide's use "may affect" a listed species or its designated critical habitat, the Agency will consult with the U.S. Fish and Wildlife Service and/or National Marine Fisheries Service (the Services), as appropriate.

- For additional information regarding the ecological effects of chlorpyrifos, please refer to the *Registration Review – Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered Species, and Drinking Water Assessments for Chlorpyrifos*, which may be found in the docket (EPA-HQ-OPP-2008-0850) at www.regulations.gov.

Human Health Risk:

- The most recent human health risk assessment for chlorpyrifos was conducted in June 2000 to support both the 2002 IRED and 2006 final RED for the chemical.

- In June 2000, when the Agency released its human health risk assessment, it entered into an agreement with the technical registrants to eliminate and phase out certain uses of chlorpyrifos to address food, drinking water, residential, and non-

residential uses posing the greatest risks to children. The 2002 IRED also specified a number of mitigation measures to address worker risks and ecological risks, including a combination of reduced application rates and seasonal maximum limits, increased retreatment intervals, increased personal protection equipment (PPE) and/or use of engineering control requirements, and increased re-entry intervals for a number of crops. Current labels reflect these measures.

- The Agency is updating the hazard identification and hazard characterization for chlorpyrifos, in part, by evaluating the substantial amount of research on the human health effects of chlorpyrifos that has been developed over the last decade. The Agency is particularly focusing on studies that evaluate the effects of chlorpyrifos on infants and children from *in utero* and/or post-natal exposures and on studies that evaluate population variability with respect to response to chlorpyrifos.

- The Agency has sought comments from a FIFRA Science Advisory Panel (SAP) meeting held September 16-18, 2008 on the following issues: 1) interpretation of recent epidemiological studies associating *in utero* and/or post-natal chlorpyrifos exposure with health outcomes; 2) aspects of chlorpyrifos metabolism, such as differences in paraoxonase 1 (PON 1) expression and activity, which affects population variability with respect to the effects of chlorpyrifos and its oxon metabolite; 3) cholinergic and non-cholinergic modes/mechanisms of toxicity relevant to evaluating hazard and risk to infants and children, and 4) review of the proposed regulatory endpoints for chlorpyrifos. As part of this review, the Agency is evaluating the relevance of animal studies conducted by different routes of administration (e.g., gavage or subcutaneous injection) for conducting human health risk assessment to different age groups and by different exposure pathways. Under registration review, the Agency will consider the recommendations of the SAP (http://www.epa.gov/scipoly/SAP/meetings/2008/091608_mtg.htm), which were submitted in December 2008 and are currently under review, and will decide, where appropriate, how to incorporate those recommendations in future chlorpyrifos risk assessments. The Agency plans to update the acute toxicity endpoint and revisit the chronic toxicity endpoint based on SAP recommendations. In addition, the Agency will consider comments provided by SAP in its reevaluation of the FQPA safety factor.

- During its review, the SAP identified a calculation error in the short-term inhalation toxicity endpoint for chlorpyrifos, which the Agency will account for in future human health risk assessments.

Dietary Risk (Food and Water):

- The Agency plans to update the dietary risk assessments to incorporate the revised acute toxicity endpoint and any other changes based on the SAP recommendations. The most recent Pesticide Data Program (PDP) monitoring data and percent crop treated information will be used, where applicable.
- Several residue chemistry data gaps were identified in the 2000 risk assessment. As a result of a 2003 data call-in, new crop field trial studies for cotton gin byproducts; tart cherries; sweet potatoes; grass forage and hay; and aspirated grain fractions for soybean, wheat, and sorghum have been submitted. While the results of these residue studies are not expected to have a significant impact on the current dietary

risk assessment, if the tolerances for livestock commodities are increased because of higher residues on feedstuffs, the dietary exposure assessments may be revised to reflect this, and dietary risk estimates could be expected to be higher than those presented in the 2002 IRED.

- During registration review, the Agency will revise the drinking water assessment for chlorpyrifos to consider new environmental fate and monitoring data. The assessment will include analysis of estimated water concentrations of chlorpyrifos as well as its metabolites, chlorpyrifos-oxon and TCP. While the 2000 risk assessment had included chlorpyrifos and TCP, chlorpyrifos-oxon was not included. Chlorpyrifos-oxon has been detected in environmental samples, including drinking water, surface water, and precipitation.

Residential Risk:

- In June 2000, the Agency entered into an agreement with the technical registrants to eliminate all homeowner uses of chlorpyrifos, with the exception of ant and roach baits in child-resistant packaging and all residential/recreational uses of chlorpyrifos with the exception of use as a ground-based fogger adult mosquitocide (when applied by a public agency) and for golf course turf applications, when applied at a reduced rate. Currently, these are the only uses of chlorpyrifos that remain that could factor into a residential risk assessment.

Aggregate Risk:

- Aggregate risk assessments combine dietary exposures from both food and drinking water and from non-occupational exposures. There are no longer any residential uses of chlorpyrifos that would result in non-occupational exposure, with the exception of golf course turf use and possibly mosquitocide use.
- An acute aggregate assessment is anticipated for chlorpyrifos using a revised acute oral toxicity endpoint. Consistent with the recommendation of the SAP, the Agency intends to derive a new toxicity endpoint from a benchmark dose (BMD) analysis. Similarly, if the chronic toxicity endpoint is revised after consideration of the SAP recommendations, the chronic and short-term aggregate will be revised to incorporate those toxicity endpoints, as well as any uncertainty factors.
- EPA will revise the aggregate risk assessments, as needed, by the inclusion of the metabolite chlorpyrifos-oxon in water estimates or by increased tolerances for livestock commodities or other raw agricultural commodities. Any aggregate assessments will use appropriate modeling, such as the Dietary Exposure Estimate Model (DEEM) modeling for estimating combined risks from food and water exposures. Food residues from recent monitoring data and field trials and new percent crop-treated information, where available, will be incorporated directly into the model along with any water residue estimates. Short-term aggregate assessments will include post-application (non-occupational) exposures to treated golf courses. The Agency will evaluate the need to assess potential post-application exposures from mosquitocide use.
- The Agency has not included in its previous aggregate assessments potential exposures to chlorpyrifos in air as a result of spray drift and/or volatilization. The Agency is developing methodology for these types of assessments and anticipates presenting draft methodology to the SAP in late 2009.

Occupational Risk:

- Per the 2000 *Agricultural and Occupational Exposure Assessment and Recommendations for the Reregistration Eligibility Decision Document for Chlorpyrifos*, the Agency identified exposure estimates of concern for occupational handler scenarios including mixing/loading liquids for aerial/chemigation and groundboom application, mixing wettable powder for groundboom application, aerial application, and application by backpack sprayer, high-pressure handwand, and hand-held sprayer or duster.

- Under registration review, an updated occupational assessment (handler and post-application) and updated benefits assessment will be necessary to incorporate any relevant exposure data submitted to the Agency as required in the response to the data call-in that was included in the 2006 chlorpyrifos RED as well as any changes to the toxicological endpoints and/or uncertainty factors. It is possible that upcoming policy revisions such as anticipated changes in unit exposure estimates or inputs for occupational handler scenarios will also necessitate revision of elements of the current exposure assessment [e.g., different unit exposure values for mixing/loading liquid formulations or the amount (pounds) of seed treated per day]. No new occupational exposure data gaps were identified during the registration review scoping process.

Data Needs:

- At the time of the 2000 human health risk assessment, the toxicity and exposure databases were considered substantially complete for purposes of supporting chlorpyrifos human health assessments. At this time, the only new toxicological data anticipated as being needed to support the registration review of chlorpyrifos are:

    - GLN: 870.7800 Immunotoxicology Study (Chlorpyrifos)
    - Acute and Repeated Comparative Cholinesterase Assay (CCA), with the acute and repeated exposures should be administered to post-natal day 11 (PND 11) rats and young adults. (Chlorpyrifos and Chlorpyrifos Oxon).

- CCA studies are anticipated for chlorpyrifos and the chlorpyrifos-oxon. The CCA for the oxon is necessary because there is a concern that humans may be directly exposed to chlorpyrifos-oxon through drinking water. (The oxon has also been found in air near agricultural fields.) As a degradate of chlorpyrifos, chlorpyrifos-oxon retains the cholinesterase inhibiting moiety and is known to be more potent as an inhibitor of cholinesterase than the parent chlorpyrifos. The CCA study would provide information on the cholinesterase-inhibiting activity of the oxon as well as whether juvenile animals are more susceptible to the toxicity of chlorpyrifos and its oxon than adult animals.

- For additional information regarding the human health effects of chlorpyrifos, please refer to *Chlorpyrifos. Revised Human Health Assessment Scoping Document in Support of Registration Review*, which may be found in the docket (EPA-HQ-OPP-2008-0850) at www.regulations.gov.

Additional Data Needs:

A UV/Visible Absorption (OPPTS GLN 830.7050) study is anticipated to be required for chlorpyrifos, based on the revised 40 CFR Part 158 Toxicology Data Requirements.

Timeline

During registration review, the Agency also will address the issues raised in the NRDC and PANNA petition to revoke all chlorpyrifos tolerances and cancel all chlorpyrifos registrations. As the Agency proceeds with registration review, it will consider whether to issue interim registration review determinations that address specific areas of risk. As required by FIFRA, the Agency also will consider benefits information and data in its decision where assessments indicate risks of concern. EPA has created the following estimated timeline for completion of the chlorpyrifos registration review. Registration review for chlorpyrifos-methyl, which shares the same registration review case number as chlorpyrifos, is scheduled to begin in 2011.

Table 1. Projected Chlorpyrifos Registration Review Timeline

Activities	Estimated Year and Month
Phase 1: Opening the Docket	
Open Public Comment Period	2009 March
Close Public Comment Period	2009 May
Phase 2: Case Development	
Develop Final Work Plan (FWP)	2009 August
Issue Data Call-In (DCI)	2010 April-June
Open Public Comment Period for Human Health Risk Assessment	2010 July -Sept
Close Public Comment Period for Human Health Risk Assessment	2010 Oct-Dec
Data Submission	2012 April-June
Open Public Comment Period for Ecological Risk Assessment, which will include an Endangered Species Assessment	2013 Oct-Dec
Close Public Comment Period for Ecological Risk Assessment	2014 Jan-March
Phase 3: Registration Review Decision	
Open Public Comment Period for Proposed Final Reg. Review Decision	2014 April-June
Close Public Comment Period for Final Reg. Review Decision	2014 July-Sept
Final Decision and Begin Post-Decision Follow-up	2015
Total (years)	6

Guidance for Commenters

The public is invited to comment on EPA's preliminary registration review work plan and rationale. The Agency will carefully consider all comments as well as any additional information or data provided in a timely manner prior to issuing a final work plan for the chlorpyrifos registration review case.

Through the registration review process, the Agency intends to solicit information on trade irritants and, to the extent feasible, take steps toward facilitating irritant resolution. Growers and other stakeholders are asked to comment on any trade irritant issues resulting from lack of Maximum Residue Limits (MRLs) or disparities between U.S. tolerances and

MRLs in key export markets, providing as much specificity as possible regarding the nature of the concern.

Chlorpyrifos has been identified as a cause of impairment for water bodies listed as impaired under section 303(d) of the Clean Water Act, based on information provided at http://oaspub.epa.gov/tmdl/waters_list.impairments?p_impid=3. The Agency invites submission of any other existing water quality data for this pesticide. To the extent possible, data should conform to the quality standards in Appendix A of the *OPP Standard Operating Procedure: Inclusion of Impaired Water Body and Other Water Quality Data in OPP's Registration Review Risk Assessment and Management Process* (see: http://www.epa.gov/pesticides/ppdc/2006/november06/session1-sop.pdf) in order to ensure they can be used quantitatively or qualitatively in pesticide risk assessments.

EPA seeks to achieve environmental justice, the fair treatment and meaningful involvement of all people, regardless of race, color, national origin, or income, in the development, implementation, and enforcement of environmental laws, regulations, and policies. To help address potential environmental justice issues, the Agency seeks information on any groups or segments of the population who, as a result of their location, cultural practices, or other factors, may have atypical, unusually high exposure to chlorpyrifos compared to the general population. Please comment if you are aware of any sub-populations that may have atypical or unusually high exposure compared to the general population.

Stakeholders are also specifically asked to provide information that will assist the Agency in refining the ecological risk assessment, including any species-specific effects determinations. The Agency is interested in obtaining the following information regarding the use of chlorpyrifos, for individual use sites as appropriate:

1. Confirmation of the following label information/directions for use:
    a. Sites of application
    b. Formulations
    c. Maximum application rates
    d. Frequency of application
    e. Application intervals
    f. Maximum number of applications per year (or season, as appropriate)
    g. Geographic limitations on use
    h. Application methods and equipment
2. Potential use distribution (e.g., acreage and geographical distribution of relevant crops)
3. Use history
4. Median and 90th percentile reported use rates (lbs ai/acre) (national, state, county)
5. Application timing (date of first application, intervals) (national, state, county)
6. Sub-county crop location data
7. Is the product used by/intended to be used by homeowners and or on residential sites? Is it used by, or intended to be solely used by occupational users/professional applicators, or in the case of ornamentals, in commercial production only?
8. Usage/use information for agricultural and non-agricultural sites:
    a. Directly acquired county-level usage data (not derived from state level data)
    b. Maximum reported use rate (lbs ai/acre) from usage data – county
    c. Percent crop treated – county
    d. Median and 90th percentile number of applications – county
    e. Total pounds per year – county

f. Year the pesticide was last used in the county/sub-county area
g. Years the pesticide was applied in the county/sub-county area
h. Typical retreatment interval

9. State or local use restrictions
10. Human, domestic animal, or ecological incidents (non-target species) not already reported to the Agency
11. Monitoring data (e.g., air, water)

Next Steps

After the 60-day public comment period closes, the Agency will review and respond to any comments received in a timely manner, and then issue a final work plan for this pesticide.

II. FACT SHEET: Chlorpyrifos Registration Review

Background Information for Chlorpyrifos

- Registration review case number: 0100
- Pesticide Chemical (PC) Code: 059101
- Chemical Abstracts Service (CAS) number: 2921-88-2
- Chlorpyrifos was first registered in the United States in 1965.
- A total of 22 companies hold end-use product registrations for chlorpyrifos. The following five companies: Cheminova A/S, Drexel Chemical Company, Gharda Chemicals LTD, Makhteshim Chemical Works Ltd, and Dow Agro-Sciences LLC, hold registrations for technical-grade products.
- Currently, there are a total of 8 technical products and 73 end use products. In addition, there are 74 Special Local Need (SLN) FIFRA 24(c) registrations.

Contact information

- Special Review and Reregistration Division: Karen Santora; santora.karen@epa.gov.
- Registration Division: Akiva Abramovitch; abramovitch.akiva@epa.gov.

Use & Usage Information

- Chlorpyrifos is an organophosphate insecticide, acaricide, and miticide used to control a variety of insects. Currently, registered uses include food and feed crops, golf course turf, greenhouses, non-structural wood treatments (such as utility poles and fence posts), ant bait stations, and as an adult mosquitocide.

- Based on usage data, approximately 8 million pounds of chlorpyrifos were applied to about 180 million acres of agricultural crops in the U.S. annually between 2000 and 2006.

- The Agency's Screening Level Usage Assessment (SLUA) reports that approximately 3,000,000 lbs ai/year is used on corn; use on soybeans is approximately 700,000 lbs ai/year; approximately 500,000 lbs ai/year is used on almonds; and use on alfalfa, apples, and walnuts is approximately 400,000 lbs ai/year in each crop.

- Chlorpyrifos products are formulated as liquids, granulars, and flowable concentrates. Chlorpyrifos may be applied as a spray (both ground and aerial) or as a granular insecticide for agricultural and non-agricultural uses. While foliar applications may be used, chlorpyrifos is most often applied directly to soil and incorporated to a depth of between 0.5 to 4.0 inches prior to planting.

- For additional details on label rates and allowed uses, please refer to the *Chlorpyrifos 059101 Screening Level Usage Analysis (SLUA)* in the registration review docket (EPA-HQ-OPP-2008-0850) at www.regulations.gov.

Recent Actions

- In July 2007, the United Farm Workers filed a lawsuit against the Agency claiming, among others things, that EPA: (1) violated FIFRA by reregistering chlorpyrifos uses that pose risks of concern to workers without balancing risks and benefits, and (2) lacked sufficient data to find that chlorpyrifos will not pose unreasonable risk. The plaintiffs are seeking an order requiring EPA to make a new reregistration eligibility decision expeditiously. Parties have agreed to a stay in this matter pending the 9th Circuit Court of Appeals' review of the dismissal of *UFW v. EPA* (AZM). The Agency intends to address the issues raised in the lawsuit during registration review.

- In September 2007, the Natural Resources Defense Council (NRDC) and Pesticide Action Network of North America (PANNA) petitioned the Agency to revoke all tolerances and cancel all registrations. As part of their petition, NRDC and PANNA claim that the Agency did not consider the full spectrum of potential health effects associated with chlorpyrifos in connection with EPA's reassessment of the existing tolerances, including: 1) evidence showing the potential for a greater than 10-fold difference in susceptibility to chlorpyrifos across human populations and, in particular, evidence of greater susceptibility in early life stages than EPA estimated, 2) the endocrine disrupting effects of the chemical, and 3) evidence of cancer risk data as indicated from a National Institutes of Health study. The petition further asserts that EPA's evaluation of chlorpyrifos in the organophosphate cumulative risk assessment misrepresented the risks of chlorpyrifos and that EPA failed to incorporate inhalation routes of exposure to chlorpyrifos in conducting its assessment. For additional information relating to the petition, please visit the docket (EPA-HQ-OPP-2008-0850) at www.regulations.gov. The Agency is reviewing the petition and intends to address the issues raised in the petition during registration review.

- In September 2008, the Agency held a Scientific Advisory Panel (SAP) to discuss several scientific issues associated with the Agency's evaluation of the toxicity profile for chlorpyrifos, including 1) interpretation of recent epidemiological studies associating *in utero* and/or post-natal chlorpyrifos exposure with health outcomes; 2) aspects of chlorpyrifos metabolism, such as differences in PON 1 expression and activity, which affects population variability with respect to the effects of chlorpyrifos and its oxon metabolite; 3) cholinergic and non-cholinergic modes/mechanisms of toxicity relevant to evaluating hazard and risk to infants and children, and 4) review of the proposed regulatory endpoints for chlorpyrifos. Certain issues that were raised in the NRDC and PANNA petition were submitted to the Agency's Scientific Advisory Panel (SAP) for review and discussion. The Agency is currently analyzing the SAP recommendations, which were submitted in December 2008.

- The Developmental and Reproductive Toxicant Identification Committee (DARTIC) of the California EPA Office of Environmental Health Hazard Assessment (OEHHA) scheduled a public meeting on November 20, 2008 in Sacramento, CA, to consider chlorpyrifos (and other substances) for listing under Proposition 65 as being known to the State of California to cause developmental and reproductive toxicity. At the meeting, DARTIC determined that chlorpyrifos had not been clearly shown to cause reproductive toxicity and, therefore, the

DARTIC did not add chlorpyrifos to the Proposition 65 chemical list (http://www.oehha.ca.gov/prop65/public_meetings/dart112008.html).

- On November 18, 2008, the National Marine Fisheries Service (NMFS) issued their biological opinion, which finds use of chlorpyrifos will result in jeopardy to 27 Evolutionarily Significant Units (ESUs) and is likely to adversely affect but not jeopardize, 1 ESU. The opinion further finds that use of chlorpyrifos will adversely modify designated critical habitat of all but 1 ESU (see: http://www.nmfs.noaa.gov/pr/pdfs/pesticide_biop.pdf). The biological opinion further indicates that continued use of chlorpyrifos for 12 months while EPA determines how to implement the biological opinion, will not result in jeopardy to these species. The Agency is currently evaluating how it will respond to the biological opinion and notes that action may need to be taken prior to completion of registration review.

Ecological Risk Assessment Status

The following is a summary of key findings of the most recent chlorpyrifos ecological risk assessments conducted in support of the RED. Please refer to *Registration Review – Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered Species, and Drinking Water Assessments for Chlorpyrifos*, located in the chlorpyrifos registration review docket (EPA-HQ-2008-0850) at www.regulation.gov, for a detailed discussion of the ecological risk assessment.

- The primary environmental concerns identified in the most recent chlorpyrifos environmental fate and ecological risk assessments were acute and chronic risks to birds, mammals, terrestrial invertebrates, fish, and aquatic invertebrates.

- The previous ecological risk assessments considered the parent chemical as well as the major degradation product of chlorpyrifos, 3,5,6-trichloro-2-pyridinol (TCP), but not chlorpyrifos-oxon, a minor degradate of chlorpyrifos. Acute toxicity data for birds, mammals, and freshwater and estuarine/marine fish and invertebrates suggest that the major degradation product of chlorpyrifos, TCP, is no more toxic than chlorpyrifos. Preliminary review of toxicity test data indicates that chlorpyrifos-oxon may be more toxic than the parent compound, chlorpyrifos.

- To mitigate ecological risks identified in the ecological assessment, the registrants agreed to label amendments that included: the use of buffer zones to protect water quality, fish, and wildlife; reductions in application rates and the number of applications per season; limitations on seasonal maximum amounts applied; and increases in the minimum intervals for retreatment. In addition, the residential uses of chlorpyrifos were eliminated, the termiticide use was phased out, and the application rate on golf courses was reduced from 4 to 1 lb/ai/A.

- The Agency is initiating development of an endangered species assessment evaluating the potential effects of chlorpyrifos on several species consistent with court orders and settlements *(Center for Biological Diversity v. Johnson, et al.*, No. 02-1580 (N.D. Cal., October 20, 2006) [addressing the California red-legged frog (CRLF)] (see: http://www.epa.gov/oppfead1/endanger/litstatus/effects/redleg-frog/index.html). The Agency will consider any prudent measures or risk

assessment consideration that may be included in the Services' future responses to the Agency's requests for consultation.

- The Agency has completed endangered species assessments evaluating the potential effects of chlorpyrifos on several species, which were part of court orders and litigation settlements *(Washington Toxics Coalition, et al. v. EPA,* No. C01-132C (W.D. Wash., July 2, 2002) [addressing 26 Pacific salmonid Evolutionarily Significant Units (ESUs)] (see: http://www.epa.gov/oppfead1/endanger/litstatus/effects/#chlorpyrifos). On November 18, 2008, the National Marine Fisheries Service (NMFS) issued their biological opinion, which finds use of chlorpyrifos will result in jeopardy to 27 Evolutionarily Significant Units (ESUs) and is likely to adversely affect but not jeopardize, 1 ESU. The opinion further finds that use of chlorpyrifos will adversely modify designated critical habitat of all but 1 ESU (see: http://www.nmfs.noaa.gov/pr/pdfs/pesticide_biop.pdf). The Agency is currently evaluating how it will respond to the biological opinion and notes that action may need to be taken prior to completion of registration review.

Human Health Risk Assessment Status

The following is a summary of key findings from the most recent chlorpyrifos human health risk assessments conducted in support of the RED. Please refer to the *Chlorpyrifos. Revised Human Health Assessment Scoping Document in Support of Registration Review*, which may be found in the docket (EPA-HQ-OPP-2008-0850) at www.regulations.gov, for a detailed discussion of the human health risk assessment.

- Chlorpyrifos risk assessments rely, in part, on data from studies in which adult human subjects were intentionally exposed to a pesticide or other chemical. These studies, which comprise the Pesticide Handler Exposure Database (PHED) and the Outdoor Residential Exposure Task Force studies have been reviewed by the Agency and found, on the basis of available evidence, to have been neither fundamentally unethical nor significantly deficient relative to standards of ethical research conduct prevailing when they were conducted. There is no barrier in EPA's "Protection of Human Subjects" regulation to reliance on these studies.

Dietary Risk (Food and Water):

- Although the Agency's preliminary human health risk assessment for chlorpyrifos indicated acute dietary risk concerns, with implementation of the June 2000 mitigation agreement (i.e., reduction of apple and grape tolerances and deletion of the use on tomatoes), dietary risks from food were mitigated. With these mitigation measures, (1) the acute dietary risk estimates range from 4.1% to 82% of the population adjusted dose and (2) the chronic dietary risk estimate occupies 51% of the population adjusted does. In both cases children (1-6 years) are the highest exposed population.
- EPA considered both acute and chronic drinking water risks for chlorpyrifos and used both conservative modeling and actual monitoring data to estimate the environmental concentration of chlorpyrifos in groundwater- and surface water-based drinking water. The 2000 risk assessment indicated that, based on estimated environmental concentrations of chlorpyrifos in surface water and groundwater, acute and chronic exposures are not of concern. The 2000 risk assessment included

chlorpyrifos and TCP but not the chlorpyrifos-oxon. While the Agency had concerns about exposure to chlorpyrifos in drinking water associated with termiticide use, because termiticide use was phased out in December 2005, these exposures were not included in the drinking water dietary risk assessment.

- As part of the organophosphate cumulative risk assessment, a chlorination study for chlorpyrifos was completed.

Residential Risk:

- A residential risk assessment for registered homeowner uses was performed in 2000. The risk estimates of concern resulted in the Agency entering into an agreement with the registrants to eliminate all homeowner uses of chlorpyrifos, with the exception of ant and roach baits in child-resistant packaging. The distribution and sale of products for all other residential uses were prohibited after December 31, 2001. In addition, a phase-out schedule was developed for termite treatment products, with the elimination of all uses, both pre- and post-construction, on December 31, 2005. Uses remain for ground-based fogger adult mosquitocide (when applied by a public agency) and for golf course turf applications, when applied at a reduced rate.

Aggregate Risk:

- Aggregate risk assessments combine dietary exposures from both food and drinking water and from non-occupational exposures. There are no longer any residential uses of chlorpyrifos that would result in non-occupational exposure, with the exception of golf course turf use and possibly mosquitocide use.

Occupational Risk:

- Per the *Agricultural and Occupational Exposure Assessment and Recommendations for the Reregistration Eligibility Decision Document for Chlorpyrifos* completed in 2000, the Agency identified exposure estimates of concern (MOEs < 100) for occupational handler scenarios including mixing/loading liquids for aerial/chemigation and groundboom application, mixing wettable powder for groundboom application, aerial application, and application by backpack sprayer, high-pressure handwand, and hand-held sprayer or duster. The result of the chlorpyrifos post-application assessment indicated that restricted entry intervals (REIs) needed to be established or revised. Post-application risks to greenhouse/nursery workers were not assessed due to a lack of data. Information was requested concerning application timing in relation to the post-application activities and residue data (foliar and bark treatment activities) to assess REIs for the ornamental/greenhouse uses.

- Even with all feasible PPE or engineering controls, there were still occupational scenarios that were of concern, (MOEs< 100). In such cases, and in accordance with PR Notice 2000-9, EPA further characterized these risks by looking at the strengths and weaknesses of the data and assumptions used in the risk assessment and evaluated the benefits of the chemical's use.

Cumulative Risk:

- Chlorpyrifos is a member of the organophosphate (OP) class of pesticides. The Agency completed a cumulative risk assessment for OPs in 2001, a revised cumulative risk assessment for OPs in 2002, and an updated OP cumulative risk assessment in August 2006, which can be found on the Agency's website at: http://www.epa.gov/pesticides/cumulative/rra-op/. The OP cumulative assessment assesses the cumulative effects of exposure to multiple OPs, including chlorpyrifos.

Human Studies:

- EPA has received several toxicology and exposure studies including studies with intentional exposure of human subjects. The 2000 chlorpyrifos risk assessment did not rely on any human toxicology studies for toxicological points of departure or changing default uncertainty factors. The 2000 risk assessment did rely on several human exposure studies for assessing occupational exposure (MRIDs 43027901, 42974501, 43138102, 44483501, 44739302, and 43062701). MRIDs 43027901, 42974501, 43138102 have received an ethics review. Exposure assessments also used the PHED Task Force, 1995, The Pesticide Handlers Exposure Database, Version 1.1., which has undergone ethics review. If, after considering any of the submitted studies as well as the recommendations of the Scientific Advisory Panel (September 16-19, 2008), the Agency decides to rely on any human studies for risk assessment under registration review, the Agency will ensure that all applicable regulatory requirements are met, including, but not limited to, the requirements for EPA ethics reviews and Human Studies Review Board review of certain research involving intentional exposure of human subjects.

Incident Reports

- A preliminary review of the Agency's Ecological Incident Information System (EIIS), indicates that between 1974 and 2005, a total of 278 reported ecological incidents occurred that were associated with the use of chlorpyrifos. Chlorpyrifos was reported as the "probable" or "highly probable" causative agent for 108 (of the reported 121) adverse aquatic incidents (e.g., fish kills) and for 79 (of the reported 107) terrestrial incidents, many of which were bird and honey bee kills. For additional characterization of this ecological incident data, please refer to Section C of the *Registration Review – Preliminary Problem Formulation for Ecological Risk and Environmental Fate, Endangered Species, and Drinking Water Assessments for Chlorpyrifos*, which may be found in the docket (EPA-HQ-OPP-2008-0850) at www.regulations.gov.

- The OPP Incident Database System (IDS) was searched for human incidents in the United States from 2002 to the present involving chlorpyrifos. IDS includes reports of incidents from various sources, including mandatory FIFRA Section 6(a)(2) reports from registrants, other federal and state health and environmental agencies and individual consumers. IDS contained 126 incidents involving chlorpyrifos that were reported between 2002 and the present, with more than 150 people affected; at least 17 of those affected were children. For details, please refer to the *Updated Review of Chlorpyrifos Incident Reports* (dated 10/15/08) in the chlorpyrifos docket (EPA-HQ-OPP-2008-0850) at www.regulations.gov.

Tolerances

- Tolerances for chlorpyrifos and its metabolite, 3,5,6-trichloro-2-pyridinol (TCP), appear at 40 CFR part 180.484 (revised as of July 1, 2007).

- A final rule was published in the *Federal Register* on September 17, 2008 (73 FR 53732), which established administrative changes to chlorpyrifos tolerances and nomenclature based on the reassessment in the RED.

- Maximum Residue Limits (MRLs) for chlorpyrifos have been established by the Codex Alimentarius Commission, Canada, and Mexico; however, the majority of these MRLs are not harmonized with U.S. tolerances. Any chlorpyrifos tolerances reassessed during registration review will be considered for possible harmonization with international MRLs.

- For additional information, including copies of: (1) 40 CFR part 180.484, (2) the August 8, 2008 *Federal Register* notice proposing the tolerance action for chlorpyrifos, and (3) a summary of U.S. and international tolerances and MRLs for chlorpyrifos, please refer to *Chlorpyrifos. Revised Human Health Assessment Scoping Document in Support of Registration Review*, which may be found in the docket (EPA-HQ-OPP-2008-0850) at www.regulations.gov.

Data Call-In Status

Environmental Fate and Ecological Effects:

- There are no outstanding data requirements for environmental fate and ecological effects data for chlorpyrifos. A DCI for the data outlined in this document is expected to be issued during the registration review process.

Human Health Effects:

- The following are outstanding data requirements from the RED DCI for chlorpyrifos. For additional details on these outstanding DCIs, please refer to *Chlorpyrifos. Revised Human Health Assessment Scoping Document in Support of Registration Review*, which may be found in the docket (EPA-HQ-OPP-2008-0850) at www.regulations.gov.
    - The registrant is member of the Agricultural Handlers Exposure Task Force (AHETF) and will be relying on data generated by the task force for the following data requirements:
        - Exposure data for seed treatment uses.
        - Exposure data for mixing wettable powders for aerial/chemigation application.
        - Exposure data for loading and applying granulars for aerial application.
        - Exposure data for groundboom application and human flaggers for aerial application.
    - Exposure data for reentry into treated areas with soil incorporated/directed applications.

    - The registrant has requested a waiver for this data requirement based on a lack of exposure to the incorporated material and a lack of reentry activities for a crop immediately after planting and soil incorporation. The Agency will review this waiver request under registration review.
- Use pattern information for hydraulic handheld and high pressure hand-wand spray applications (amounts handled per day, per season; types of sprayers used).
    - A use survey has been submitted for this data request.
- Use pattern information, i.e., timing of application relative to postapplication activities, greenhouse dislodgeable foliar residues (DFR) data, and biological monitoring data to develop transfer coefficients for various greenhouse/nursery activities are required.
    - The registrant has requested a waiver for this data requirement based on the fact that none of its chlorpyrifos products are labeled for use on ornamentals grown in greenhouses. The Agency will review this waiver request under registration review.
- Usage data to confirm the acres treated for the 3 lb/A on sod farms for mole crickets.
    - Survey results from sod farm managers that determined actual use data for use of chlorpyrifos to control mole crickets has been submitted.
- Exposure data for backpack spray application.
    - An exposure study of a backpack application crew has been completed but has not yet been submitted to the Agency.

Labels

Current registration numbers for products containing chlorpyrifos are listed below. Images of the labels can be obtained from the Pesticide Product Label System (PPLS) website at http://oaspub.epa.gov/pestlabl/ppls.home.

Table 2. Section 3 registrations for products containing chlorpyrifos

Registration #	Registrant	Product Name	Percent A.I.
264-932	Bayer Cropscience LP	Gustafson Lorsban 30 Flowable	30
499-367	Whitmire Micro-Gen Research Laboratories Inc.	Whitmire Pt 275 Dur-O-Cap Microencapsulated Chlorpyrifos Liq	20
499-405		Whitmire Pt 1920 Total Release Insecticide	8
499-405		Whitmire Pt 1920 Total Release Insecticide	1.6
499-419		Whitmire Pt 275 Dur-O-Cap Microencapsulated Chlorpyrifos	20
829-279	Southern Agricultural Insecticides, Inc.	SA-50 Dursban 2e Insecticide	24.7
829-280		SA -50 Dursban 4-E Insecticide	44.9
829-291		SA -50 Brand Dursban 1% Mole Cricket Bait	1
829-292		SA -50 Dursban 2.5% Granular Insecticide	2.5
4787-40	Cheminova A/S	Chlorpyrifos Technical	98.5
4787-41		Nufos Technical	97
5481-525	AMVAC Chemical Corporation	Lorsban 15G Smartbox	15
8329-18	Clarke Mosquito Control Products, Inc.	Mosquitomist Two U.L.V.	24.6
8329-20		Mosquitomist 1.5 U.L.V.	19.36
8329-24		Mosquitomist One U.L.V.	13.624
8329-36		ULV Mosquito Master 412	12
8329-36		ULV Mosquito Master 412	4
8329-73		ULV Mosquito Master 2+6	2
8329-73		ULV Mosquito Master 2+6	6
9198-167	The Andersons Lawn Fertilizer Division, Inc.	Andersons Golf Products Insecticide III	1.34
9688-67	Chemsico	Chemsico Roach Control	0.5
10404-67	Lesco Inc.	Lesco 1% Dursban Granular	1
11678-58	Makhteshim Chemical Works Ltd	Pyrinex Chlorpyrifos Insecticide	97.9
13283-14	Rainbow Technology Corp.	Rainbow Fire Ant Killer	5
13283-17		Rainbow Ko Fire Ant Killer	7
13283-37		Fire Ant Killer Granules	5
19713-300	Drexel Chemical Company	Chlorpyrifos 4 Wood	44.9
19713-505		Drexel Chlorpyrifos 15g	15
19713-517		Drexel Chlorpyrifos 4ec	44.9
19713-518		Drexel Chlorpyrifos Termiticide	44.9

19713-520		Drexel Chlorpyrifos 4e-Ag	44.9
19713-521		Drexel Chlorpyrifos 15gr	15
19713-527		Drexel Chlor-Py-Rex Chlorpyrifos Insecticide	97
19713-573		Drexel Chlorpyrifos 99.3% Technical	99.3
19713-575		Drexel Chlorpyrifos 99% Technical	99
19713-599		Drexel Chlorpyrifos 4e-Ag2	44.9
33658-17	Gharda Chemicals Ltd	Chlorpyrifos Technical	99.3
34704-857	Loveland Products, Inc.	Warhawk	44.9
39039-6	Y-Tex Corporation	Warrior Insecticide Cattle Ear Tag	30
39039-6		Warrior Insecticide Cattle Ear Tag	10
45600-1	Insecta Marketing, Inc.	Insecta	0.86
62719-11	Dow AgroSciences LLC	Dursban 4e Insecticide	44.9
62719-34		Lorsban 15g	15
62719-47		Dursban TC	44.9
62719-65		Dursban 2E	24.8
62719-69		Dursban WT Insecticidal Wood Treatment Concentrate	44.9
62719-72		Dursban 50W in Water Soluble packets	50
62719-77		Lentrek* 6 WT	62.5
62719-79		Lock-On	22.9
62719-88		Dursban ME20	20
62719-89		Dursban ME04 Microencapsulated	0.4
62719-90		Dursban ME02 Microencapsulated	0.2
62719-166		Dursban Pro	23.5
62719-210		Dursban 1G Insecticide	1
62719-220		Lorsban -4E	44.9
62719-221		Lorsban 50W Insecticide In Water Soluble Packets	50
62719-254		Dursban 4E-N	44.9
62719-271		Dursban 1F	1
62719-276		Dursban 2.5G	2.5
62719-301		Lorsban * 75WG	75
62719-351		Dursban HF	62.5
62719-352		Dursban W	50
62719-353		Dursban F	97
62719-355		Dursban R	99
62719-364		Dursban 20 MEC	20
62719-575		Cobalt	0.54
62719-575		Cobalt	30
62719-591		Lorsban Advanced	40.18
66222-3	Makhteshim-Agan of North America Inc.	Pyrinex 4 Ec	44.9
66222-18		Chlorpyrifos 15G	15
66222-19		Chlorpyrifos 4E AG	42.5
66330-278	Arysta Lifescience North America, LLC	Chlorpyrifos 4# Ag	44.7
66330-281		Chlorpyrifos 15G	15

66330-302		Chlorpyrifos 61.5% MUP	61.5
67760-14	Cheminova, Inc.	Nufos 15g Insecticide	15
67760-28		Nufos 4E	44.9
79676-5	Gro-Pro, LLC	Chlorpyrifos E-Pro 2.32% Granules	2.32
79676-6		Chlorpyrifos E-PRO 1% Mole Cricket Bait	1
79676-7		Chlorpyrifos E-PRO 0.5% Mole Cricket Bait	0.5
79676-9		Chlorpyrifos E-PRO 4 Insecticide	44.7
79676-10		Chlorpyrifos E-PRO 2 Insecticide	24.66
84836-8	Gharda Generics, Inc.	Pilot 4e Chlorpyrifos Agricultural Insecticide	45
84836-9		Pilot 15G Chlorpyrifos Agricultural Insecticide	15
84836-10		Navigator Specialty Insecticide	45
84930-7	Arcana, LLC	Arc-Chlor 4# Ag	44.7

III. Glossary of Terms and Abbreviations

A	Acre
AHETF	Agricultural Handlers Exposure Task Force
ai	Active Ingredient
ARETF	Agricultural Reentry Exposure Taskforce
BEAD	Biological and Economic Analysis Division
BMD	Benchmark Dose
CAS	Chemical Abstracts Service
CCA	Comparative Cholinesterase Assay
CFR	Code of Federal Regulations
DARTIC	Developmental and Reproductive Toxicant Identification Committee
DCI	Data Call-In
DEEM	Dietary Exposure Estimate Model
DFR	Dislodgeable Foliar Residues
EIIS	Ecological Incident Information System
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FQPA	Food Quality Protection Act
FWP	Final Work Plan
GLN	Guideline Number
IDS	Incident Database System
IRED	Interim Reregistration Eligibility Decision
lb	Pound
LOC	Level of Concern
MOE	Margin of Exposure
MRID	Master Record Identification (number). EPA's system of recording and tracking submitted studies.
MRL	Maximum Residue Limits
NMFS	National Marine Fisheries Service
NOAEL	No Observable Adverse Effect Level
NRDC	National Resources Defense Council
OEHHA	Office of Environmental Health Hazard Assessment
OP	Organophosphate
OPP	EPA Office of Pesticide Programs
PANNA	Pesticide Action Network of North America
PC	Pesticide Chemical
PDP	Pesticide Data Program
PHED	Pesticide Handler Exposure Database
POD	Point of Departure
PON 1	Paraoxonase 1
PND 11	Post-natal Day 11
PPE	Personal Protective Equipment
PPLS	Pesticide Product Label System
PRIA	Pesticide Registration Improvement Act
PWP	Preliminary Work Plan
RED	Reregistration Eligibility Decision
REI	Restricted Entry Interval
RPA	Reasonable and Prudent Alternative

SAP	Scientific Advisory Panel
SLN	Special Local Need (Registrations Under Section 24(C) of FIFRA)
SLUA	Screening Level Use Analysis
TC	Transfer Coefficient
TCP	3,5,6-trichloro-2-pyridinol
UF	Uncertainty Factor
USEPA	United States Environmental Protection Agency
UV	Ultraviolet