UNIVERSITY OF CALIFORNIA

University of California Pesticide Hazard Tiering System

Adapted from the City and County of San Francisco's SF Environment *Guide to San Francisco's Reduced Risk Pesticide List* Revised September 1, 2013

Introduction

The University of California Pesticide Hazard Classification System is a hazards based screening algorithm performed automatically by Risk and Safety Solution using the methodology detailed in this document.

This pesticide hazard classification system documented in this paper is maintained by the Systemwide Pesticide Oversight Committee and describes the current hazard assessment of both the active ingredients and the formulated product. An EH&S Chemical Informatics team evaluates each pesticide known to be in use at UC for identified hazard criteria and places the products into Hazard Tiers (Table 1) based on the toxicity of the active ingredient(s) and the other ingredients (if they are identified) in the product. The specific hazards assessed are described in Table 2 and the ingredients in the product are evaluated for each category and ranked as high, moderate or low hazard, according to the criteria in Table 3. The pesticide's classification for any given hazard will be deemed to be the highest tier for any active ingredient.

Hazard Tier Review Process

Pesticide products are assigned a hazard tier ranking after evaluating the hazard indices listed in the following section. The product is assigned a ranking as Red (high), Yellow (moderate), or Green (low) for each characteristic based on the ranges or values shown in Table 3 below. If any of the criteria are in the Red (high) category, the product is placed in Tier 1. If the chemical does not have any criteria in the Red (high) category but does have at least one criterion in the moderate category, the product is placed in Tier 2. Products with criteria only in the Green (low) category are placed in Tier 3. See Table 1 for a summary of rankings, and Table 2 for a summary of data sources.

Table 1: Tier Rankings Derived from Hazard Screening

Tier	Definition
Tier 1 Red (high)	**Highest concern.** At least one criterion in Table 3 placed in the highest hazard category for any ingredient in the pesticide.
Tier 2 Yellow (moderate)	**Moderate concern.** At least one criterion in Table 3 placed in the moderate hazard category for any ingredient in the pesticide.
Tier 3 Green (low)	**Lowest concern.** No criteria flagged for Tier 1 or Tier 2 for any ingredient in the pesticide.

UNIVERSITY OF CALIFORNIA

Table 2: Hazards Evaluated and Data Sources Used

Tier	Definition
Acute toxicity	Product label: Signal word (Caution, Warning or Danger).
Restricted use	Product label: Use restricted to professional applicators.
Cancer	Cancer classification of ingredient by US EPA, State of California (Proposition 65 list)[1], National Toxicology Program (Report on Carcinogens)[2], or the International Agency for Research on Cancer (IARC Monographs).[3]
Reproductive or Developmental Toxicity	Designation of ingredient by the State of California (Proposition 65 list), US EPA on the Toxics Release Inventory list.[4]
Endocrine disruption	Designation of ingredient by the European Commission[5] or included in the book Environmental Endocrine Disruptors by Lawrence H. Keith.[6]
Water pollution potential	Ingredient listed under Clean Water Act Section 303(d).[7]
Hazard to birds	Product label or MSDS: Presence and wording of bird hazard statement or LD_{50} or LC_{50} of product (if available).
Hazard to aquatic life	Product label or MSDS: Presence and wording of fish hazard statement or LC_{50} of product (if available).
Hazard to bees	Product label or MSDS: Presence and wording of bee hazard statement or LD_{50} or LC_{50} of product (if available).
Hazard to wildlife	Product label or MSDS: Presence and wording of wildlife hazard statement or LD_{50} or LC_{50} of product (if available).
Soil mobility	Soil mobility score (Groundwater Ubiquity Score or GUS) calculated from physical properties or CA DPR's assessment of groundwater contamination potential using physical properties. Physical property data available in the OSU Pesticide Properties Database,[8] CA DPR Pesticide Contamination Prevention Act Status Reports,[9] or the EU Footprint Pesticide Properties database.[10]
Persistent,	US EPA Waste Minimization priority chemical[11] or listed by the European

[1] CA OEHHA, Proposition 65 List of Chemicals Known to Cause Cancer, Developmental or Reproductive Toxicity. California Office of Environmental Health Hazard Assessment. http://oehha.ca.gov/prop65/prop65_list/Newlist.html.

[2] CA OEHHA, Proposition 65 List of Chemicals Known to Cause Cancer, Developmental or Reproductive Toxicity. California Office of Environmental Health Hazard Assessment. http://oehha.ca.gov/prop65/prop65_list/Newlist.html.

[3] IARC, IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. http://monographs.iarc.fr/

[4] US EPA. 2012. TRI-Listed Chemicals. http://www2.epa.gov/toxics-release-inventory-tri-program/toxicity-data-categorytri-listed-chemicals

[5] EC, 2000. Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, Annex 13 (List of 146 substances with endocrine disruption classifications prepared in the Expert meeting). European Commission. Final Report, November 2000. http://ec.europa.eu/environment/docum/01262_en.htm#bkh.

[6] Keith LH. 1997. *Environmental Endocrine Disruptors: A Handbook of Property Data.* Wiley Interscience (New York, 1997)

[7] US EPA. National Summary of Impaired Waters and TMDL Information. http://iaspub.epa.gov/waters10/attains_nation_cy.control?p_report_type=T.

[8] OSU. OSU Extension Pesticide Properties Database. http://npic.orst.edu/ingred/ppdmove.htm.

[9] CA DPR, Status Report Pesticide Contamination Prevention Act (issued annually). Environmental Monitoring Reports. California Department of Pesticide Regulation. http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps.htm.

[10] EU Footprint Database. 2011. http://www.eu-footprint.org.

[11] US EPA. Waste Minimization Priority Chemicals List. National Waste Minimization Partnership Program.

Bioaccumulative, Toxic substances (PBTs)	Union as fulfilling PBT or Persistent Organic Pollutant (POP) criteria.[12]

Table 3: Criteria for San Francisco Hazard Tier Ranking

Hazard	Red (high)	Yellow (moderate)	Green (low)
Signal word	Danger	Warning	Caution or none
Restricted use (Federal or California)	Yes	-	No
Cancer (see Table 1)	Known or Probable	Possible	Unclassifiable, Not Likely, Not Listed
Reproductive or Developmental Toxicity	Listed	-	Not listed
Endocrine disruption	EC category I or II	-	EC category III or not listed
Water pollution	303(d) listed	-	Not listed
Hazard to birds	"Extremely toxic" or "Highly toxic" according to product label, or high product toxicity based on LC_{50} or LD_{50} (see below)	"Toxic" according to product label, or moderate product toxicity based on LC_{50} or LD_{50} (see above)	No warning on product label, or low product toxicity based on LC_{50} or LD_{50} (see above)
Hazard to aquatic life	"Extremely toxic" or "Highly toxic" according to product label, or high product toxicity based on LC_{50} (see above)	"Toxic" according to product label, or moderate product toxicity based on LC_{50} (see above)	No warning on product label, or low product toxicity based on LC_{50} (see above)
Hazard to bees	"Extremely toxic" or "Highly toxic" according to product label, or high product toxicity based on LD_{50} (see above).	"Toxic" according to product label, or moderate product toxicity based on LD_{50} (see above)	No warning on product label, or low product toxicity based on LD_{50} (see above)
Soil mobility	-	GUS ≥2 or DPR classifies AI as exceeding SNVs	GUS <2 and Not listed by DPR as exceeding SNVs.
PBT	Listed	-	Not listed

http://www.epa.gov/epawaste/hazard/wastemin/priority.htm.

[12] EU. 2012. Persistent Bioaccumulative Toxins. European Commission Joint Research Centre, Institute for Health and Consumer Protection (IHCP). http://esis.jrc.ec.europa.eu/index.php?PGM=pbt.

UNIVERSITY OF CALIFORNIA

Below are details on the hazard indices used in the evaluation:

Acute Toxicity

EPA assigns every pesticide product to a hazard category based on the results of acute toxicity testing of the full product including inert ingredients. The testing includes the single dose required to cause death in test animals via ingestion, inhalation, and skin absorption. The testing also considers the degree of skin and eye irritation or damage. Based on the results of these tests, EPA assigns the product to a hazard category and requires a signal word such as Caution, Warning, or Danger to be placed on the label. Danger indicates the highest hazard, Warning indicates moderate hazard, and Caution indicates a lower hazard.

Restricted Use

Some pesticides are restricted to use only by certified pesticide applicators and are not available to the general public because of high toxicity, particularly hazardous ingredients, or environmental hazards. Pesticides designed as restricted use are so indicated on the product label.

Cancer (known ingredients only)

Various state, federal, and international organizations evaluate or list chemicals for carcinogenicity, their potential to cause cancer.[13] [14] [15] [16] Due to the expense and difficulty of such evaluations, not all agencies have reviewed the same chemicals and not all reach the same conclusions on a given chemical. For this reason, we use the ratings of several agencies whenever possible. These ratings indicate the strength of the scientific evidence that a particular chemical can cause cancer in humans, but they do not consider the potency of the chemical, i.e., the number of cancers that will result from a standard level of exposure to a population. The various agencies use different words to describe the strength of evidence, such as possible, probable, likely, known, etc. In order to simplify the rating, we have assigned the various phrases used by the different agencies to a standard phrase used in the Hazard Tier assessment (see Table 4). The tier rating is based on the highest likelihood assigned by any agency that has evaluated the chemical.

[13] US EPA, List of Chemicals Evaluated for Carcinogenic Potential. US Environmental Protection Agency. http://www.epa.gov/opp00001/carlist/.

[14] CA OEHHA, Proposition 65 List of Chemicals Known to Cause Cancer, Developmental or Reproductive Toxicity. California Office of Environmental Health Hazard Assessment. http://oehha.ca.gov/prop65/prop65_list/Newlist.html.

[15] NTP, 2011. 12th Report on Carcinogens. National Toxicology Program. http://ntp.niehs.nih.gov/?objectid=03C9AF75-E1BF-FF40-DBA9EC0928DF8B15

[16] IARC, IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. http://monographs.iarc.fr/

UNIVERSITY OF CALIFORNIA

Table 4: Standardized Cancer Rankings Used in Hazard Tier Assessment

Organization	Organization Rating	Standardized Rating Cancer Hazard Tier
US EPA[17]	Group A: Known Human Carcinogen	Known or Probable
	Known/Likely	Known or Probable
	Likely to be Carcinogenic to Humans	Known or Probable
	Group B: Probable Human Carcinogen	Known or Probable
	B1: Sufficient evidence of carcinogenicity from animal studies with limited evidence of carcinogenicity from epidemiologic studies in humans	Known or Probable
	B2: Sufficient evidence of carcinogenicity from animal studies with inadequate or no data from epidemiologic studies in humans	Known or Probable
	Group C: Possible Human Carcinogen	Possible
	Likely to be Carcinogenic to Humans at High Doses, but Not Likely at Low Doses	Possible
	Suggestive Evidence of Carcinogenicity to Humans	Possible
	Group D: Not classifiable as to human carcinogenicity	Unclassifiable
	Data are inadequate for an assessment of human carcinogenic potential	Unclassifiable
	Group E: Not Likely to be Carcinogenic to Humans	Not Likely
IARC[18]	Group 1: Carcinogenic to Humans	Known or Probable
	Group 2A: Probably Carcinogenic to Humans	Known or Probable
	Group 2B: Possibly Carcinogenic to Humans	Possible
	Group 3: Unclassifiable as to Carcinogenicity to Humans	Unclassifiable
	Group 4: Probably not Carcinogenic to Humans	Not Likely
NIH/NTP[19]	Known to be a Human Carcinogen	Known or Probable
	Reasonably Anticipated to be a Human Carcinogen	Known or Probable
	Reviewed but not listed	Not Listed
Prop. 65[20]	Known to the State of California to Cause Cancer	Known or Probable

[17] US EPA, List of Chemicals Evaluated for Carcinogenic Potential. US Environmental Protection Agency. http://www.epa.gov/opp00001/carlist/.

[18] IARC, IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. http://monographs.iarc.fr/

[19] NTP, 2011. 12th Report on Carcinogens. National Toxicology Program. http://ntp.niehs.nih.gov/?objectid=03C9AF75- E1BF-FF40-DBA9EC0928DF8B15

[20] CA OEHHA, Proposition 65 List of Chemicals Known to Cause Cancer, Developmental or Reproductive Toxicity. California Office of Environmental Health Hazard Assessment. http://oehha.ca.gov/prop65/prop65_list/Newlist.html.

UNIVERSITY OF CALIFORNIA

Reproductive/Developmental Toxicants (known ingredients only)

Known ingredients in the products are screened against the State of California lists of known reproductive and developmental toxicants,[21] the US EPA Toxics Release Inventory (TRI) chemical hazard list,[22] or the list from the National Toxicology Program's Health Assessment and Translation (formerly the Center for Evaluation of Risks to Human Reproduction).[23]

Endocrine Disruptors (known ingredients only)

Under the Food Quality Protection Act, the EPA is required to screen pesticide ingredients for endocrine system effects. Until that screening is done, a comprehensive list of endocrine disruptors will not be available. For purposes of this screening, we used the list of endocrine disruptors compiled by the European Commission[24] and in the book Environmental Endocrine Disruptors by Lawrence Keith.[25] Chemicals on the EU list are classified for both humans and wildlife as Category I: evidence for endocrine disruption in living organisms, Category II: evidence of potential to cause endocrine disruption, or Category III: low exposure concern, no scientific basis for inclusion, or insufficient information. The list of endocrine disruptors will likely be expanded at a later date, when the US EPA publicizes the results of the Endocrine Disruptor Screening Program.

Water Pollution (known ingredients only)

Section 303(d) of the federal Clean Water Act requires states to compile a list of water bodies with excessive contamination. The list of impaired water bodies in the area where the product will be used (available from the US EPA 303(d) web site[26]) is searched for pesticide active ingredients. Based on a site-specific analysis of the water bodies, products are assessed as to whether they contain priority 303(d) pollutants for that area.

Hazards to Birds, Aquatic Life, Bees, and Other Wildlife

The US EPA requires particular hazard warning statements on pesticide product labels depending on the toxicity of the active ingredients and the formulated product to particular off-target species, evidence that adverse effects have occurred, and the use for which the product is intended. The hazard assessment is based on whether such warnings appear on the specific product label or the acute toxicity of the product as described in the MSDS. This toxicity is expressed as an LC_{50} (or LD_{50}) that is the lethal concentration (or dose) to 50% of the test organisms in a laboratory test. The criteria for defining toxicity for different species are shown in Table 5 below.

---

[21] NTP, 2011. 12th Report on Carcinogens. National Toxicology Program. http://ntp.niehs.nih.gov/?objectid=03C9AF75- E1BF-FF40-DBA9EC0928DF8B15

[22] US EPA. 2012. TRI-Listed Chemicals. http://www2.epa.gov/toxics-release-inventory-tri-program/toxicity-data-categorytri-listed-chemicals

[23] NTP. 2012. Health Assessment and Translation (Formerly CERHR). http://ntp.niehs.nih.gov/?objectid=497C419D-E834- 6B35-8AF15D389859AF07.

[24] *Reference needed.*

[25] *Reference needed.*

[26] US EPA. How's My Waterway? http://watersgeo.epa.gov/mywaterway/.

UNIVERSITY OF CALIFORNIA

Table 5: Toxicity Reference Values for Terrestrial and Aquatic Wildlife

Category	Mammal and Bird LD_{50} (mg/kg)[27]	Mammal and Bird LC_{50} (mg/kg of food)[28]	Aquatic LC_{50} (mg/L)[29]	Bee LD_{50} (µg/bee)[30]
High Toxicity	< 50	< 500	< 1	< 2
Moderate Toxicity	50–500	500–1,000	1–10	2–11
Low Toxicity	> 500	> 1,000	> 10	> 11

Mobility in Soil (known ingredients only)

The potential for ground-water or surface-water pollution by pesticides is dependent on many factors, including persistence of the ingredients, water solubility, soil binding, amount of rainfall or irrigation, soil properties, amount and frequency of applications, soil slope, vegetation present, proximity to ground- or surface-water, etc. The hazard assessment only considers the properties that relate strictly to the pesticide itself. The potential for a pesticide moving to surface water or groundwater is thus assessed in one of three ways:

1. The Ground-water Ubiquity Score (GUS) is an empirically derived index that relates pesticide persistence and soil binding to mobility. The GUS index is defined mathematically as:

   $$GUS = \log_{10}(\text{half-life}) \times [4 - \log_{10}(K_{oc})]$$

   where K_{oc} is the soil sorption coefficient and half-life is the soil half-life in days. Information on pesticide K_{oc} values can be found in the OSU Pesticide Properties database,[31] the California Department of Pesticide Regulation groundwater Status Reports,[32] or in the EU Footprint Pesticide Properties database.[33]

   A pesticide movement rating ranging from “extremely low” to “very high” has been assigned to the numerical values by the researchers in the OSU Extension Pesticide Properties Database.[34] The values are shown in Table 6.

[27] US EPA. Series 870 *Health Effects Test Guidelines: Acute Toxicity Testing Background*, US EPA Office of Pollution Prevention and Toxic Substances Harmonized Test Guidelines, US EPA, http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OPPT-2009-0156-0002

[28] Kamrin, MA. 1997. *Pesticide Profiles: Toxicity, Environmental Impact, and Fate*. Lewis Publishers. Boca Raton, FL

[29] Ibid.

[30] US EPA 2012. *Label Review Manual, Chapter 8: Environmental Hazards*. http://www.epa.gov/oppfead1/labeling/lrm/.

[31] Reference needed.

[32] Reference needed.

[33] Reference needed.

[34] Reference needed.

UNIVERSITY OF CALIFORNIA

Table 6: Pesticide Mobility in Soil as a Function of Groundwater Ubiquity Score

GUS Value	Pesticide Movement Rating
<2	Low
2.0 - 3.0	Moderate
>3.0	High

2. The California Department of Pesticide Regulation (DPR) lists pesticide active ingredients as potential groundwater contaminants when physical properties exceed Specific Numeric Values (SNVs). In order for a chemical to be listed, one of the following must be true:

   Water solubility: > 3 ppm (mg/L), or
   Soil adsorption coefficient (Koc): < 1,900 cm^3/g

   AND one of the following must be true

   Hydrolysis half-life: > 14 days, or
   Aerobic soil metabolism half-life: > 610 days, or
   Anaerobic soil metabolism half-life: > 9 days

   The list of pesticides that exceed SNVs is available from DPR's annual Groundwater Status Reports.[35]

3. In addition to the GUS index and DPR's assessment, information on pesticide water contamination potential is noted from product label warnings. EPA requires two levels of warnings for products with characteristics that have been determined to result in likely contamination of groundwater from use as labeled. A lower level of warning is required if no actual detections have occurred or no field studies have been done. A higher level of warning is required if detections have occurred or field studies have shown that the chemical leaches. For purposes of the initial screening, the presence of either warning is considered an indication that the chemical has high mobility. In rare cases where a label ground-water advisory occurs but the GUS index or DPR assessment did not indicate high mobility, the label advisory is given priority.

Pesticides that have high soil mobility according to the criteria above, but are not otherwise toxic or bioaccumulative are classified as Tier 2.

Persistent, Bioaccumulative, Toxic Chemicals (PBTs)

In recent years much attention has been paid to toxic chemicals that persist in the environment and bioaccumulate. PBTs pose a serious threat because they can build up in ecosystems, wildlife, and humans even when deposited slowly. Many organizations including the United Nations, International Joint Commission on the Great Lakes, U.S. EPA, and Washington State Department of Ecology have proposed strategies to reduce or eliminate them. The list used for this evaluation is EPA's Waste Minimization Priority Chemicals list or listed by the European Union as fulfilling PBT or Persistent Organic Pollutant (POP) criteria. New lists will be added as more information becomes available.

[35] Reference needed.