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Methodology for Prioritizing Pesticides for Surface Water Monitoring in Agricultural and Urban Areas

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Summary

This report describes the methodology and computer implementation to prioritize pesticides for surface water monitoring in agricultural and urban areas of California. The prioritization scheme is based on pesticide use and aquatic toxicity. Use data is retrieved from the Pesticide Use Report (PUR) database for the year, months, and counties of interests. Pesticide toxicity data is primarily based on the USEPA Office of Pesticide Program (OPP)'s Aquatic Life Benchmarks. For pesticides without OPP benchmarks we developed toxicological reference values based on aquatic toxicological data from USEPA Eligibility Decisions (RED) or from the FOOTPRINT Pesticide Properties DataBase (PPDB) by following OPP's procedures. Pesticides are ranked by their use amounts and toxicity values, and categorized by assigning "use scores" from 1 (low use) to 5 (high use) and "toxicity scores" from 1 (low toxicity) to 8 (high toxicity). A "final score" was calculated then as the product of use score and toxicity score. Based on the final score, a list of pesticides is generated and ranked from high to low scores for purposes of prioritization. Using the latest pesticide use data and toxicity data, the methodology will be applied to identify potential candidates for California Department of Pesticide Regulation's (CDPR) monitoring projects. The prioritization procedure will be useful in providing a consistent and transparent approach to other state and local agencies for their surface water monitoring efforts, and for the information of all stakeholders. In addition, the updated lists will provide useful information for prioritizing the needs for the development of analytic methods and toxicity benchmarks.

This document summarizes the prioritization procedure. For the computer implementation, please refer to the user's manual (Luo et al., 2013).

1. Introduction

A major goal of CDPR's Surface Water Protection Program is to characterize pesticide residues in surface water for both agricultural and urban areas of the state. This is done primarily through surface water monitoring to assess pesticide concentrations for high priority chemicals and their spatial and temporal distributions of detections in high use or problem areas. According to the Pesticide Use Report (CDPR, 2013a), more than 600 pesticide active ingredients (AIs) were applied in California during 2011. Environmental monitoring studies have shown that pesticide applications result in potentially toxic surface water runoff. For example, Starner and Zhang (2011) identified ten AIs which frequently exceeded the USEPA Aquatic Life Benchmarks (USEPA Benchmarks) (USEPA, 2013c). Based on a multi-area urban monitoring program, 50% of water samples contained five or more pesticides, and detected concentrations of pesticides in water samples frequently exceeded their lowest USEPA Benchmarks (Ensminger et al., 2012).

Pesticide prioritization is needed to identify potential candidates for surface water monitoring. Starner (2007) developed prioritized monitoring recommendations from available toxicity data for 39 pesticides and their average annual agricultural use in 2002-2003. A more detailed assessment was also provided for high use counties and seasons for each of the primary AIs. This study was updated in 2008 (Starner, 2008) by reviewing pesticide concentrations (CDPR, 2013b) with USEPA Benchmarks. Pepple (2009) developed a procedure for identifying pesticides with a high potential to contaminate surface water, mainly based on pesticide monitoring data in surface water or sediment and USEPA Benchmarks.

Pesticide use patterns and use amounts change significantly over time. Every year there are new AIs being introduced into the California market (Newhart, 2011). At the same time, some pesticide products are cancelled or have label changes (USEPA, 2013d). Updating priority lists is time consuming. As such, we haven't officially updated the agricultural pesticide list for several years. The objectives of this study are to [1] develop a systematic approach to prioritize pesticides for CDPR's surface water monitoring projects in agricultural and urban areas, and [2] establish computer programs to integrate and facilitate the automation of updating the priority lists.

2. Methodology development

2.1 Overview

Prioritization of pesticides for surface water monitoring is mainly based on their use data and toxicological reference values (Figure 1). While the toxicity data are preprocessed as static data, pesticide use amounts are dynamically retrieved from the PUR database according to the user-specified conditions such as use patterns, years, months, and counties. Quantitative classifications (a use score and a toxicity score) are assigned to each pesticide by ranking its use amount and the lowest toxicity values. The product of the two scores is used to prioritize pesticides. Additional options, such as use data lumping (combining similar pesticides) and chemical screening (removing pesticides from the analysis), are also available to focus our efforts in the selection of candidates for surface water monitoring.

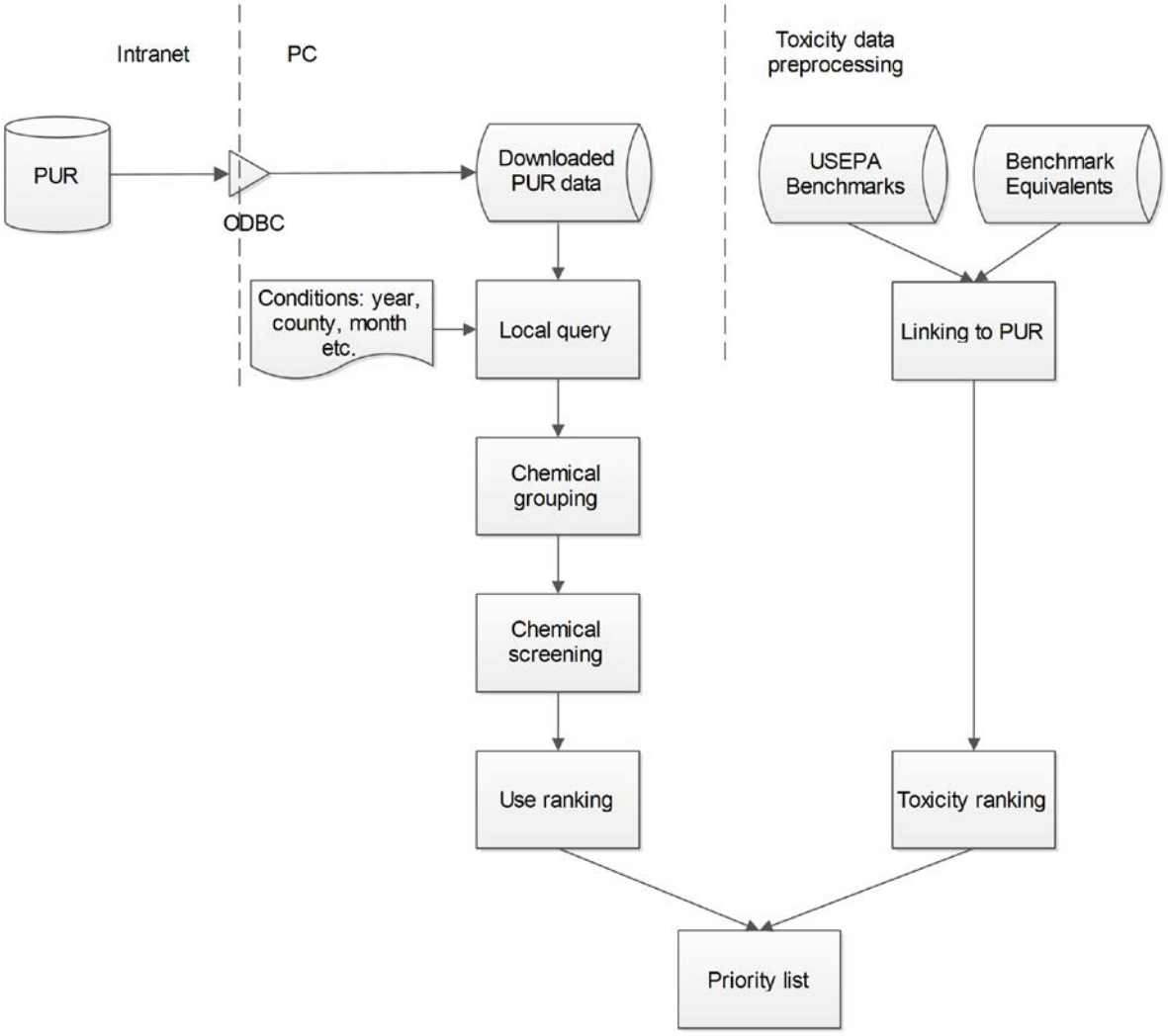

Figure 1. Flowchart of pesticide prioritization for surface water monitoring

2.2 Pesticide use data

2.2.1 Use pattern

Agricultural and urban uses of pesticides, associated with different transport mechanisms to surface water bodies, can be separately considered in the prioritization. California has a broad legal definition of "agricultural use" so the reporting requirements include pesticide applications to parks, golf courses, cemeteries, rangeland, pastures, and along roadside and railroad rights-of-way. In addition, all postharvest pesticide treatments of agricultural commodities must be reported along with all pesticide treatments in poultry and fish production as well as some livestock applications (CDPR, 2008). For the purpose of monitoring prioritization, agricultural use here is defined by the "SITE_CODE" field in the PUR and refined by "UNIT_TREATED",

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where …
(SITE_CODE between 150 and 40000) OR SITE_CODE=40008
AND UNIT_TREATED='A'
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"Urban use" is defined as reported use amounts for "structural pest control" (SITE_CODE=10), "landscape maintenance" (SITE_CODE=30), and "rights of way" (SITE_CODE=40). Pesticide applications in "rights of way" are legally considered as non-production agricultural use (CDPR, 2008), but can be also applied to urban areas. Therefore, we have the option for users to include or exclude the rights-of-way applications in querying pesticide uses.

2.2.2 Use data query

Query for pesticide use data is designed to reflect a spatiotemporal resolution of county by month. For each pesticide, its use data is retrieved from the PUR and summarized as an annual average for the user-defined counties and months. Pesticide use data for prioritization can be from a single year or a set of consecutive years. Only officially approved and/or released PUR data should be used for the prioritization.

2.2.3 Use data ranking

Pesticides are ranked by their use amounts with a probability-based approach. For example, the top 2% pesticides with highest use amounts are assigned a highest "use score". To be consistent with our previous methods (Starner, 2007; 2008), a 5-class ranking system with numerical scores of 1~5 for "very low" to "very high" classes are used here. The following method should be considered in assigning the probabilities: [1] majority of chemicals should be classified as "very low" use class; [2] there is a general decreasing trend in the percentages of chemicals from "very high" to "very low" classes; and [3] return to unit, i.e., the sum of all percentages is 100%. Default settings are: $X_1\%$ = 70% (score= 1, very low), $X_2\%$ = 16% (score=2), $X_3\%$ = 8% (score= 3), $X_4\%$ = 4% (score= 4), $X_5\%$ = 2% (score= 5, very high). The program also allows users to change the percentile cutoffs during prioritization if desired. In the previous studies, pesticide use was usually classified based

on a bracketing system with prescribed critical values and ranges of use amounts (Starner, 2007; 2008). For example, a pesticide was assigned to the "very high" use class if its statewide annual agricultural use >= 500,000 lb[AI]. Compared to the bracketing system, the probability-based method used here is more flexible especially when applied to regional and/or seasonal prioritization processes. In addition, it will work long-term with changing AI list, use pattern, and use amounts.

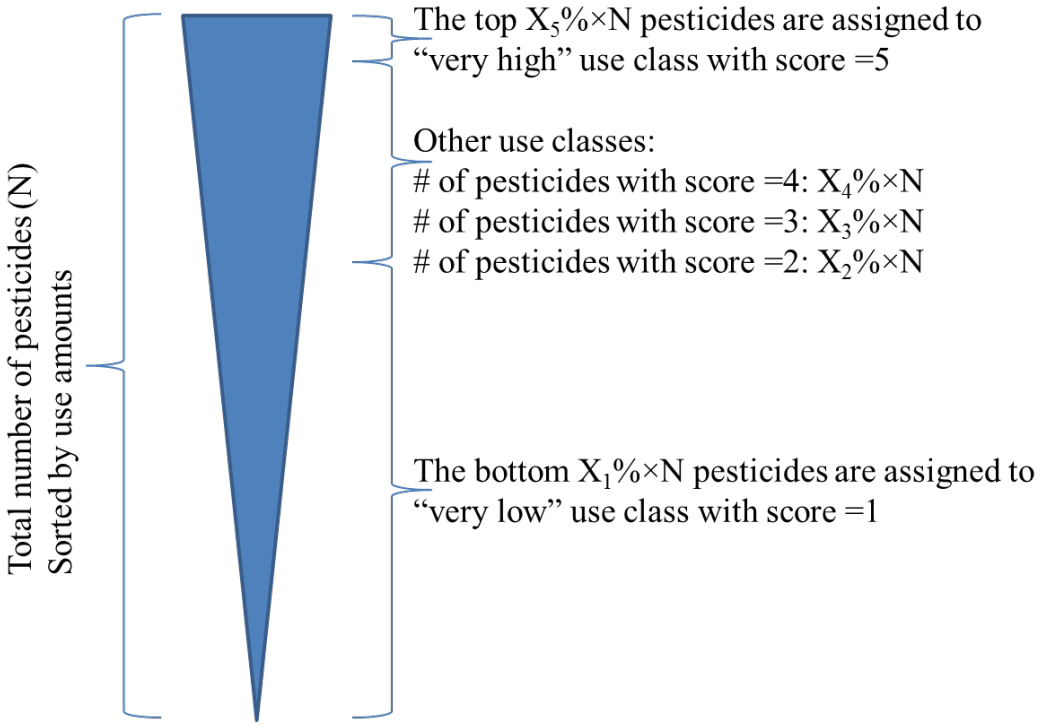

Figure 2. Probability-based method for use data ranking

The probability-based use ranking is implemented as follows (Figure 2):

1. Pesticides are sorted by their use amounts in descending order.
2. The user-defined probabilities are converted into percentiles. For example, the default values of 70%, 16%, 8%, 4%, 2% can be converted to the 70th, 86th, 94th, 98th percentiles.
3. The critical values of pesticide use amounts are calculated based on the percentiles.
4. Pesticides are ranked based on the ranges defined from the critical values.
5. Two major results are reported from the use ranking process: [1] a "use score" (1~5) for each pesticide, and [2] the ranges of pesticide use amounts for each score.

2.2.4 Use data lumping

Chemicals monitored in surface water are usually the active ingredients reported in pesticide products. For some group of A.I.'s, however, chemicals should be lumped for the purposes of aquatic toxicity assessment since they are likely transformed into a single significant residue in surface water. For the same reason, only one benchmark is provided

by USEPA for the whole group of chemicals. Chemical grouping is conducted for the following two conditions:

- The chemical groups of: [1] "2,4-D acids and salts", [2] "2,4-D esters", and [3] "copper-based pesticides".
- Chemicals associated with "other, related" designations.

For the purpose of prioritization, we selected a representative chemical in each group for lumping their use data. Specifically, 2,4-D, 2-Ethylhexyl ester (CHEM_CODE=1622) is selected for the group of 2,4-D esters; 2,4-D (636) for the group of 2,4-D acids and salts; copper (714) for the group of copper-based pesticides; and the parent/main chemicals for those associated with "other, related" designations in the PUR. Appendix 1 lists chemicals which are lumped in the 2,4-D and copper groups.

2.3 Toxicity data

The following two sources are used to obtain toxicity data:

- USEPA Office of Pesticide Program (OPP)'s Aquatic Life Benchmarks (USEPA Benchmarks).
- "OPP Benchmark Equivalents" developed by DPR's Surface Water Protection Program staff by following the USEPA Benchmark calculation procedures.

2.3.1 USEPA Benchmarks

Toxicity data is retrieved from the USEPA aquatic life benchmarks (http://www.epa.gov/oppefed1/ecorisk_ders/aquatic_life_benchmark.htm, downloaded on 10/1/2012). Benchmarks are reported for 335 chemicals. Both acute toxicity values (for fish, invertebrates, nonvascular plants, and vascular plants) and chronic toxicity values (for fish and invertebrates) are used in the prioritization. Toxicity ranking is based on the lowest toxicity value in each category (acute or chronic). If the toxicity is listed as "larger than (>)" or "less than (<)" some value, the provided value will be used for prioritization and flagged in the final results. Toxicity data for the prioritization will be updated annually to reflect the changes in the OPP Benchmarks.

USEPA Benchmarks are indexed by chemical name and CAS number which may not completely match the chemical names and CAS numbers used in PUR. Therefore, a relational table is developed to assign the "CHEM_CODE" of PUR to each chemical in the USEPA Benchmarks (Appendix 2). The current version of USEPA aquatic benchmarks are developed for freshwater species. However, aquatic toxicity to saltwater species can be included in the prioritization process when data is approved and posted by USEPA.

2.3.2 Benchmark Equivalents

Our preliminary analysis identified some pesticides that are associated with high use amount in California, but have no benchmark values officially posted on the USEPA

Benchmarks. To generate a more accurate prioritization, we developed toxicological reference values for selected pesticides. The new database was derived based on the OPP's method, and referred to as the OPP aquatic life Benchmark Equivalents. Acute toxicity values from fish, invertebrates, non-vascular and vascular plants for those pesticides were initially retrieved from two sources: [1] the Reregistration Eligibility Decisions (RED) approved by USEPA (USEPA, 2013e) and [2] the IUPAC (International Union of Pure and Applied Chemistry) FOOTPRINT Pesticide Properties Database (PPDB, 2013). Retrieved toxicity values were then converted to aquatic life benchmarks. According to the OPP's method, acute aquatic life benchmarks are calculated by using 96-hour LC50 values times LOC (Level of Concern). The LOC is set as 0.5 for fish and invertebrates, and 1.0 for vascular and non-vascular plants. The lowest benchmark value among all the taxa was used to categorize the toxicity rankings as described previously in this document. Toxicity determined from Benchmark Equivalents was flagged as "R" (for the RED-based data) or "P" (for the PPDB-based data) in the prioritization results (Appendix 3). Detailed information on the development of the Benchmark Equivalents, including original toxicity values from fish, invertebrates, non-vascular and vascular plants, and the species used to determine the benchmarks, are available in the RED documentation (USEPA, 2013e) or in the PPDB online database (PPDB, 2013). Benchmark Equivalents will be replaced by OPP benchmarks when they are developed in the future.

2.3.3 Toxicity ranking

Pesticide toxicity ranking, for acute or chronic toxicity, is based on an 8-class system developed previously (Starner, 2007; 2008) (Table 1). For pesticides without reported toxicity values, a zero score is assigned. The descriptive classifications by (Zucker, 1985) for aquatic toxicity and by SWPP for pesticide registration evaluation (Luo and Deng, 2012) are also listed for comparison. Please note that toxicity ranking for prioritization is based on benchmarks while USEPA and SWPP classifications are based on LC50 or EC50 values.

Table 1. Ranking schemes for pesticide toxicity

Toxicity score	Lowest benchmarks (BM) (ppb)	Category description	
		SWPP [1]	USEPA [2]
8	BM≤0.001	Very highly toxic	Very highly toxic
7	0.001<BM≤0.01		
6	0.01<BM≤0.1		
5	0.1<BM≤1		
4	1<BM≤10	Highly toxic	
3	10<BM≤100		
2	100<BM≤1000		Highly toxic
1	BM>1000	Moderately to slightly toxic	Moderately toxic to practically non-toxic
0	No data		

Notes: The SWPP toxicity rating was used in the registration evaluation for surface water protection. The listed narrative descriptions are for toxicity values (LC_{50} or EC_{50}) in water

column for fish and invertebrates in freshwater and saltwater (Luo and Deng, 2012). The USEPA classifications were mainly based on toxicity values (LC_{50} or EC_{50}) for fishes (Zucker, 1985).

2.4 Pesticide screening

Some chemicals are unlikely to cause surface water quality problems, and hence excluded in the prioritization. Those chemicals are determined based on their use types or chemical groups. We also make sure that the pesticides specifically identified in the Clean Water Act 3403(d) list (CEPA, 2010) won't be manually excluded in the prioritization results. The full list of chemical screening is provided in Appendix 4. Further details on the screening are available in Budd et al. (2013).

2.5 Prioritization

The use and toxicity scores are used for prioritizing pesticides for surface water monitoring. A final score is defined as the product of both scores.

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[final score] = [use score] * [toxicity score]
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where use score and toxicity score are from pesticide use ranking and toxicity ranking described in previous sections, respectively. Users may develop and test other functions for final scores according to their study objectives as both the individual use and toxicity scores are reported in the spreadsheet output. In the priority list, pesticides are sorted by their final scores in descending order. For tied final scores, pesticides are further sorted by their annual average use amount. All scores represent the relative priority of pesticides with each prioritization criteria. Their values are not quantitatively comparable between the results for different prioritization scenarios (such as the priority list for agricultural vs. that for urban, or for different years).

With this process, pesticides without toxicity data, indicated by zero toxicity scores and final scores, will be automatically placed at the bottom portion of the priority list. We keep those chemicals in the list to prioritize the request for additional toxicity data. The resultant information has been incorporated in our development of Benchmark Equivalents. For example, toxicological reference values have been derived for 59 out of the top 100 chemicals without USEPA Benchmarks, based on the prioritization for agricultural use during 2009-2011.

3. Computer implementation

A computer program with graphical user interface (Prioritization Program) was developed to implement the prioritization procedures described above. The documentation and user's manual are presented in a help file for the program (Luo et al., 2013).

4. Methodology testing

Statewide pesticide use data during 2009-2011 was applied in the methodology testing. The Prioritization Program generates results separately for agricultural and urban uses, and the resultant top 20 chemicals are shown in Table 2.

Table 2. Prioritization results based on statewide pesticide use data during 2009-2011, top 20 chemicals in the priority list are presented

(a) Agricultural use (including the "rights-of-way" applications)

CHEM_CODE	CHEMNAME	use (lb/yr)	use score	toxicity (ppb)	toxicity score	final score
253	CHLORPYRIFOS	1272008	5	0.05	6	30
2008	PERMETHRIN	110699.7	3	0.01	7	21
714	COPPER	5376041	5	2.05	4	20
1929	PENDIMETHALIN	1828242	5	5.2	4	20
1601	PARAQUAT DICHLORIDE	834420.5	4	0.396	5	20
1973	OXYFLUORFEN	741259.1	4	0.29	5	20
367	MALATHION	500500.9	4	0.3	5	20
2300	BIFENTHRIN	85142.5	3	0.075	6	18
677	CHLOROTHALONIL	844526.5	4	1.8	4	16
629	ZIRAM	746496.9	4	9.7	4	16
231	DIURON	559389.2	4	2.4	4	16
597	TRIFLURALIN	498297.3	4	7.52	4	16
5133	S-METOLACHLOR	283394.8	4	8	4	16
560	SULFUR	46920849	5	31.5	3	15
503	PROPANIL	2115559	5	16	3	15
198	DIAZINON	117339.1	3	0.11	5	15
335	PHOSMET	114325.4	3	1	5	15
105	CARBARYL	101807	3	0.85	5	15
5802	FLUMIOXAZIN	82513.9	3	0.852	5	15
2297	LAMBDA-CYHALOTHRIN	43484	2	0.0035	7	14

(b) Urban use (including the "rights-of-way" applications)

CHEM_CODE	CHEMNAME	use (lb/yr)	use score	toxicity (ppb)	toxicity score	final score
2008	PERMETHRIN	167717.9	5	0.01	7	35
2300	BIFENTHRIN	85854	5	0.075	6	30
1973	OXYFLUORFEN	131913	5	0.29	5	25
2297	LAMBDA-CYHALOTHRIN	8173	3	0.0035	7	21
714	COPPER	520582.2	5	2.05	4	20
231	DIURON	274649.7	5	2.4	4	20
3	ACROLEIN	120384.1	5	7	4	20

2171	CYPERMETHRIN	58544.1	4	0.195	5	20
3995	FIPRONIL	43482.3	4	0.11	5	20
229	DIQUAT DIBROMIDE	41777.9	4	0.75	5	20
2223	CYFLUTHRIN	24437.2	3	0.0125	6	18
3956	BETA-CYFLUTHRIN	7765.6	3	0.034	6	18
3010	DELTAMETHRIN	6938.5	3	0.055	6	18
677	CHLOROTHALONIL	85836.9	4	1.8	4	16
1929	PENDIMETHALIN	58864.8	4	5.2	4	16
83	BROMACIL	38799.2	4	6.8	4	16
2236	PRODIAMINE	26378.7	4	3	4	16
2149	SULFOMETURON-METHYL	11859.7	3	0.48	5	15
5802	FLUMIOXAZIN	10523.4	3	0.852	5	15
367	MALATHION	9600	3	0.3	5	15

Notes:

[1] Settings for the demonstrated prioritization:

[a] Pesticide use: agriculture use (panel a) or urban use (b) for all counties and all months during 2009-2011, reported as annual average use (lb) in the table. Use ranking was based on the default values of probability.

[b] Toxicity data: acute toxicity data from USEPA Benchmarks (Appendix 2) and Benchmark Equivalents (Appendix 3).

[c] Use data lumping is enabled, therefore, use data for a chemical (e.g., copper) in the table may present the total use amount of its chemical group (Appendix 1).

[d] Pesticide screening is enabled. The chemicals in the screening list (Appendix 4) have been excluded in the prioritization.

[2] CHEM_CODE and CHEMNAME: chemical code and name used in the PUR; use (lb) = annual average use amount; use score = quantitative classification by use ranking described in Section 2.2.3; toxicity (ppb) = lowest toxicity value in the USEPA Benchmarks (Appendix 2) or in Benchmark Equivalents (Appendix 3); toxicity score = quantitative classification by toxicity ranking in Section 2.3.3; final score = [use score]*[toxicity score]

Prioritization results for agricultural use have been applied to identify potential monitoring candidates in CDPR's 2013 agricultural surface water monitoring project. Pesticide AIs were selected from the top chemicals in the statewide priority list for inclusion in the project. Further details are available in the protocol for CDPR Study 282 (Starner, 2013).

Results for urban pesticide prioritization were consistent with CDPR monitoring projects in urban areas. In the top 20 statewide priority AIs, 14 AIs are in the current or previous monitoring screen. The methodology was also used to prioritize urban pesticides for surface water monitoring with PUR data of 2009-2011 (Budd et al., 2013).

5. Discussions

As mentioned before, the general purpose of this study is to develop a consistent and transparent methodology to prioritize pesticides for surface water monitoring for CDPR. This methodology was tested with available data of pesticide use and toxicity. In the development, we also considered the extensibility of the prioritization procedure. In another words, additional data, if available in the future, can be applied in the same procedure without significant changes on the methodology. For example, the methodology will also work with more Benchmarks data released by USEPA, with reliable data for pesticide use unreported in the PUR, and with analytical methods developed for more chemicals. These additional data and methods will potentially improve the resultant priority list, however, it's impossible in this single study to actually accomplish all the potential improvements. The following discussion provides more information on the data used in the current study and proposed in the future development.

5.1 Unreported use of pesticides

Some pesticide uses such as home owner applications are not reported in the PUR (CDPR, 2013a). Therefore, use scores of some pesticides in urban prioritization may be underestimated. However, we concluded that there is no reliable information at this time to estimate those unreported uses, and that the exclusion of those uses may not significantly affect the relative ranking of pesticides in urban areas for surface water monitoring.

[1] *Estimation of unreported urban use from sales data is not appropriate*: CDPR conducted a comprehensive study to compare the use and sales of group III pyrethroid pesticides, and concluded that "it is impossible to derive meaningful estimates of unreported urban use at any of the levels of data aggregation studied (product, EPA primary registration number or total pounds active ingredient)" (Zhang and Spurlock, 2010).

[2] *Shelf survey on retail stores generates limited information on pesticide use amount*. The existing store survey studies on pesticide products were focused on the number and type of pesticide products or active ingredients (Flint, 2003; Osienski et al., 2010), while the total sold amount of each pesticide is not reported. The reported data is mainly used to determine the popularity of a pesticide for its use by home owners.

[3] *Shelf survey results indicated that the inclusion of home owner use data may not significantly alter the prioritization results for surface water monitoring*. According to the most recent survey conducted in 2010 for northern and southern California (Osienski et al., 2010), the most common pesticides in retail stores were glyphosate, 2,4-D dimethylamine salt, and pyrethroid insecticides. Those pesticides are already associated with high reported uses or listed as top chemicals in the urban prioritization.

5.2 Toxicity data for pesticide degradates and water quality standards for human health and drinking water

A complete version of pesticide toxicity database for surface water quality is under development by SWPP and will be incorporated in the prioritization procedure after data

verification. The database includes toxicity data for pesticides and their degradates based on USEAP aquatic life benchmarks, USEPA drinking water standards (USEPA, 2013a), USEPA human health benchmarks (HHBP) (USEPA, 2013b). For pesticides not covered by the USEPA lists, benchmark equivalents for aquatic life are developed for the parent chemicals and their degradates as described in the section 2.3.2. Appendix 5 demonstrates the toxicity database for the top chemicals identified in the prioritization for both agricultural and urban areas (Table 2).

This database allows users to select toxicity data according to their evaluation endpoints. For example, among the 112 chemicals with acute benchmarks for both acute aquatic life and human health, 6 chemicals are associated with significantly lower HHBP than aquatic benchmarks (with different toxicity scores generated from 10-based logarithm transformation, section 2.2.3), including fosthiazate (no use reported in 2009-2011), metaldehyde, cycloate, acephate, ethephon (in the screening list, Appendix 4), monosodium acid methanearsonate (MSMA). Similarly, the comparison of aquatic toxicity data between active ingredients and their breakdown products suggested the following pesticides associated with relatively high uses and with significantly more toxic degradates: bifenazate (degradate: D3598), indoxacarb (IN-JT333), naled (dichlorvos), PCNB (hexachlorobenzene), spinetoram (N-demethyl-spinetoram-J), and thiophanate-methyl (carbendazim). With the consideration of degradate aquatox, these pesticides would be further prioritized in the list.

5.3 Additional considerations in monitoring planning

The prioritization procedure presented here is mainly based on pesticide use and toxicity. The finalization of monitoring candidates requires more considerations. Therefore, best professional judgment is required in the generation of a final list of prioritized pesticides for surface water monitoring. Additional considerations include the availability of analytical methods and knowledge from past monitoring, including pesticides in the 303(d) list.

5.4 Related studies which may improve the prioritization procedure

[1] Further development for chemical grouping. In addition to 2,4-D acids and salts, 2,4-D esters, and copper-based pesticides considered in the current procedure, several pyrethroids and other chiral pesticides have similar related compounds that cannot be distinguished in environmental samples and those could also be grouped together,
[2] Identification and prioritization of chemicals for requesting analytical methods and toxicity data,
[3] Consideration of physio-chemical properties and pesticide use patterns for monitoring prioritization, and
[4] Incorporation of the flagged pesticides from the registration evaluation in the prioritization procedure.

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Appendix 1. Groups of chemicals to be lumped in the prioritization

(a) Groups of [1] "2,4-D acids and salts", [2] "2,4-D esters", and [3] "copper-based pesticides", with the representative chemicals highlighted

CHEM_CODE	Chemical name and group
	Group: 2,4-D esters
802	2,4-D, BUTOXYETHANOL ESTER
803	2,4-D, BUTOXYPROPYL ESTER
804	2,4-D, BUTYL ESTER
809	2,4-D, ISOOCTYL ESTER
810	2,4-D, ISOPROPYL ESTER
812	2,4-D, PROPYLENE GLYCOL BUTYL ETHER ESTER
1255	2,4-D, BUTOXY ETHOXY PROPANOL ESTER
1275	2,4-D, PROPYL ESTER
1622	2,4-D, 2-ETHYLHEXYL ESTER
1999	2,4-D, OCTYL ESTER
6041	2,4-D, METHYL ESTER
	Group: 2,4-D acids and salts
636	2,4-D
801	2,4-D, ALKANOLAMINE SALTS (ETHANOL AND ISOPROPANOL AMINES)
805	2,4-D, DIETHANOLAMINE SALT
806	2,4-D, DIMETHYLAMINE SALT
807	2,4-D, DODECYLAMINE SALT
811	2,4-D, LITHIUM SALT
813	2,4-D, SODIUM SALT
814	2,4-D, TETRADECYLAMINE SALT
815	2,4-D, TRIETHANOLAMINE SALT
816	2,4-D, TRIISOPROPYLAMINE SALT
875	2,4-D, DIETHYLAMINE SALT
1032	2,4-D, MORPHOLINE SALT
1096	2,4-D, N-OLEYL-1,3-PROPYLENEDIAMINE SALT
1138	2,4-D, TRIETHYLAMINE SALT
1259	2,4-D, N,N-DIMETHYL OLEYL-LINOLEYLAMINE SALT
1962	2,4-D, HEPTYLAMINE SALT
3953	2,4-D, ISOPROPYLAMINE SALT
5538	2,4-D, TRIISOPROPANOLAMINE SALT
	Group: copper-based pesticides
60	COPPER CARBONATE, BASIC

147	COPPER ACETATE
	COPPER HYDROXIDE
153	COPPER NAPHTHENATE
	COPPER OLEATE
155	COPPER SALTS OF FATTY AND ROSIN ACIDS
	COPPER OXYCHLORIDE
158	COPPER OXYCHLORIDE SULFATE
	COPPER 8-QUINOLINOLEATE
161	COPPER SULFATE (PENTAHYDRATE)
	COPPER SULFATE (BASIC)
163	COPPER-ZINC CHROMATE COMPLEX
	COPPER-ZINC SULFATE COMPLEX
175	COPPER OXIDE (OUS)
	COPPER
753	COPPER DIHYDRAZINIUM SULFATE
	COPPER SODIUM SULFATE-PHOSPHATE COMPLEX
1110	COPPER LINOLEATE
	N-(2-HYDROXYETHYL) ETHYLENE DIAMINE TRIACETIC ACID, COPPER SALT
1135	EDTA, COPPER COMPLEX
	COPPER CITRATE
1457	COPPER BRONZE POWDER
	EDTA, DIAMMONIUM COPPER SALT
1615	COPPER TRIETHANOLAMINE COMPLEX
	COPPER-ZINC SULFATE COMPLEX, MONOHYDRATE
1762	COPPER AMMONIUM CARBONATE
	COPPER SULFATE (ANHYDROUS)
1789	COPPER SULFATE, MONOHYDRATE
	COPPER HYDROXIDE - TRIETHANOLAMINE COMPLEX
1925	LIGNIN SULFONIC ACID, COPPER SALT
	COPPER OXIDE (IC)
2235	COPPER 2-ETHYLHEXANOATE
	COPPER PHTHALOCYANINE
2480	COPPER SULFATE ETHYLENE DIAMINE
	ACETIC ACID, COPPER (2+) SALT
3173	DISODIUM EDTA-COPPER
	COPPER CITRATE CHELATE

3548	COPPER GLUCONATE CHELATE
3549	COPPER ETHYLENEDIAMINE COMPLEX
3550	COPPER AMMONIUM COMPLEX
3551	COPPER ETHANOLAMINE COMPLEXES, MIXED
3552	COPPER MONOETHANOLAMINE COMPLEX
3553	COPPER DIETHANOLAMINE COMPLEX
5225	COPPER OCTANOATE
5975	COPPER 2-PYRIDINETHIOL-1-OXIDE
6018	COPPER PYRITHIONE

(b) Chemicals associated with "other, related" designations in the PUR

Chemical with “other, related” designations		Representative chemical	
Chemical name	CHEM_CODE	Chemical name	CHEM_CODE
ALDRIN, OTHER RELATED	90009	ALDRIN	9
ALLETHRIN, OTHER RELATED	90012	ALLETHRIN	12
AMETRYNE, OTHER RELATED	90018	AMETRYNE	18
ATRAZINE, OTHER RELATED	90045	ATRAZINE	45
PROPOXUR, OTHER RELATED	90062	PROPOXUR	62
CAPTAN, OTHER RELATED	90104	CAPTAN	104
CHLORDANE, OTHER RELATED	90130	CHLORDANE	130
CROTOXYPHOS, OTHER RELATED	90140	CROTOXYPHOS	140
COUMAPHOS, OTHER RELATED	90165	COUMAPHOS	165
1,3,4,6-TETRACHLOROGLYCOLURIL, OTHER RELATED	90182	1,3,4,6-TETRACHLOROGLYCOLURIL	182
DBCP, OTHER RELATED	90183	DBCP	183
DDD, OTHER RELATED	90184	DDD	184
DDVP, OTHER RELATED	90187	DDVP	187
DEET, OTHER RELATED	90189	DEET	189
DIOXATHION, OTHER RELATED	90192	DIOXATHION	192
DIATOMACEOUS EARTH, OTHER RELATED	90195	DIATOMACEOUS EARTH	195
DICAMBA, OTHER RELATED	90200	DICAMBA	200
DIELDRIN, OTHER RELATED	90210	DIELDRIN	210
ENDRIN, OTHER RELATED	90262	ENDRIN	262
ERBON, OTHER RELATED	90266	ERBON	266
MERPHOS, OTHER RELATED	90293	MERPHOS	293
HEPTACHLOR, OTHER RELATED	90317	HEPTACHLOR	317
HEXACHLOROACETONE, OTHER RELATED	90320	HEXACHLOROACETONE	320
DINOCAP, OTHER RELATED	90344	DINOCAP	344
METHOXYCHLOR, OTHER RELATED	90384	METHOXYCHLOR	384
METHYL PARATHION, OTHER	90394	METHYL PARATHION	394

RELATED			
NAPHTHALENE, OTHER RELATED	90421	NAPHTHALENE	421
NOREA, OTHER RELATED	90435	NOREA	435
NITRAPYRIN, OTHER RELATED	90439	NITRAPYRIN	439
OMPA, OTHER RELATED	90446	OMPA	446
PARATHION, OTHER RELATED	90459	PARATHION	459
PCNB, OTHER RELATED	90464	PCNB	464
PCP, OTHER RELATED	90465	PENTACHLOROPHENOL	465
ETHYLAN, OTHER RELATED	90472	ETHYLAN	472
MEVINPHOS, OTHER RELATED	90480	MEVINPHOS	480
PHOSPHAMIDON, OTHER RELATED	90482	PHOSPHAMIDON	482
PIPERONYL BUTOXIDE, OTHER RELATED	90486	PIPERONYL BUTOXIDE	486
PHENYLMERCURIC ACETATE, OTHER RELATED	90491	PHENYLMERCURIC ACETATE	491
PYRAZON, OTHER RELATED	90509	PYRAZON	509
PYRETHRINS, OTHER RELATED	90510	PYRETHRINS	510
ROTENONE, OTHER RELATED	90518	ROTENONE	518
PCP, SODIUM SALT, OTHER RELATED	90540	PCP, SODIUM SALT	540
SULFOTEP, OTHER RELATED	90558	SULFOTEP	558
SULFOXIDE, OTHER RELATED	90559	SULFOXIDE	559
TEPP, OTHER RELATED	90577	TEPP	577
THANITE, OTHER RELATED	90586	THANITE	586
TRYSBEN, OTHER RELATED	90602	TRYSBEN	602
ORTHO-DICHLOROBENZENE, OTHER RELATED	90683	ORTHO-DICHLOROBENZENE	578
TETRACHLOROPHENOL, SODIUM SALT, OTHER RELATED	90776	TETRACHLOROPHENOL, SODIUM SALT	776
TETRACHLOROPHENOL, OTHER RELATED	90777	TETRACHLOROPHENOL	777
CHLORAMBEN, AMMONIUM SALT, OTHER RELATED	90831	CHLORAMBEN, AMMONIUM SALT	831
3,4',5-TRIBROMOSALICYLANILIDE, OTHER RELATED	90833	3,4',5-TRIBROMOSALICYLANILIDE	833
DICAMBA, DIMETHYLAMINE SALT, OTHER RELATED	90849	DICAMBA, DIMETHYLAMINE SALT	849
METHYL NONYL KETONE, OTHER RELATED	90877	METHYL NONYL KETONE	877
POTASSIUM LAURATE, OTHER RELATED	90901	POTASSIUM LAURATE	901
2,4,6-TRICHLOROPHENOL, SODIUM SALT, OTHER RELATED	90960	2,4,6-TRICHLOROPHENOL, SODIUM SALT	960
2,4,5-TRICHLOROPHENOL, POTASSIUM SALT, OTHER RELATED	91050	2,4,5-TRICHLOROPHENOL, POTASSIUM SALT	1050
PIPROTAL, OTHER RELATED	91133	PIPROTAL	1133

AKTON, OTHER RELATED	91421	AKTON	1421
CYANAZINE, OTHER RELATED	91640	CYANAZINE	1640
2,4,5-TRICHLOROPHENOL, SODIUM SALT, OTHER RELATED	91656	2,4,5-TRICHLOROPHENOL, SODIUM SALT	1656
2,3,5,6-TETRACHLORO-4-(METHYLSULFONYL) PYRIDINE, OTHER RELATED	91675	2,3,5,6-TETRACHLORO-4-(METHYLSULFONYL) PYRIDINE	1675
LEPTOPHOS, OTHER RELATED	91676	LEPTOPHOS	1676
TERBUTRYN, OTHER RELATED	91691	TERBUTRYN	1691
TETRAMETHRIN, OTHER RELATED	91695	TETRAMETHRIN	1695
OXYTETRACYCLINE HYDROCHLORIDE, OTHER RELATED	91798	OXYTETRACYCLINE HYDROCHLORIDE	1798
DIALIFOR, OTHER RELATED	91799	DIALIFOR	1799
DICAMBA, MONOETHANOLAMINE SALT, OTHER RELATED	91829	DICAMBA, MONOETHANOLAMINE SALT	1829
PROFLURALIN, OTHER RELATED	91897	PROFLURALIN	1897
FENVALERATE, OTHER RELATED	91963	FENVALERATE	1963
PERMETHRIN, OTHER RELATED	92008	PERMETHRIN	2008
PHENOTHRIN, OTHER RELATED	92093	PHENOTHRIN	2093
RESMETHRIN, OTHER RELATED	92119	RESMETHRIN	2119
PRODIAMINE, OTHER RELATED	92236	PRODIAMINE	2236
ABAMECTIN, OTHER RELATED	92254	ABAMECTIN	2254
D-ALLETHRIN, OTHER RELATED	92293	D-ALLETHRIN	2293
NONANOIC ACID, OTHER RELATED	92739	NONANOIC ACID	2739
DELTAMETHRIN, OTHER RELATED	93010	DELTAMETHRIN	3010
MEFENOXAM, OTHER RELATED	94011	MEFENOXAM	4011
D-TRANS ALLETHRIN, OTHER RELATED	94038	D-TRANS ALLETHRIN	4038

Appendix 2. Toxicity data from the OPP Benchmarks

Notes:

1. CHEM_CODE = CDPR chemical code in the PUR, CHEMNAME = chemical names in the PUR.
2. toxA = lowest value (ppb) of reported acute toxicity; toxAflag = flag for acute toxicity: if the original toxicity data is reported as "larger than (>)" or "less than (<)" some value, the provided value will be used with a flag of ">" or "<", respectively.
3. toxC = lowest value (ppb) of reported chronic toxicity. toxCflag = flag for chronic toxicity: if the original toxicity data is reported as "larger than (>)" or "less than (<)" some value, the provided value will be used with a flag of ">" or "<", respectively.
4. Some pesticides in the OPP Benchmarks are not registered in California. Only pesticides associated with a valid CDPR chemical code ("CHEM_CODE" in the PUR) are listed.

CHEM_CODE	CHEMNAME	toxA (ppb)	toxAflag	toxC (ppb)	toxCflag
1	TEMEPHOS	5			
3	ACROLEIN	7		7.1	
7	DAMINOZIDE	35500			
12	ALLETHRIN	1.05			
18	AMETRYNE	3.67		240	
34	MSMA	2800			
45	ATRAZINE	1		60	
49	TRIALLATE	45.5		13	
53	BENEFIN	34.85		1.9	
62	PROPOXUR	5.5			
63	FENTHION	2.6		0.013	
70	BENSULIDE	290		374	
72	DICROTOPHOS	6.35		0.99	
83	BROMACIL	6.8		3000	
88	TRICHLORFON	2.65		0.0057	
104	CAPTAN	13.1		16.5	
105	CARBARYL	0.85		0.5	
106	CARBOFURAN	1.12		0.75	
108	CARBON DISULFIDE	430			
111	FORMETANATE HYDROCHLORIDE	45		0.5	
112	DICHLOBENIL	30		330	<
136	CHLOROPICRIN	8.49	<		
165	COUMAPHOS	0.037		0.037	
166	FLUOMETURON	30			
179	CHLORTHAL-DIMETHYL	11000	>		
187	DDVP	0.035		0.0058	
190	S,S,S-TRIBUTYL PHOSPHOROTRITHIOATE	3.4		1.56	
198	DIAZINON	0.11		0.17	
200	DICAMBA	61			
211	MANCOZEB	47			

216	DIMETHOATE	21.5		0.5	
229	DIQUAT DIBROMIDE	0.75		36	
230	DISULFOTON	1.95		0.01	
231	DIURON	2.4		26	
233	DAZOMET	25.6			
245	DODINE	0.95		7.3	
251	DSMA	1500			
253	CHLORPYRIFOS	0.05		0.04	
259	ENDOSULFAN	0.05		0.01	
264	EPTC	1400		810	
305	TETRACHLORVINPHOS	0.95			
314	AZINPHOS-METHYL	0.08		0.036	
335	PHOSMET	1		0.8	
346	DICOFOL	26.5		4.4	
359	LINDANE	0.5		2.9	
361	LINURON	2.5		0.09	
367	MALATHION	0.3		0.035	
369	MANEB	13.4			
375	METHIOCARB	3.5		0.1	
379	METALDEHYDE	34500			
382	OXYDEMETON-METHYL	95		5	
383	METHOMYL	2.5		0.7	
384	METHOXYCHLOR	0.7			
385	METHYL BROMIDE	1300		100	
392	METHYL ISOTHIOCYANATE	26.55			
394	METHYL PARATHION	0.49		0.25	
401	MINERAL OIL	1200			
404	ETHOPROP	22		0.8	
418	NALED	25		0.045	
445	PROPARGITE	37		9	
449	MOLINATE	105		340	
464	PCNB	50		13	
465	PENTACHLOROPHENOL	25			
473	PETROLEUM HYDROCARBONS	10			
478	PHORATE	0.3		0.21	
486	PIPERONYL BUTOXIDE	225		30	
488	PIPERALIN	385			
499	PROMETON	98		3500	
502	PROMETRYN	1		620	
503	PROPANIL	16		9.1	
504	PROPAZINE	24.8		47	
505	PROPIONIC ACID	11350			
511	PROPACHLOR	13.5			
516	CYCLOATE	1300			
518	ROTENONE	0.97		1.01	

531	SIMAZINE	36		960	
532	TERBACIL	11		640	
536	SODIUM CHLORATE	43000		500000	
565	BUTYLATE	4.6		300	
573	1,3-DICHLOROPROPENE	45		70	
575	ALDICARB	10		0.46	
589	THIRAM	21		170.6	
590	PEBULATE	230			
593	PICLORAM	4900		550	
597	TRIFLURALIN	7.52		1.14	
603	SIDURON	212		6	
616	METAM-SODIUM	25.6			
629	ZIRAM	9.7		39	
633	1080	27000			
636	2,4-D	13.1		14200	
641	MCPB, SODIUM SALT	210			
677	CHLOROTHALONIL	1.8		0.6	
678	ALACHLOR	1.64		110	
688	SODIUM CYANIDE	94			
694	PROPYZAMIDE	1180		600	
714	COPPER	2.05		1.11	
769	BORIC ACID	66500			
786	MCPA, DIMETHYLAMINE SALT	130		11000	
788	MCPA, SODIUM SALT	34000	>		
834	BROMOXYNIL OCTANOATE	26.5		2.5	
838	4-(2,4-DB), DIMETHYLAMINE SALT	1567			
849	DICAMBA, DIMETHYLAMINE SALT	488500			
979	LIMONENE	19500			
1099	PICLORAM, TRIISOPROPANOLAMINE SALT	187500			
1461	PYRETHRUM NARC	2.55		0.86	
1512	CHLORMEQUAT CHLORIDE	2800		5000	
1601	PARAQUAT DICHLORIDE	0.396		36.9	<
1622	2,4-D, 2-ETHYLHEXYL ESTER	66		79.2	
1626	ETHEPHON	2500		17000	
1685	ACEPHATE	550		150	
1689	METHIDATHION	1.1		0.66	
1692	METRIBUZIN	8.7		1290	
1695	TETRAMETHRIN	1.85			
1696	THIOPHANATE-METHYL	930		2	
1697	METHAMIDOPHOS	13		4.5	
1728	NAPROPAMIDE	3200		1100	
1746	ASULAM, SODIUM SALT	140			

1755	CARBOXIN	370			
1784	METHOPRENE	165		48	
1798	OXYTETRACYCLINE HYDROCHLORIDE	47450	>		
1810	TEBUTHIURON	50		9300	
1855	GLYPHOSATE, ISOPROPYLAMINE SALT	42450			
1857	FENAMIPHOS	0.95		0.12	
1868	ORYZALIN	15.4		220	
1871	HEXAZINONE	7		17000	
1875	PIRIMICARB	9.5			
1876	FENBUTATIN-OXIDE	0.85		0.31	
1910	OXAMYL	90		27	
1921	FOSAMINE, AMMONIUM SALT	15000	>		
1929	PENDIMETHALIN	5.2		6.3	
1930	DIFENZOQUAT METHYL SULFATE	120			
1933	THIOBENCARB	17		1	
1944	BENTAZON, SODIUM SALT	60			
1973	OXYFLUORFEN	0.29		1.3	
1980	FENARIMOL	100		113	
1992	DIFLUBENZURON	0.0014		0.0003	
1996	METOLACHLOR	8		1	
2001	ANTIMYCIN A	0.004			
2008	PERMETHRIN	0.01		0.0014	
2016	AMITRAZ	17.5		1.1	
2017	OXADIAZON	5.2		0.88	
2019	NORFLURAZON	9.7		770	
2042	PROFENOFOS	0.465		0.2	
2081	IPRODIONE	50		170	
2093	PHENOTHRIN	2.2		0.47	
2119	RESMETHRIN	0.14		0.32	
2122	PROPETAMPHOS	1.65			
2129	VINCLOZOLIN	900	>	60	
2131	TRICLOPYR, TRIETHYLAMINE SALT	4100		25000	
2132	METALAXYL	14000		100	
2143	CHLORSULFURON	0.055		20000	
2149	SULFOMETURON-METHYL	0.48		97000	
2166	ETHALFLURALIN	16		0.4	
2170	TRICLOPYR, BUTOXYETHYL ESTER	70		19	
2171	CYPERMETHRIN	0.195		0.069	
2177	SETHOXYDIM	281	>		
2195	TAU-FLUVALINATE	0.175		0.1	
2202	THIODICARB	2.7		9	

2203	HYDRAMETHYLNON	45			
2217	PIRIMIPHOS-METHYL	55		180	
2218	ACIFLUORFEN, SODIUM SALT	8500		0.57	<
2223	CYFLUTHRIN	0.0125		0.007	
2226	QUIZALOFOP-ETHYL	82.8	>	11	
2234	FENPROPATHRIN	0.265		0.064	
2238	HYDROGEN CYANAMIDE	650		100	
2245	MYCLOBUTANIL	830		980	
2249	CLOFENTEZINE	7.3	>	6	
2256	IMAZAPYR	24		43100	
2259	PACLOBUTRAZOL	8000			
2260	TRIFLUMIZOLE	140		33	
2265	ALDOXYCARB	140			
2270	UREA DIHYDROGEN SULFATE	11500			
2273	SODIUM TETRATHIOCARBONATE	3300			
2276	PROPICONAZOLE	21		95	
2279	FLURIDONE	650		480	
2283	FENOXYCARB	200		0.0016	
2286	CYROMAZINE	44850		310	
2289	ISOXABEN	550	>	400	
2292	ETOFENPROX	0.4		0.17	
2297	LAMBDA-CYHALOTHRIN	0.0035		0.002	
2300	BIFENTHRIN	0.075		0.0013	
2303	HEXYTHIAZOX	265		6.1	
2305	FLUTOLANIL	1250		233	
2320	FLURPRIMIDOL	840		944	
2321	ESFENVALERATE	0.025		0.017	
2325	FOSTHIAZATE	130		61	
2326	MCPA	170			
2329	TRALOMETHRIN	0.0195		0.0044	
2349	ACETOCHLOR	1.43		22.1	
2361	ALDICARB SULFOXIDE	21.5			
2429	BROMOXYNIL PHENOL	1050			
2468	CHLORPYRIFOS-METHYL	0.085			
2472	NICLOSAMIDE	15		56	
2520	O,O-DIMETHYL O-(4-NITRO-M-TOLYL) PHOSPHOROTHIOATE	1.15		0.087	
2601	HYDROTREATED PARAFFINIC SOLVENT	205			
2925	TERBUFOS	0.1		0.03	
2997	GLYPHOSATE	11900		1800	
2999	BENTAZON	4500			
3004	TERBUTHYLAZINE	1700			
3010	DELTAMETHRIN	0.055		0.0041	

3537	CLOMAZONE	167		350	
3538	LACTOFEN	0.6		1.4	
3566	CLETHODIM	1100			
3835	RIMSULFURON	11.6			
3849	IMIDACLOPRID	35		1.05	
3850	TEBUCONAZOLE	151.5		12	
3866	(S)-CYPERMETHRIN	0.0018		0.0006	
3885	CYPHENOTHRIN	0.17			
3898	FLUAZINAM	18		0.69	
3899	HEXAFLUMURON	0.0555			
3927	FLUMETSULAM	3.1		111000	
3938	CHLORFENAPYR	2.915		3.57	
3946	GLUFOSINATE-AMMONIUM	1470		32000	
3957	TEBUFENOZIDE	740	>	4.3	
3959	PYRIDABEN	0.265		0.044	
3983	SPINOSAD	90		0.6	
3985	PRALLETHRIN	3.1		0.325	
3995	FIPRONIL	0.11		0.011	
4000	CYPRODINIL	16		8	
4011	MEFENOXAM	20950		100	
4014	DIFETHIALONE	2.2			
4019	PYRIPROXYFEN	56		0.015	
4034	HYMEXAZOL	8800			
4037	AZOXYSTROBIN	49		44	
4038	D-TRANS ALLETHRIN	3.95			
4040	ESBIOTHRIN	4.45			
4047	ENDOSULFAN SULFATE	1.9			
4051	DEETHYL-ATRAZINE	1000			
4059	CHLOROALLYL ALCOHOL	493			
4083	METHYL PARAOXON	1.15		1	
5020	2,4-DB ACID	932			
5027	FLUDIOXONIL	70		19	
5028	DIAMINOCHLOROTRIAZINE	50000	>		
5036	BROMOXYNIL HEPTANOATE	14.5			
5057	DICAMBA, SODIUM SALT	17300			
5059	MCPA, 2-ETHYL HEXYL ESTER	20			
5062	TRIFLUOROMETHYL-4-NITROPHENOL	300			
5086	FOMESAFEN SODIUM	92		9400	
5090	FLUMICLORAC-PENTYL	550			
5100	TRIASULFURON	50000	>	68600	
5104	QUINCLORAC	500	>	16000	
5111	MECOPROP-P	45500	>	50800	
5112	DIMETHENAMID	8.9		300	
5122	PHOSTEBUPIRIM	0.039		0.011	

5123	FENOXAPROP-P-ETHYL	155		22	
5133	S-METOLACHLOR	8		30	
5135	CLOPYRALID	56500			
5136	SULFOSULFURON	1		100000	
5321	TRIFLOXYSTROBIN	7		2.8	
5330	PICLORAM, POTASSIUM SALT	6500		550	
5333	MCPP-P, DIMETHYLAMINE SALT	14			
5451	KRESOXIM-METHYL	29.2		55	
5457	TRALKOXYDIM	2600		2100	
5598	THIAMETHOXAM	17.5		20000	
5756	IMAZAMOX	11			
5759	PYRACLOSTROBIN	1.5		2.35	
5768	FLUROXYPYR	7150			
5769	ZOXAMIDE	10		3.48	
5783	METHYL IODIDE	285			
5790	BOSCALID	533	>	116	
5801	ACEQUINOCYL	1.2		0.98	
5806	METOLACHLOR ETHANESULFONIC ACID	24000			
5807	METOLACHLOR OXANILIC ACID	7700			
5813	ENDOTHALL	24500		1300	
5864	PYRIMETHANIL	1500		20	
5877	GAMMA-CYHALOTHRIN	0.0002			
5904	ORTHOSULFAMURON	0.7		6100	
5918	FLUROXYPYR, 1-METHYLHEPTYL ESTER	54.5	>	60	
5923	SULFENTRAZONE	1.8		200	
5942	DIFENACOUM	32			
5948	FLUBENDIAMIDE	27.4	>	41.5	
5955	SPIROTETRAMAT	330		100	
5961	MANDIPROPAMID	2500	>	220	
5964	CHLORANTRANILIPROLE	4.9		4.5	
5978	IPCONAZOLE	765		0.18	
5984	PINOXADEN	1200			
5991	PYRIDALYL	2.1		4.4	
6016	THIENCARBAZONE-METHYL	0.8		3540	
6030	PYROXSULAM	2.57		10100	
6037	FIPRONIL SULFIDE	1.07		0.11	
6038	FIPRONIL SULFONE	0.36		0.037	
6039	DESULFINYL FIPRONIL	10		0.59	
6043	DISULFOTON SULFONE	17.5		0.14	
6049	AMINOMETHYLPHOSPHONIC ACID	249500			
6069	MESOTRIONE	9.8		11000	

Appendix 3. Toxicity data from the OPP Benchmark Equivalents

Notes:

1. CHEM_CODE = CDPR chemical code in the PUR, CHEMNAME = chemical names in the PUR.
2. toxA = lowest value (ppb) of reported acute toxicity; toxAflag = flag for acute toxicity
3. Benchmarks for Glyphosate, isopropylamine salt will replace the corresponding values in the OPP Benchmarks. The posted data in the USEPA website are incorrect based on our data analysis, and we will contacting OPP about the discrepancy.
4. No chronic toxicity in the Benchmark Equivalents

(a) Benchmark Equivalents, RED (Reregistration Eligibility Decisions)-based

CHEM_CODE	CHEMNAME	Benchmarks (ppb)				Lowest benchmark	
		Fish	Invertebrate	Nonvascular	Vascular	toxABM	toxAflag
1855	GLYPHOSATE, ISOPROPYLAMINE SALT	29054	35946	16351	16081	16081	R
2257	IMAZAPYR, ISOPROPYLAMINE SALT	50000	50000	12000	24	24	R
2301	GLYPHOSATE, MONOAMMONIUM SALT	22872	28298	12872	12660	12660	R
5810	GLYPHOSATE, DIAMMONIUM SALT	25904	32048	14578	14337	14337	R
5820	GLYPHOSATE, POTASSIUM SALT	26543	32840	14938	14691	14691	R

(a) Benchmark Equivalents, PPDB (Pesticide Properties Database)-based

CHEM_CODE	CHEMNAME	Toxicity values (LC50, ppb)			Lowest benchmark	
		Fish	Invertebrate	Algae	toxABM	toxAflag
8	ETHYL ALCOHOL	13200000	12340000	50000	50000	P
20	AMITROLE	1000000	6100	2300	2300	P
50	4-AMINOPYRIDINE	3400	3200		1600	P
60	COPPER CARBONATE, BASIC	17		550	8.5	P
68	BENZYL BENZOATE	4600			2300	P
81	DICLORAN	480	2070	1200	240	P
86	BACILLUS THURINGIENSIS (BERLINER)	656	13000		328	P
110	CARBOPHENOTHION	56			28	P
135	CHLORONEB	3300	5800		1650	P
139	GLUTARALDEHYDE		22500		11250	P
141	CHLORPROPHAM	7500	2600	1000	1000	P
151	COPPER HYDROXIDE	17	38	9	8.5	P
156	COPPER OXYCHLORIDE	43800	290	33	33	P
175	COPPER OXIDE (OUS)	207	450	147	103.5	P
180	DALAPON	105000			52500	P
181	FENSULFOTHION	72			36	P
183	DBCP	20000			10000	P

189	DEET	71300	75000		35650	P
192	DIOXATHION	118	0.35		0.175	P
194	FENAMINOSULF	143000	3700		1850	P
206	DICHLOROPHEN	540	6200	10000	270	P
225	DIPHACINONE	2800	1800		900	P
226	DIPHENAMID	97000	58		29	P
228	DIPHENYLAMINE	2200	1200	300	300	P
238	DINOSEB	44	240		22	P
254	FONOFOS	28	2.3	1500	1.15	P
256	ANILAZINE	95	560	1020	47.5	P
262	ENDRIN	0.73	4.2		0.365	P
263	EPN	110	0.06		0.03	P
268	ETHION	500	0.056		0.028	P
292	CAPTAFOL	500	3340		250	P
293	MERPHOS	16			8	P
294	FOLPET	233	680	10000	116.5	P
295	FORMALDEHYDE	1840	430	880	215	P
310	GIBBERELLINS	100000	100000	100000	50000	P
317	HEPTACHLOR	7	42	27	3.5	P
321	HEXACHLOROBENZENE	30	500	10	10	P
322	HEXACHLOROPHENE	21	8		4	P
344	DINOCAP	5.3	4.2	320	2.1	P
347	CHLORDECONE	20	30	270	10	P
374	MCPP	240000	200000	237000	100000	P
408	MONURON	36500	10600		5300	P
417	NABAM	240	5.6	2400	2.8	P
422	1-NAPHTHALENEACETAMIDE	44000	56000	100000	22000	P
423	NAA	56000	56000	18050	18050	P
424	NEBURON	100		15	15	P
439	NITRAPYRIN	6500	2200	920	920	P
448	ORTHO-PHENYLPHENOL	4000	2700	850	850	P
459	PARATHION	1500	2.5	500	1.25	P
480	MEVINPHOS	12	0.16	71000	0.08	P
482	PHOSPHAMIDON	6000	8	260000	4	P
484	ALUMINUM PHOSPHIDE	9.7	370	58	4.85	P
491	PHENYLMERCURIC ACETATE	11		6	5.5	P
507	PROPYLENE GLYCOL	710000	10000000		355000	P
509	PYRAZON	41300	132000	3000	3000	P

510	PYRETHRINS	32	25	320000	12.5	P
517	RONNEL	740			370	P
558	SULFOTEP	3.61	2	7200	1	P
560	SULFUR	63	63	63	31.5	P
577	TEPP	867	55		27.5	P
580	TERRAZOLE	2400	3100	300	300	P
587	THIABENDAZOLE	550	810	9000	275	P
594	TOXAPHENE	4.4	14.1	380	2.2	P
618	SULFURYL FLUORIDE	890	620	580	310	P
621	WARFARIN	65000	105000	8500	8500	P
626	ZINC PHOSPHIDE	21700	114000	3.8	3.8	P
638	2,4-XYLENOL	9200	4800		2400	P
675	PHENMEDIPHAM	1710	410	86	86	P
760	CHLORFLURENOL, METHYL ESTER	1160	5100		580	P
925	4-CHLORO-3,5-XYLENOL	1600	6700		800	P
933	ACETIC ACID	45000	31500	16000	15750	P
971	TCMTB	2.1	15.3	430	1.05	P
1081	DALAPON, SODIUM SALT	100000	6000	20000	3000	P
1314	POLY-I-PARA-MENTHENE	20000	55000	3000	3000	P
1329	BENZOIC ACID	180000	500000	10000	10000	P
1363	AMMONIUM SULFATE	38200	14000	10000	7000	P
1434	OXYCARBOXIN	19900	69100	460	460	P
1552	BENOMYL	170	280	2000	85	P
1625	CHLOROPHACINONE	350	420		175	P
1640	CYANAZINE	10000	49000	200	200	P
1682	DIDECYL DIMETHYL AMMONIUM CHLORIDE	1160	94		47	P
1733	CHLORBROMURON	5000	5800	17	17	P
1744	ANCYMIDOL	100000	100000	26900	26900	P
1748	DESMEDIPHAM	250	450	10	10	P
1791	1-DECANOL	2400	1800	1570	900	P
1794	HYDROGEN PEROXIDE	22	24		11	P
1858	MUSCALURE	1000000	266		133	P
1881	OCTHILINONE	65	180		32.5	P
1893	1,2-BENZISOTHIAZOLIN-3-ONE	1600	4400		800	P
1900	ETHOFUMESATE	11000	14000	3900	3900	P
1905	TRIFORINE	1000000	25000	380000	12500	P
1924	BENDIOCARB	1550	30	1710	15	P

1927	EPICHLOROHYDRIN	9100	20400	6000	4550	P
1949	KINOPRENE	351000	100		50	P
1953	BIFENOX	670	660	0.18	0.18	P
1963	FENVALERATE	3.6	0.03	50000	0.015	P
1987	VERNOLATE	4600	1800	540	540	P
1995	DIETHATYL-ETHYL	1820			910	P
2004	DIKEGULAC SODIUM	10000000	10000000		5000000	P
2006	SULPROFOS	11000	0.83	64000	0.415	P
2034	DICLOFOP-METHYL	310	230	2230	115	P
2049	BRODIFACOUM	51	980		25.5	P
2075	MEPIQUAT CHLORIDE	100000	68500	14400	14400	P
2084	IMAZALIL	1480	3500	870	740	P
2085	MAGNESIUM PHOSPHIDE	9.3			4.65	P
2133	TRIADIMEFON	4080	7160	2010	2010	P
2135	BROMADIOLONE	8000		17	17	P
2147	PROPAMOCARB	96800	106000	301000	48400	P
2162	THIDIAZURON	19000	10000	150	150	P
2176	CARBENDAZIM	190	150	7700	75	P
2186	FLUAZIFOP-BUTYL	530	316000		265	P
2210	FOSETYL-AL	122000	100000	5900	5900	P
2222	METSULFURON-METHYL	150000	150000	45	45	P
2232	CHOLECALCIFEROL	1000000	13000		6500	P
2236	PRODIAMINE	829	658	3	3	P
2240	IMAZAMETHABENZ	100000	100000	89100	50000	P
2244	HYDROPRENE	500	130	6350000	65	P
2254	ABAMECTIN	3.6	0.1	1590	0.05	P
2263	BENSULFURON METHYL	66000	130000	20	20	P
2285	OMETHOATE	9100	22	167500	11	P
2288	BROMETHALIN	38	5		2.5	P
2307	TRIADIMENOL	21300	51000	9600	9600	P
2308	DITHIOPYR	360	14000	20	20	P
2311	FENOXAPROP-ETHYL	480	11500	430	240	P
2312	UNICONIZOLE-P	14800	10000		5000	P
2314	SULFLURAMID	8000	370		185	P
2327	GLYPHOSATE-TRIMESIUM	1800000	12000		6000	P
2328	AZADIRACHTIN	4000	11600		2000	P
2338	TRIBENURON-METHYL	738000	894000	110	110	P
2340	IMAZETHAPYR	340000	1000000	71000	71000	P

2345	TRINEXAPAC-ETHYL	35000	135000	9400	9400	P
2503	DICHLORPROP	500	100000	1100000	250	P
2672	META-MITRON	190000	5700	400	400	P
3208	FORMIC ACID	175000	68000	26900	26900	P
3829	NICOSULFURON	65700	90000	7800	7800	P
3832	OXYTETRACYCLINE, CALCIUM COMPLEX	116000	102000	342	342	P
3875	TRIFLUSULFURON-METHYL	730000	960000	46	46	P
3905	FENBUCONAZOLE	1500	2300	330	330	P
3919	HALOSULFURON-METHYL	131000	107000	5.3	5.3	P
3940	PYRITHIOBAC-SODIUM	930000	1100000	107	107	P
3947	BUPROFEZIN	330	420	2100	165	P
3956	BETA-CYFLUTHRIN	0.068	0.29	10000	0.034	P
3984	THIAZOPYR	3400	6100	40	40	P
4002	CYMOXANIL	29000	27000	254	254	P
4003	DIMETHOMORPH	3400	10600	29200	1700	P
4022	PROPAMOCARB HYDROCHLORIDE	99000	100000	85000	49500	P
4030	CYCLANILIDE	11000	13000	1700	1700	P
4032	FENHEXAMID	1240	18800	26100	620	P
4039	S-BIOALLETHRIN	19000	21		10.5	P
4094	PROTHIOFOS	500	14	2300	7	P
5024	DIFENOCONAZOLE	1100	770	32	32	P
5026	S-METHOPRENE	760	360	1330	180	P
5037	POTASSIUM BICARBONATE	1400000	1200000		600000	P
5055	MCPB	4300	55000	41000	2150	P
5060	DICHLORPROP-P	109000	100000	67000	50000	P
5129	NITHIAZINE	110000	33000		16500	P
5130	CARFENTRAZONE-ETHYL	1600	9800	12	12	P
5232	PYMETROZINE	100000	87000	21600	21600	P
5295	1-METHYLCYCLOPROPENE	966	776	838	388	P
5327	IMIPROTHRIN	38	51	3100	19	P
5331	INDOXACARB	650	600	110	110	P
5336	2,4-DP-P, DIMETHYLAMINE SALT	109000	100000	67000	50000	P
5338	ACIBENZOLAR-S-METHYL	400	2400	500	200	P
5497	PROHEXADIONE CALCIUM	100000	100000	100000	50000	P
5557	FORCHLORFENURON	8800	8000	3300	3300	P
5657	BIFENAZATE	580	500	300	250	P
5698	METHOXYFENOZIDE	4200	3700	3400	1850	P

5748	CYHALOFOP-BUTYL	790	2700	960	395	P
5749	BISPYRIBAC-SODIUM	95000	95000	3200	3200	P
5754	NOVALURON	1000	58	9680	29	P
5757	IMAZAMOX, AMMONIUM SALT	122000	122000	37	37	P
5762	ACETAMIPRID	100000	49800	98300	24900	P
5763	MILBEMECTIN	4.4	11		2.2	P
5784	FENPYROXIMATE	1	3	10000	0.5	P
5787	QUINOXYFEN	270	80	27	27	P
5791	FENAMIDONE	740	190	3840	95	P
5792	CLOTHIANIDIN	104200	40000	55000	20000	P
5799	TRITICONAZOLE	3600	9000	1000	1000	P
5802	FLUMIOXAZIN	2300	5900	0.852	0.852	P
5815	FLUAZIFOP-P-BUTYL	1410	620	1800	310	P
5816	NOVIFLUMURON	1800	3110		900	P
5820	GLYPHOSATE, POTASSIUM SALT	1227000	1227000	35000	35000	P
5822	DINOTEFURAN	100000	1000000	100000	50000	P
5849	ETOXAZOLE	2800	7.1	10000	3.55	P
5851	FORAMSULFURON	100000	100000	3300	3300	P
5857	SPIRODICLOFEN	35	51	60	17.5	P
5858	SPIROMESIFEN	16	92	94	8	P
5861	PAECILOMYCES LILACINUS STRAIN 251	100000	100000	71770	50000	P
5865	PYRAFLUFEN-ETHYL	100	100	0.23	0.23	P
5878	FAMOXADONE	11	12	22	5.5	P
5885	TRIFLOXYSULFURON-SODIUM	103000	108000	6.5	6.5	P
5886	FLONICAMID	100000	100000	100000	50000	P
5888	THIACLOPRID	30200	85100	60600	15100	P
5889	PENOXSULAM	100000	98300	490	490	P
5898	MESOSULFURON-METHYL	100000	100000	200	200	P
5911	IMAZAPIC	100000	100000	51	51	P
5915	FLUOXASTROBIN	435	480	350	217.5	P
5919	DIMETHENAMID-P	6300	12000	17	17	P
5930	CYAZOFAMID	560	190	25	25	P
5935	METAFLUMIZONE	343	331	310	165.5	P
5939	TETRACONAZOLE	4300	3000	2400	1500	P
5943	METOFLUTHRIN	1200	4.7		2.35	P
5946	SPINETORAM	3460	3170		1585	P
5949	FLUOPICOLIDE	360	1800	29	29	P

5972	GLYPHOSATE, DIMETHYLAMINE SALT	38000	40000	4400	4400	P
5983	METCONAZOLE	2100	4200	1700	1050	
5990	METRAFENONE	820	920	710	410	P
5999	INDAZIFLAM	1000	10000	750	500	
6051	THIENCARBAZONE-METHYL, TRIAZOLIDONE ADDUCT	104000	98600	1020	1020	P
6062	QUIZALOFOP-P-ETHYL	210	290	21	21	
6070	FIPRONIL AMIDE	17000	20000		8500	P

Appendix 4. Lists of pesticides excluded in the monitoring prioritization

(a) By pesticide use type

CHEM_CODE	CHEMNAME	Use Type
2610	2-(3-HYDROXYPROPYL)-HEPTA-METHYL TRISILOXANE, ETHOXYLATED, ACETATE	Adjuvant
1788	4-NONYLPHENOL, FORMALDEHYDE RESIN, PROPOXYLATED	Adjuvant
3567	ACRYLAMIDE/SODIUM ACRYLATE COPOLYMER	Adjuvant
4015	ALKYL (C8,C10) POLYGLUCOSIDE	Adjuvant
2376	ALLYLOXYPOLYETHYLENE GLYCOL ACETATE	Adjuvant
5895	ALPHA-(ORTHO,PARA-DINONYLPHENYL)-OMEGA-HYDROXYPOLYOXY(ETHYLENE) PHOSPHATE	Adjuvant
1879	ALPHA-(PARA-DODECYLPHENYL)-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
2046	ALPHA-(PARA-NONYLPHENYL)-OMEGA-HYDROXYPOLY (OXYETHYLENE) SULFATE, AMMONIUM SALT	Adjuvant
5016	ALPHA-(PARA-NONYLPHENYL)-OMEGA-HYDROXYPOLY(OXYETHYLENE), PHOSPHATE ESTER	Adjuvant
1605	ALPHA-(PARA-TERT-BUTYLPHENYL)-OMEGA-HYDROXYPOLY(OXYETHYLENE) PHOSPHATE	Adjuvant
1932	ALPHA-[PARA-(1,1,3,3-TETRAMETHYLBUTYL)PHENYL]-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
2077	ALPHA-ALKYL (C10-C12)-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
1844	ALPHA-ALKYL (C10-C14)-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
1766	ALPHA-ALKYL (C12-C14)-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
5740	ALPHA-ALKYL (C12-C15)-OMEGA-HYDROXYPOLY(OXYETHYLENE) SULFATE, SODIUM SALT	Adjuvant
5863	ALPHA-ALKYL (C12-C16)-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
2123	ALPHA-ALKYL (C12-C18)-OMEGA-HYDROXYPOLY(OXYETHYLENE) POLY(OXYPROPYLENE)	Adjuvant
2023	ALPHA-ALKYL (C8-C18)-OMEGA-HYDROXYPOLY(OXYETHYLENE) POLY(OXYPROPYLENE)	Adjuvant
2700	ALPHA-ALKYL (C9-C11)-OMEGA-	Adjuvant

	HYDROXYPOLY(OXYETHYLENE)	
1884	ALPHA-ALKYL (C9-C16)-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
5862	ALPHA-ALKYL (C9-C18)-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
1392	ALPHA-ALKYL (MIXED)-OMEGA-HYDROXYPOLY (OXYETHYLENE) SULFATE	Adjuvant
5854	ALPHA-ALKYL (SECONDARY C12-C14)-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
748	ALPHA-ALKYLARYL-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
1874	ALPHA-ALKYL-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
1173	ALPHA-ALKYLPHENYL-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
5872	ALPHA-DECYL-OMEGA-HYDROXYPOLY(OXYETHYLENE) PHOSPHATE	Adjuvant
1244	ALPHA-OCTYLPHENYL-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
3929	ALPHA-UNDECYL-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Adjuvant
3046	AMMONIUM DODECYL POLY OXYETHYLENE SULFATE	Adjuvant
1075	CASEIN	Adjuvant
5719	DERIVATED NATURAL POLYMERS	Adjuvant
1108	DEXTRIN	Adjuvant
2028	DIMETHYL SILICONE FLUID EMULSION	Adjuvant
1776	DIPROPYLENE GLYCOL METHYL ETHER	Adjuvant
1702	EDTA	Adjuvant
1757	EDTA, SODIUM SALT	Adjuvant
759	EDTA, TETRASODIUM SALT	Adjuvant
1514	EMULSIFIABLE POLYETHYLENE	Adjuvant
5204	FATTY ACIDS DERIVED FROM TALLOW	Adjuvant
5881	FATTY ACIDS, C16-C18 AND C18-UNSATURATED, METHYL ESTERS	Adjuvant
389	FATTY ACIDS, METHYL ESTERS	Adjuvant
2069	FATTY ACIDS, MIXED	Adjuvant
1147	GLYCEROL	Adjuvant
4009	HEPTAMETHYLTRISILOXANE ETHOXYLATED	Adjuvant
5827	HEPTAMETHYLTRISILOXANE-1,3-PROPANEDIOL ETHER, ETHOXYLATED PROPOXYLATED	Adjuvant
5324	LAURIC ACID	Adjuvant
2636	LAURYL DIMETHYLAMINE OXIDE	Adjuvant
3689	METHYL SILICONE RESINS	Adjuvant
3519	METHYLATED SOYBEAN OIL	Adjuvant
3519	METHYLATED SOYBEAN OIL	Adjuvant
1159	MODIFIED PHTHALIC GLYCEROL ALKYD RESIN	Adjuvant
2807	N,N-BIS-(2-OMEGA-HYDROXYPOLY(OXYETHYLENE)ETHYL)ALKYLAMINE,	Adjuvant

	ALKYL DERIVED FROM TALLOW FATTY ACIDS	
1156	OLEIC ACID	Adjuvant
2266	OLEIC ACID, METHYL ESTER	Adjuvant
865	OLEIC ACID, POTASSIUM SALT	Adjuvant
3997	ORGANO/MODIFIED POLYSILOXANE	Adjuvant
5231	ORGANOSILICONE, POLY OXYALKYLENE ETHER COPOLYMER	Adjuvant
766	PETROLEUM SULFONATES	Adjuvant
2111	POLYACRYLAMIDE POLYMER	Adjuvant
2822	POLYACRYLAMIDE, POLYETHYLENE GLYCOL MIXTURE	Adjuvant
2196	POLYACRYLIC POLYMER	Adjuvant
3520	POLYALKENE OXIDE MODIFIED HEPTAMETHYL TRISILOXANE	Adjuvant
2271	POLYALKYLENE ETHER	Adjuvant
5203	POLYALKYLENEOXIDE MODIFIED POLYDIMETHYL-SILOXANE	Adjuvant
5223	POLYETHER MODIFIED POLYSILOXANE	Adjuvant
1600	POLYETHYLENE GLYCOL	Adjuvant
3841	POLYETHYLENE GLYCOL MONO(3-(TETRAMETHYL-1-(TRIMETHYLSILOXY)DISILOXANYL)PROPYL)ETHER	Adjuvant
3738	POLYMERIZED ACRYLIC ACID	Adjuvant
3744	POLYOXYETHYLENE DIOLEATE	Adjuvant
1698	POLYOXYETHYLENE POLYOXYPROPYLENE	Adjuvant
5873	POLYOXYETHYLENE SORBITAN MIXED FATTY ACID ESTERS	Adjuvant
2814	POLYOXYETHYLENE SORBITAN TRIOLEATE	Adjuvant
2112	POLYSACCHARIDE POLYMER	Adjuvant
5718	POLYSILOXANE	Adjuvant
998	PROPYLENE GLYCOL, METHYL ETHER	Adjuvant
1365	SALICYLIC AND BENZOIC ESTERS OF PROPYLENE GLYCOL	Adjuvant
1316	SAWDUST	Adjuvant
3796	SILICONE	Adjuvant
1917	SILICONE DEFOAMER	Adjuvant
909	SODIUM XYLENE SULFONATE	Adjuvant
1882	SOYBEAN FATTY ACIDS, DIMETHYLAMINE SALT	Adjuvant
5399	STYRENE BUTADIENE COPOLYMER	Adjuvant
2912	TALL OIL	Adjuvant
1389	TALL OIL FATTY ACIDS	Adjuvant
1754	VINYL POLYMER	Adjuvant
2272	XANTHAN GUM	Adjuvant
3658	FISH OIL	Adjuvant, Deer Repellent, Dog and Cat Repellent
911	N-(2-HYDROXYETHYL)ETHYLENEDIAMINETRIACETIC ACID,	Adjuvant,

	TRISODIUM SALT	
596	TRIETHYLENE GLYCOL	Adjuvant, Microbiocide
1937	2-ETHYLHEXYL SULFATE, SODIUM SALT	
3573	ALKYL (AS IN FATTY ACIDS OF COCONUT OIL) MONOETHANOLAMIDE	Adjuvant, Soap/Surfactant
2024	ALPHA-[PARA-(1,1,3,3,-TETRAMETHYLBUTYL)PHENYL]-OMEGA-HYDROXYPOLY(OXYETHYLENE) PHOSPHATE ESTER	
3920	ALPHA-ALKYL (C10-C16)-OMEGA-HYDROXYPOLY(OXYETHYLENE) POLY(OXYPROPYLENE) PHOSPHATE	Adjuvant, Soap/Surfactant
2368	ALPHA-ALKYLARYL-OMEGA-HYDROXYPOLY(OXYETHYLENE) PHOSPHATE	
4008	ALPHA-ISODECYL-OMEGA-HYDROXYPOLY(OXYETHYLENE) PHOSPHATE	Adjuvant, Soap/Surfactant
5974	CASTOR OIL ETHOXYLATE	
3976	N,N-BIS-(2-(OMEGA-HYDROXYPOLY(OXYETHYLENE)/POLY(OXYPROPYLENE))ETHYL)ALKYL (C8-C18) AMINE	Adjuvant, Soap/Surfactant
3740	POLYETHOXYLATED CASTOR OIL	
2796	POLYETHYLENE GLYCOL DIACETATE	Adjuvant, Soap/Surfactant
2800	POLYETHYLENE GLYCOL OLEATE	
2064	SORBITAN FATTY ACID ESTERS	Adjuvant, Soap/Surfactant
2870	SORBITAN MONOOLEATE	
2872	SORBITAN TRIOLEATE	Adjuvant, Soap/Surfactant
2334	DIETHYLENE GLYCOL	
1503	POLYOXYETHYLENE SORBITAN MONOOLEATE	Adjuvant, Surfactant
3628	CORN SYRUP	
708	SUGAR	Bait
3971	METHYL ANTHRANILATE	
5833	5,5-DIMETHYLHYDANTOIN	Breakdown product
5925	COYOTE URINE	
5926	FOX URINE	Deer Repellent
90877	METHYL NONYL KETONE, OTHER RELATED	
3515	D & C RED NO. 28	Dye
3991	D & C YELLOW NO. 8	
366	MALACHITE GREEN	Dye
508	PROPYLENE OXIDE	
618	SULFURYL FLUORIDE	Fumigant

616	METAM-SODIUM	Fumigant, Herbicide, Fungicide, Microbiocide, Algaecide
484	ALUMINUM PHOSPHIDE	Fumigant, Fungicide
233	DAZOMET	Fumigant, Fungicide, Nematicide
329	HYDROGEN CHLORIDE	Fumigant, Fungicide, Nematicide, pH Adjustment, Herbicide
1459	FREON 12	Fumigant, Insecticide
1460	TRICHLOROFLUOROMETHANE	Fumigant, Insecticide
385	METHYL BROMIDE	Fumigant, Insecticide, Herbicide, Nematicide
392	METHYL ISOTHIOCYANATE	Fumigant, Insecticide, Herbicide, Nematicide, Breakdown product
3541	PHOSPHINE	Fumigant, Insecticide, Metabolite
2085	MAGNESIUM PHOSPHIDE	Fumigant, Insecticide, Rodenticide
573	1,3-DICHLOROPROPENE	Fumigant, Nematicide
136	CHLOROPICRIN	Fumigant, Nematicide
5782	OIL OF LEMON EUCALYPTUS	Insect repellent
410	OXYTHIOQUINOX	Insecticide, Fungicide, Fumigant
89	2-BUTOXYETHANOL	Other product constituent
1629	SORBITOL	Other product constituent
622	XYLENE	Other product constituent
1399	BENTONITE	Other product constituent, Adjuvant
1364	MALIC ACID	Other product constituent, Microbiocide

5786	1,7-DIOXASPIRO-(5,5)-UNDECANE	Pheromone
	E,E-8,10-DODECADIEN-1-OL	Pheromone
2269	FARNESOL	Pheromone
	GERMAN COCKROACH PHEROMONE	Pheromone
2268	NEROLIDOL	Pheromone
	Z,E-9,12-TETRADECADIEN-1-YL ACETATE	Pheromone
2343	LAURYL ALCOHOL	Pheromone, Adjuvant
	MYRISTYL ALCOHOL	Pheromone, Fragrance
5770	BACILLUS PUMILUS, STRAIN QST 2808	Plant Growth Regulator
	DAMINOZIDE	Plant Growth Regulator
2004	DIKEGULAC SODIUM	Plant Growth Regulator
	ETHEPHON	Plant Growth Regulator
2320	FLURPRIMIDOL	Plant Growth Regulator
	GIBBERELLINS	Plant growth regulator
323	IBA	Plant Growth Regulator
	N6-BENZYL ADENINE	Plant Growth Regulator
423	NAA	Plant Growth Regulator
	NAA, AMMONIUM SALT	Plant Growth Regulator
749	NAA, ETHYL ESTER	Plant Growth Regulator
	PACLOBUTRAZOL	Plant Growth Regulator
3933	OLEIC ACID, ETHYL ESTER	Plant Growth Regulator, Adjuvant
	ALPHA-(PARA-NONYLPHENYL)-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Plant Growth Regulator, Adjuvant, Surfactant
421	NAPHTHALENE	Repellent, Other product constituent
	METHYL NONYL KETONE	Repellent, Sterilant
3981	BENZYLDIETHYL [(2,6-XYLYLCARBAMOYL)METHYL] AMMONIUM SACCHARIDE	Rodent Repellent, Bird Repellent, Deer Repellent
	BUTYL ALCOHOL	Solvent
2601	HYDROTREATED PARAFFINIC SOLVENT	Solvent
	METHYLENE CHLORIDE	Solvent
1174	TETRACHLOROETHYLENE	Solvent

595	TRICHLORO ETHYLENE	Solvent
276	ETHYLENE GLYCOL	Solvent, Adjuvant
	ETHYLENE GLYCOL MONOMETHYL ETHER	Solvent, Adjuvant
5866	SODIUM DECYL SULFATE	Surfactant
	SODIUM LAUROAMPHO ACETATE	Surfactant
396	N-OCTYL BICYCLOHEPTENE DICARBOXIMIDE	Synergist
	PIPERONYL BUTOXIDE	Synergist
90486	PIPERONYL BUTOXIDE, OTHER RELATED	Synergist
	SULFAQUINOXALINE	Synergist
182	1,3,4,6-TETRACHLOROGLYCOLURIL	Unclassified
	ABIETIC ANHYDRIDE	Unclassified
2118	ACRYLIC ACID	Unclassified
	ALKANOIC AND ALKENOIC (C18) MONO- AND DIESTERS OF ALPHA-HYDRO-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Unclassified
4006	ALKYL (C9-C11) OLIGOMERIC D-GLUCOPYRANOSIDE	Unclassified
	ALMOND, BITTER	Unclassified
1196	ALPHA-2,6,8-TRIMETHYL-4-NONYLOXY-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Unclassified
	ALPHA-ALKYL (C10-C16)-OMEGA-HYDROXYPOLY(OXYETHYLENE)	Unclassified
1889	AMYL ACETATE	Unclassified
	AURAMINE	Unclassified
94	CADMIUM CHLORIDE	Unclassified
	CADMIUM SEBACATE	Unclassified
2078	COTTONSEED FLOUR	Unclassified
	DIETHYLENE GLYCOL ABIETATE	Unclassified
223	DIOCTYL PHTHALATE	Unclassified
	FATTY ACIDS (C12-C18), METHYL ESTERS	Unclassified
3657	FENUGREEK	Unclassified
	HALAZONE	Unclassified
3668	HEPTYL BUTYRATE	Unclassified
	ISOOCTYL PHTHALATE	Unclassified
1641	ISOPARAFFINIC HYDROCARBONS	Unclassified
	LACTOSE	Unclassified
1765	LIGNIN SULFONIC ACID	Unclassified
	LIGNIN SULFONIC ACID, COPPER SALT	Unclassified
1770	LIGNIN SULFONIC ACID, MANGANESE SALT	Unclassified
	LIGNIN SULFONIC ACID, ZINC SALT	Unclassified
658	MANGANESE SULFATE	Unclassified
	METHYL CELLULOSE	Unclassified
5292	METHYLATED SILICA	Unclassified
	PETROLEUM DERIVATIVE RESIN	Unclassified

513	PHOSPHORUS	Unclassified
	PIPERINE	Unclassified
1764	POTASSIUM RESINATE	Unclassified
	SESAME OIL	Unclassified
3396	SODIUM DIHEXYL SULFOSUCCINATE	Unclassified
	SODIUM PERSULFATE	Unclassified
2863	SODIUM POLYACRYLATE	Unclassified
	STARCH	Unclassified
90559	SULFOXIDE, OTHER RELATED	Unclassified
	VANILLIN	Unclassified
700	POTASSIUM CHROMATE	Wood Preservative

(b) Chemical group

CHEM_CODE	CHEMNAME	Group
1935	PUTRESCENT WHOLE EGG SOLIDS	Animal derived
2094	PHENYLETHYL PROPIONATE	Botanical
2328	AZADIRACHTIN	Botanical
5969	BALSAM FIR OIL	Botanical
470	CAPSICUM OLEORESIN	Botanical
2322	CORN PRODUCT, HYDROLYZED	Botanical
756	CUBE EXTRACTS	Botanical
2213	GARLIC	Botanical
3264	LECITHIN	Botanical
6065	MARGOSA OIL	Botanical
6009	METHYL EUGENOL	Botanical
3979	CLARIFIED HYDROPHOBIC EXTRACT OF NEEM OIL	Botanical
75	NICOTINE	Botanical
485	PINE OIL	Botanical
510	PYRETHRINS	Botanical
3779	QUILLAJA	Botanical
518	ROTENONE	Botanical
90518	ROTENONE, OTHER RELATED	Botanical
554	STRYCHNINE	Botanical
2330	THYME	Botanical
2739	NONANOIC ACID	Fatty acid
4025	METHYLATED FATTY ACIDS FROM CANOLA OIL	Fatty acid ester
1198	FREE FATTY ACIDS AND/OR AMINE SALTS	Fatty acid, Soap
3038	AMMONIUM BICARBONATE	Inorganic
3052	AMMONIUM NITRATE	Inorganic
21	AMMONIUM SULFAMATE	Inorganic

1363	AMMONIUM SULFATE	Inorganic
892	AMMONIUM THIOSULFATE	Inorganic
79	BORAX	Inorganic
769	BORIC ACID	Inorganic
5951	BORON OXIDE	Inorganic
2323	BROMINE CHLORIDE	Inorganic
326	CALCIUM HYPOCHLORITE	Inorganic
712	CARBON	Inorganic
131	CHLORINE	Inorganic
2053	CHLORINE DIOXIDE	Inorganic
173	CRYOLITE	Inorganic
2238	HYDROGEN CYANAMIDE	Inorganic
195	DIATOMACEOUS EARTH	Inorganic
90195	DIATOMACEOUS EARTH, OTHER RELATED	Inorganic
5053	DISODIUM OCTABORATE ANHYDROUS	Inorganic
1800	DISODIUM OCTABORATE TETRAHYDRATE	Inorganic
1811	FERRIC SULFATE (ANHYDROUS)	Inorganic
289	FERROUS SULFATE	Inorganic
1812	FERROUS SULFATE (MONOHYDRATE)	Inorganic
718	IODINE	Inorganic
5014	IRON PHOSPHATE	Inorganic
358	LIME-SULFUR	Inorganic
365	MAGNESIUM CHLORIDE	Inorganic
1339	MAGNESIUM SULFATE	Inorganic
2267	NITROGEN, LIQUIFIED	Inorganic
899	OXALIC ACID	Inorganic
871	PHOSPHORIC ACID	Inorganic
2777	PHOSPHORIC ACID, MONOPOTASSIUM SALT	Inorganic
1306	POTASSIUM HYDROXIDE	Inorganic
726	POTASSIUM NITRATE	Inorganic
498	POTASSIUM PERMANGANATE	Inorganic
529	SILICA AEROGEL	Inorganic
1103	SODIUM BROMIDE	Inorganic
6031	SODIUM BROMOSULFAMATE, SODIUM CHLOROSULFAMATE, POTASSIUM BROMOSULFAMATE, POTASSIUM CHLOROSULFAMATE	Inorganic
2148	SODIUM CHLORITE	Inorganic
537	SODIUM FLUORIDE	Inorganic
538	SODIUM FLUOSILICATE	Inorganic
362	SODIUM HYDROXIDE	Inorganic

539	SODIUM HYPOCHLORITE	Inorganic
689	SODIUM METABORATE	Inorganic
4013	SODIUM METABORATE TETRAHYDRATE	Inorganic
1840	SODIUM METASILICATE	Inorganic
696	SODIUM NITRATE	Inorganic
1808	SODIUM TETRABORATE (PENTAHYDRATE)	Inorganic
1024	SODIUM TRIPOLYPHOSPHATE	Inorganic
560	SULFUR	Inorganic
561	SULFUR DIOXIDE	Inorganic
1918	TETRAPOTASSIUM PYROPHOSPHATE	Inorganic
1579	TRISODIUM PHOSPHATE	Inorganic
2270	UREA DIHYDROGEN SULFATE	Inorganic
626	ZINC PHOSPHIDE	Inorganic
662	UREA	Inorganic
624	ZINC CHLORIDE	Inorganic
1111	ZINC NAPHTHENATE	Inorganic
667	ZINC SULFATE	Inorganic
40	ARSENIC ACID	Inorganic compound
42	ARSENIC TRIOXIDE	Inorganic compound
1007	CALCIUM CARBONATE	Inorganic compound
920	CALCIUM CHLORIDE	Inorganic compound
99	CALCIUM HYDROXIDE	Inorganic compound
854	SODIUM CARBONATE	Inorganic compound
536	SODIUM CHLORATE	Inorganic compound
721	SODIUM CHLORIDE	Inorganic compound
5766	POTASSIUM PHOSPHITE	Inorganic salt mixture
283	SODIUM ARSENATE	Inorganic, Heavy metal
2856	SILVER NITRATE	Inorganic, Heavy metal
5150	SILVER, IONIC	Inorganic, Heavy metal
2409	BACILLUS SPHAERICUS, SEROTYPE H-5A5B, STRAIN 2362	Microbial
3945	BACILLUS SUBTILIS GB03	Microbial
86	BACILLUS THURINGIENSIS (BERLINER)	Microbial
3856	BACILLUS THURINGIENSIS (BERLINER), SUBSP. AIZAWAI, SEROTYPE H-7	Microbial
3857	BACILLUS THURINGIENSIS (BERLINER), SUBSP. ISRAELENSIS, SEROTYPE H-14	Microbial
3970	BACILLUS THURINGIENSIS (BERLINER), SUBSP. KURSTAKI STRAIN SA-12	Microbial
3858	BACILLUS THURINGIENSIS (BERLINER), SUBSP. KURSTAKI,	Microbial

	SEROTYPE 3A,3B	
3860	BACILLUS THURINGIENSIS (BERLINER), SUBSP. KURSTAKI, STRAIN EG2371	
3862	BACILLUS THURINGIENSIS (BERLINER), SUBSP. KURSTAKI, STRAIN SA-11	Microbial
	BACILLUS THURINGIENSIS, SUBSP. AIZAWAI, STRAIN ABTS-1857	
5841	BACILLUS THURINGIENSIS, SUBSP. ISRAELENSIS, STRAIN AM 65-52	Microbial
	BACILLUS THURINGIENSIS, SUBSP. KURSTAKI, STRAIN ABTS-351, FERMENTATION SOLIDS AND SOLUBLES	
4023	BACILLUS THURINGIENSIS, SUBSP. KURSTAKI, STRAIN HD-1	Microbial
	BACILLUS THURINGIENSIS, VAR. KURSTAKI DELTA ENDOTOXINS CRY 1A(C) AND CRY 1C (GENETICALLY ENGINEERED) ENCAPSULATED IN PSEUDOMONAS FLUORESCENS (KILLED)	
3993	BEAUVERIA BASSIANA STRAIN GHA	Microbial
	GLIOCLADIUM VIRENS GL-21 (SPORES)	
3935	METARHIZIUM ANISOPLIAE, VAR. ANISOPLIAE, STRAIN ESF1	Microbial
	MYROTHECIUM VERRUCARIA, DRIED FERMENTATION SOLIDS & SOLUBLES, STRAIN AARC-0255	
92739	NONANOIC ACID, OTHER RELATED	Microbial
	NOSEMA LOCUSTAE SPORES	
5861	PAECILOMYCES LILACINUS STRAIN 251	Microbial
	PANTOEA AGGLOMERANS STRAIN E325, NRRL B-21856	
2842	PSEUDOMONAS FLUORESCENS, STRAIN A506	Microbial
	QST 713 STRAIN OF DRIED BACILLUS SUBTILIS	
5823	REYNOUTRIA SACHALINENSIS	Microbial
	STREPTOMYCES LYDICUS WYEC 108	
3977	TRICHODERMA HARZIANUM RIFAI STRAIN KRL-AG2	Microbial
	TRICHODERMA ICC 012 ASPERELLUM	
5982	TRICHODERMA ICC 080 GAMSII	Microbial
	EMAMECTIN BENZOATE	
1217	STREPTOMYCIN	Micro-organism derived
	ESSENTIAL OILS	
979	LIMONENE	Oil - essential
	METHYL SALICYLATE	
1051	OIL OF ANISE	Oil - essential
	OIL OF BLACK PEPPER	
143	OIL OF CITRONELLA	Oil - essential
	OIL OF JOJOBA	
2058	OIL OF PEPPERMINT	Oil - essential

5332	CANOLA OIL	Oil - vegetable
1013	CASTOR OIL	Oil - vegetable
	COTTONSEED OIL	Oil - vegetable
2335	SOYBEAN OIL	Oil - vegetable
	VEGETABLE OIL	Oil - vegetable
2395	AROMATIC 150	Petroleum derivative
	COAL TAR NEUTRAL OILS AND COAL TAR ACID COMBINATIONS	Petroleum derivative
2071	KEROSENE	Petroleum derivative
	MINERAL OIL	Petroleum derivative
5179	ORCHEX 796 OIL	Petroleum derivative
	PARAFFIN WAX	Petroleum derivative
763	PETROLEUM DISTILLATES	Petroleum derivative
	PETROLEUM DISTILLATES, ALIPHATIC	Petroleum derivative
1814	PETROLEUM DISTILLATES, AROMATIC	Petroleum derivative
	PETROLEUM DISTILLATES, REFINED	Petroleum derivative
473	PETROLEUM HYDROCARBONS	Petroleum derivative
	PETROLEUM NAPHTHENIC OILS	Petroleum derivative
2045	PETROLEUM OIL, PARAFFIN BASED	Petroleum derivative
	PETROLEUM OIL, UNCLASSIFIED	Petroleum derivative
862	XYLENE RANGE AROMATIC SOLVENT	Petroleum derivative
	LINALOOL	Plant derived
5230	SUCROSE OCTANOATE	Plant derived
	THYMOL	Plant derived
1017	AMMONIUM LAURYL SULFATE	Soap
	AMMONIUM TALL OIL FATTY ACID SOAP	Soap
2088	COCONUT OIL SOAP	Soap
	DODECYLBENZENE SULFONIC ACID	Soap
3247	ISOPROPYLAMINE DODECYLBENZENE SULFONATE	Soap
	POTASH SOAP	Soap
772	SOAP	Soap
	SODIUM DODECYLBENZENE SULFONATE	Soap
907	SODIUM LAURYL SULFATE	Soap

Appendix 5. Template of the pesticide toxicity database to be used in the prioritization

Notes:

1. data for 30 chemicals are demonstrated in the table, selected from the top 20 chemicals in the statewide, annual prioritization results for agricultural and urban areas of California (Table 2),
2. All toxicity data are in the unit of ppb,
3. BMA: (USEPA) acute toxicity benchmark, BMAD: (USEPA) the lowest acute toxicity benchmark of degredates, BMC (USEPA) chronic toxicity benchmark
4. BMAP: acute toxicity benchmark equivalent, BMAPD: the lowest acute toxicity benchmark equivalent of degredates.

CHEM_ CODE	CHEMNAME	**Aquatic life benchmark**							Drinking water standard	**Human health benchmark**	
		USEPA Benchmarks				Benchmark equivalent					
		BMA	BMAD		BMC	BMAP	BMAPD			Acute	Chronic
3	ACROLEIN	7			7.1	11					
3956	BETA-CYFLUTHRIN					0.034	500	3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylic acid			
2300	BIFENTHRIN	0.075			0.001	0.055				3300	91
83	BROMACIL	6.8			3000	13			70		
105	CARBARYL	0.85			0.5	3.2	2120	1-naphthol	400		
677	CHLOROTHALONIL	1.8	4600	SDS-3701	0.6	19	4600	2-amido-3,5,6-trichlo-4-cyanobenzenesulphonic acid	150		
253	CHLORPYRIFOS	0.05			0.04	0.05	610	3,5,6-trichloro-2-pyridinol	2		
714	COPPER	2.05			1.11				1300		
2223	CYFLUTHRIN	0.013			0.007	0.08	500	3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropanecarboxylic acid		200	168
2171	CYPERMETHRIN	0.195			0.069	0.15	25	3-phenoxybenzoic acid		1000	420
3010	DELTAMETHRIN	0.055			0.004	0.13	25	3-phenoxybenzoic acid		100	70
198	DIAZINON	0.11	50500	Oxypyrimidine	0.17	0.5	50000	pyrimidinol	1		
229	DIQUAT DIBROMIDE	0.75	21500	CGA-354743	36	21			20		

231	DIURON	2.4			26	2.7	60	3,4-dichloroaniline	100		
3995	FIPRONIL	0.11			0.011	68	12.5	fipronil sulfone		250	1
5802	FLUMIOXAZIN					0.852				990	140
2297	LAMBDA-CYHALOTHRIN	0.004			0.002	0.105	25	3-phenoxybenzoic acid		50	7
367	MALATHION	0.3			0.035	0.35	1750	malathion monocarboxylic acid	200		
383	METHOMYL	2.5			0.7	3.8			200		
1973	OXYFLUORFEN	0.29			1.3	125					210
1601	PARAQUAT DICHLORIDE	0.396			36.9	320			30		
1929	PENDIMETHALIN	5.2			6.3	6					210
2008	PERMETHRIN	0.01			0.001	0.3				2500	1750
335	PHOSMET	1			0.8	1				356	42
2236	PRODIAMINE					3					
503	PROPANIL	16			9.1	110	60	P{3,4-dichloroaniline}			63
5133	S-METOLACHLOR	8			30	8					
2149	SULFOMETURON-METHYL	0.48			97000	6250				2750	1925
597	TRIFLURALIN	7.52			1.14	12.2			10		
629	ZIRAM	9.7			39	0.485	5.5	P{thiram}		500	112