**Department of Pesticide Regulation**
**Environmental Monitoring Branch**
**1001 I Street**
**Sacramento, CA 95812**

# STUDY 329: Surface Water Monitoring for Pesticides in Urban Areas of Northern California (WY 2022/2023)

**Joshua Alvarado**
**Kari McClanahan**
**May 2023**

## 1.0 INTRODUCTION

Pesticides are commonly applied in urban areas. More than 5.75 million pounds of pesticides were reported as used in 2021 for structural and landscape applications in the California Department of Pesticide Regulation (CDPR) Pesticide Use Reporting Database (PUR) (CDPR, 2021). The total amount of pesticides applied in urban areas is likely higher, as non-professional use is not reported in PUR. Although it is difficult to quantify the amount of non-professional use, numerous products are available to the general public and it has been estimated that up to 70% of all urban pesticide use is from non-professional application sources (Budd and Peters, 2018; Moran, 2008). With this urban load, there is high potential for pesticide runoff into urban creeks and rivers. Monitoring studies have frequently detected pesticides in urban surface waters. Toxicity testing has revealed that urban-use pesticides have the potential to adversely affect aquatic invertebrate organisms in urban surface waters (Budd et al, 2020; Holmes et al., 2008; Lao et al., 2010; Weston and Jackson, 2009; Weston and Lydy, 2014). Other studies have associated potential toxicity based on exceedances of US EPA's aquatic benchmarks (Budd et al., 2015; Ensminger et al., 2013, Gan et al., 2012, Batikian et al., 2019). Label changes or regulations have been enacted to mitigate the effects of specific pesticides where toxicity was a concern (CDPR, 2020b; UC ANR, 2019, USEPA, 2017a, b, c).

To determine pesticide exposures in urban runoff and surface waters, CDPR's Surface Water Protection Program (SWPP) began monitoring California's urban areas in 2007; the study became a statewide monitoring program in 2008 (He, 2008; Kelley, 2007). This program helped define pesticide runoff patterns from urban neighborhoods and watersheds (Budd et al, 2020; Budd et al., 2015; Ensminger et al., 2013). Continued high use of pesticides in urban areas, frequent detections in surface water, and implementation of mitigation actions warrant continued monitoring of the state's urban waterways. Study 329 continues its urban monitoring in Northern California from FY 2020/2021 (Smith, 2021) and FY 2021/2022. Due to staff changes in the latter year, a study protocol was not completed. During FY 2021/2022, study 329 monitoring followed the protocol outlined in FY 2020/2021 (Smith, 2021). This study will continue to evaluate sources of pesticide runoff, monitor larger urban watersheds, and evaluate toxicity at selected sites.

Data from all the sites will be used to evaluate urban pesticide water quality trends. The plan will also serve as a guide in transitioning from a fiscal to water year calendar for this and future study years.

## 2.0 OBJECTIVES

For Study 329 (WY 2022/2023), Northern California urban monitoring, the objectives are:

1) Identify the presence and concentrations of pesticide contamination in urban runoff and waterways;
2) Evaluate the magnitude of measured concentrations relative to water quality or aquatic toxicity thresholds;
3) At selected monitoring sites, determine the toxicity of water samples in laboratory toxicity tests conducted with *Hyalella azteca* and *Chironomus dilutus*;
4) Evaluate the effectiveness of surface water regulations or label changes through long-term (multi-year) monitoring at selected sampling locations;
5) Monitor the concentration of sediment-bound pyrethroids at long-term monitoring sites;
6) At selected monitoring sites, determine the effectiveness of a structural BMP's (i.e., carbon sock) removal of pesticide residues from runoff;
7) At selected monitoring sites, determine the toxicity of water samples, with respect to particle-bound contaminants.

## 3.0 PERSONNEL

The study will be conducted by staff from the CDPR's Environmental Monitoring Branch, Surface Water Protection Program, under the general direction of Anson Main, Environmental Program Manager I. Key personnel are listed below:

- Co-Project Leaders: Joshua Alvarado (2022-2023) and Kari McClanahan (2023)
- Field Coordinator: N/A
- Reviewing Scientist: Robert Budd, Ph.D.
- Statistician: Xuyang Zhang, Ph.D.
- Laboratory Liaison: Joshua Alvarado
- Analytical Chemistry: Center for Analytical Chemistry, California Department of Food and Agriculture (CDFA)

Please direct questions regarding this study to Joshua Alvarado and Kari McClanahan, Environmental Scientists, at Joshua.Alvarado@cdpr.ca.gov and Kari.McClanahan@cdpr.ca.gov.

## 4.0 STUDY PLAN

**4.1 Site Selection.** Historically, sites for CDPR's Northern California urban monitoring project were selected based on various criteria with professional judgement accounting for a large portion of the final site selection (Ensminger, 2008). Now, the Surface Water Monitoring Prioritization (SWMP) model is used to identify priority areas for monitoring (Luo et al., 2017). The SWMP model incorporates pesticide use, aquatic toxicity, and population density data at the Hydrological Unit Code 12 (HUC;

USGS, 2020a) watershed level to rank areas for monitoring by aggregating HUC12s into larger HUC8 watersheds.

The SWMP model limits personal bias although the numbers of pesticides to consider and HUC8 watersheds to incorporate into the model are still determined by the user. For this study, HUC12s were considered if they met the following criteria:

1) Contained in the eight Northern California HUC4s (HUC4=18**) as defined in Luo et al. (2017);
2) Ranked in the top eight HUC8s by SWMP (based on final pesticide priority score of ≥ 9 for urban pesticide use [structural pest control and landscape maintenance]);
3) Ranked in the top three mainstem or tributary type watersheds at the HUC12 level.

Using a ranking of ≥ 9 allows for selecting monitoring areas that have a higher potential for adverse risk to more sensitive aquatic organisms. Final HUC12 selection was then based on historical monitoring, fulfilling study objectives, site access and safety, budget constraints, exclusion of agricultural inputs, and spatial distribution between top ranked HUC12s selected by the model. With updated PUR data incorporated into the SWMP model, the top monitoring priority areas for WY 2022/2023 remain fairly constant from the previous protocol. The Sacramento and San Francisco Bay areas are the two main areas of Northern California where the highest levels of pesticide are expected in urban runoff. Of the top eight ranked HUC8s, three are in the Sacramento area, four are in the San Francisco Bay area, and one is in the San Joaquin Delta (Appendix 1).

Surface water monitoring programs generally monitor at urban creeks or rivers. In addition to these waterbodies, SWPP's urban monitoring program also monitors at storm drain outfalls. Because of lower dilution effects and proximity to the source of pesticide applications compared to waterbodies, storm drain outfalls tend to have higher pesticide detections and concentrations. Information from storm drain outfalls allows for a more direct measure of land use contributions (e.g., residential, commercial, industrial, and other non-residential areas).

**4.1.1 Sacramento Area**. The Sacramento area ranks higher than the San Francisco Bay area in the SWMP, with two top ranked HUC8s (Appendix 1), even given the much larger population in the San Francisco Bay area (California Department of Finance: Demographics, 2020). Monitoring will occur within the two top ranked HUC8s at three HUC12 watersheds: Pleasant Grove Creek, Miner's Ravine, and Arcade Creek (Figure 1). Monitoring will occur at established mainstem creek sites in the Pleasant Grove Creek (PGC058) and Arcade Creek (ARC_ARC) watersheds (Appendix 2). The Arcade Creek site is near the USGS gage station 11447360. Sampling sites at or near USGS gage stations allow for a QC check on storm runoff collection percentage and can be used to estimate mass loading. In the Miner's Ravine Watershed, the mainstem creek site has been moved upstream from Dry Creek since FY 2020/2021. The move upstream will allow for sampling closer to urban sources.

For WY 2022/2023, the Northern California Urban Monitoring Program will monitor three storm drain outfalls, two in the Pleasant Grove Creek Watershed and one in the Lower American Watershed (Appendix 2; Figure 1). These sites have been monitored for at least eleven years and are considered long-term monitoring sites, used for trend analysis. The Lower American Watershed (site FOL2) does not rank in the top three HUC12s for monitoring in SWMP as described in the criteria for HUC12 selection, but because of concentration trends in past monitoring data, it will continue to be monitored. Carbon sock structural BMPs will be deployed at two sites (FOL2 and PGC022) during the dry season. Effectiveness of BMP treatment will be determined by comparing pre- and post- carbon sock pesticide concentrations. In addition, water samples from two sites

(FOL2 and PGC022) will be collected and mechanically filtered to remove particle-bound contaminants prior to chemical and toxicological analyses. This will help in determining the impact particle-bound contamination has on both pesticide concentration and aquatic toxicity.

**4.1.2 San Francisco Bay Area.** In the San Francisco Bay area, monitoring will continue at mainstem creeks and rivers in three top ranked HUC8s (consisting of five HUC12 watersheds; Appendix 2, Figure 2). All these mainstem sites were monitored in the past few years, but two of these (Guadalupe River and Silver Creek HUC12s) continue to have limited storm runoff data collected by autosamplers due to issues with site access, autosampler failure, and staffing resource. In the three other HUC12 watersheds (Walnut Creek, San Lorenzo Creek, and South San Ramon Creek), autosampler collection has been successful and began to provide sufficient data to better understand the storm runoff profile. The San Lorenzo and Guadalupe sites are also important as a quality control check of the autosampler collection. These sites are at or near USGS gage stations, which allows SWPP staff to calculate the percentage of the storm runoff sampled. Insufficient storm water sampling could mark the storm samples as of poor quality for a storm composite sample.

**4.1.3 Exploratory Sites.** During WY 2022/2023, monitoring may include water samples from sites intended to broaden spatial distribution, investigate runoff from other sources, or collaborate with other monitoring studies. Monitoring will occur in top ranked HUC12s (Figures 1, 2). Samples collected will be <15% of the total samples collected in WY 2022/2023.

**4.2 Selection of Pesticides.** For ambient monitoring, the SWMP model was used to assist in pesticide selection. Based on current use patterns, aquatic toxicity benchmarks, and physicochemical properties; the SWMP output is presented as a relative prioritization (final) score (Budd et al., 2013; Luo, 2015). The final score provides a guideline for monitoring. However, the decision to monitor a specific pesticide is influenced by other factors, including previous monitoring data, budgetary constraints, pesticide use patterns, and current analytical capabilities.

For this study, pesticides that received a final score of nine or higher in the SWMP model for urban use (structural pest control and landscape maintenance) were considered for monitoring unless: 1) they received a “false” recommendation in the SWMP model, based on the pesticides physicochemical properties, and are not likely to cause surface water toxicity; 2) there is no CDFA analytical method; 3) previous monitoring results had few detections, or 4) their use pattern is not likely to runoff into surface water. Pesticides with a score of less than 9 will not be monitored unless they are included in the same analytical screen as higher ranking pesticides. Other pesticides that received final scores less than 9 have either low urban use or low potential toxicity; therefore, these active ingredients were not considered high priority for monitoring.

The Sacramento and San Francisco Bay areas were modeled separately in SWMP as two distinct geographical areas. In Sacramento, the SWMP model selected 24 pesticides for monitoring with a final score $\geq$9. Currently, CDFA has analytical methods for 21 of these pesticides (Appendix 3). In the San Francisco Bay area, the SWMP model selected 27 pesticides; CDFA has methods for 21 of the pesticides (Appendix 4).

The SWPP will monitor all the selected pesticides with a CDFA analytical method except glufosinate-ammonium (see Appendix 5 excluded chemicals).

**4.3 Water Sampling.** In transitioning from fiscal year (FY2021/2022) to water year (WY2022/2023), there will be three dry-season and two storm samplings (Table 1). One dry event will occur between July-Sept 2022 and the remaining two will occur between June-Sept 2023. The two storm collections will occur between October 2022 and March 2023. The first storm will be collected in the fall (October-December), with priority to the "first flush" storm after the long dry season, regardless of month. The second storm will be collected in the winter (January–March). Water samples from exploratory sites may be monitored during a third storm during the rainy season. During dry-season monitoring, water samples will be collected as grab samples directly into 1-L amber bottles (Bennett, 1997). Where the stream is too shallow to collect water directly into these bottles, a stainless-steel container will be used to initially collect the water samples. During storm events, samples will usually be collected with Teledyne ISCO automatic 6700 series samplers unless resources are lacking; in these cases, grab samples may be substituted. For ISCO samplers, time- weighted aliquots of the entire storm sample will be collected as a composite sample (Jones, 2000). Samples will be transported on wet ice and then refrigerated at 4°C until analyzed.

**4.4 Sediment Sampling.** Sediments will be collected with stainless steel scoops from the top bed layer (Mamola, 2005). All sediments will be sifted through a 2-mm sieve to remove gravel and plant material and analyzed for pyrethroids and total organic carbon. In the Sacramento area, sediments will be collected twice a year at select Roseville and Folsom sites during the dry season (Table 1). In the San Francisco Bay area, sediments will be collected once a year at San Ramon and Silver Creek sites, usually during the second dry sampling event. During this transitionary period, Sacramento area sites will be collected during all dry events (three events) and San Francisco Bay area sites will only be collected during the second dry events (two events). Other sites in the San Francisco Bay area where sediments can be collected are currently monitored through the stream pollution trends (SPOT) monitoring program (SWRCB, 2020).

**4.5 Toxicity.** Water samples will be collected from a subset of the sampling sites and sent to the University of California, Davis, Aquatic Health Program to be tested for toxicity to *H. azteca* and *C. dilutus*. Roseville monitoring sites and joint SPOT-CDPR sampling sites are the focus for toxicity testing because of historical testing at these sites.

**4.6 Field Measurements.** Water physicochemical properties (dissolved oxygen, electrical conductivity, pH, salinity, temperature, and total dissolved solids) will be measured *in situ* during all sampling events with a calibrated Aqua TROLL 400 multiparameter probe. Flow data at or near sites at USGS gaging stations (Arcade Creek, Guadalupe River, and San Lorenzo Creek) will be utilized to estimate storm percentage completion (USGS, 2020b).

**4.7 Sample Transport.** SWPP staff will transport samples following the procedures outlined in CDPR SOP QAQC004.01 (Jones, 1999). A chain-of-custody record will be completed and accompany each sample.

**4.8 Modifications for WY 2022/2023.** The current sampling plan is an extension of urban monitoring in Northern California (previous sampling protocols, including Studies 269, 299, and

329 can be found here). The sampling and analysis schedule are similar to previous years. There are a few main differences from FY 2021/2022:

1) Transitioning Study 329 from a fiscal year (FY) to water year (WY) calendar.
2) Continuing the expansion of exploratory sites in ranked HUC12 watersheds to cultivate potentially new monitoring sites through a collaboration with the San Francisco Estuary Institute (SFEI). This will expand the knowledge of urban runoff in the San Francisco Bay area. Exploratory sites in the Sacramento area may also be investigated.
3) Study 329 will investigate the effects that bio-char carbon socks have on removing pesticide residues at select sites during the dry season. Samples will be collected prior to and after carbon sock filtration of runoff.
4) During dry-weather events, at select sites, additional samples will be collected and filtered prior to chemical and toxicological analyses. This will investigate the effects particulate-bound pesticides have on both concentration and toxicity of collected runoff.

## 5.0 LABORATORY ANALYSES

**5.1. Chemical Analysis**. CDFA will conduct pesticide analysis for water and sediment samples. CDFA will analyze up to 74 different pesticides and degradates in five different analytical screens (Appendixes 6 and 7). All laboratory QA/QC will follow CDPR guidelines and will consist of laboratory blanks, matrix spikes, matrix spike duplicates, surrogate spikes, and blind spikes (Peoples, 2019). Laboratory blanks and matrix spikes will be included in each extraction set.

**5.2 Organic Carbon and Suspended Sediment Analysis.** SWPP staff will analyze water samples for total organic carbon (TOC) and dissolved organic carbon (DOC) using a TOC-V CSH/CNS analyzer (Shimadzu Corporation, Kyoto, Japan) (Goh, 2011; Ensminger, 2013a). The system will be upgraded to a Vario TOC Cube TOC/TNb Analyzer (Elementar Analysensysteme GmbH, Langenselbold, Germany), where TOC and DOC analyses will continue once operational, based on previously outlined methods (Goh, 2011; Ensminger, 2013a). Water samples will also be analyzed for suspended sediment (Goh, 2010; Ensminger, 2013b). Sediment samples will be analyzed for TOC (Goodell, 2016).

## 6.0 DATA ANALYSIS

All data generated by this project will be entered into a Microsoft® Office Access database that holds site information, field measurements, and laboratory data since the state-wide project was initiated in 2008. All ambient monitoring analytical, toxicity, and water quality data will also be uploaded into the publicly-available CDPR Surface Water Database (SURF) (CDPR, 2018c). Toxicity and water quality data are not accessible via SURF; however, they are available upon request. An annual report will be written to summarize detections, exceedances of aquatic life toxicity benchmarks (USEPA, 2020), and potential sediment toxicity; upon completion the report will be available at CDPR Environmental Monitoring's Study Report web page. In the annual report, recommendations will be made for any follow-up or detailed data analysis for pesticides that consistently exceeded benchmarks.

## 7.0 TIMETABLE

| | |
|---|---|
| Field Sampling: | July 2022- September 2023 |
| Chemical Analysis: | July 2022 - December 2023 |
| Summary Report: | January - March 2024 |
| SURF Data Upload: | March - May 2024 |

## 8.0 LABORATORY BUDGET

SWPP requests that CDFA analyze 276 water samples and 16 sediment samples over a minimum five monitoring events for Study 329, WY 2022/2023 (Table 1).

## 9.0 LITERATURE CITED


Batikian, C.M., A. Lu, K. Watanabe, J. Pitt, R.M. Gersberg. 2019. Temporal pattern in levels of the neonicotinoid insecticide, imidacloprid, in an urban stream. Chemosphere 223:83-90.

Bennett, K. 1997. California Department of Pesticide Regulation SOP FSWA002.00: Conducting surface water monitoring for pesticides. http://www.cdpr.ca.gov/docs/emon/pubs/sops/fswa002.pdf.

Budd, R. 2018. Urban monitoring in Southern California watersheds FY2017/2018. https://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/study_270_fy_17_18_mngt_rpt.pdf.

Budd, R. and K. Peters. 2018. Survey of pesticide products sold in retail stores in Northern California. https://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis_memos/pesticide_product_survey_120718.pdf.

Budd, R., A. O'Geen, K. S. Goh, S. Bondarenko, J. Gan. 2009. Efficacy of constructed wetlands in pesticide removal from tailwaters in the Central Valley, California. Environmental Science and Technology 43: 2925-2930.

Budd, R., X. Deng, M. Ensminger, K. Starner, and Y. Luo. 2013. Method for Prioritizing Urban Pesticides for Monitoring California's Urban Surface Waters http://cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis_memos/budd_et_al_2013.pdf.

Budd, R., M.P. Ensminger, D. Wang, K.S. Goh. 2015. Monitoring fipronil and degradates in California surface waters, 2008-2013. Journal of Environmental Quality. DOI: 10.2134/jeq2015.01.0018.

Budd, R., D. Wang, M. Ensminger, B. Phillips. 2020. An evaluation of temporal and spatial trends of pyrethroid concentrations in California surface waters. Science of the Total Environment 718, 137402.

California Department of Finance: Demographics. 2020. http://www.dof.ca.gov/Forecasting/Demographics/.

CDPR. 2020a. California Pesticide Information Portal (CALPIP). https://calpip.cdpr.ca.gov/main.cfm.

CDPR. 2020b. California Code of Regulations. Section 6970. http://www.cdpr.ca.gov/docs/legbills/calcode/040501.htm#a6970.

CDPR. 2020c. Surface Water Database (SURF). https://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm.

CDPR. 2021. Pesticide use annual report, 2021 data summary

Ensminger, M. 2008. Statewide urban pesticide use analysis and water quality monitoring: monitoring sites and sample collection schedule for urban areas in Northern California. https://www.cdpr.ca.gov/docs/emon/pubs/protocol.htm?filter=surfwater.

Ensminger, M. 2013a. Water TOC analysis using the Shimadzu TOC-VCSN and ASI-V autosampler. http://cdpr.ca.gov/docs/emon/pubs/sops/meth01100.pdf.

Ensminger, M. 2013b. Analysis of whole sample suspended sediments in water http://cdpr.ca.gov/docs/emon/pubs/sops/meth010.01.pdf.

Ensminger, M. P., R. Budd, K. C. Kelley, and K.S. Goh. 2013. Pesticide occurrence and aquatic benchmark exceedances in urban surface waters and sediments in three urban areas of California, USA, 2008-2011. Ambient urban monitoring methodology for surface water protection. https://www.cdpr.ca.gov/docs/emon/pubs/sops/meth01400.pdf.

Ensminger, M., R. Budd, Y. Luo, X. Deng, D. Wang. 2017. Ambient urban monitoring methodology for surface water protection. https://www.cdpr.ca.gov/docs/emon/pubs/sops/meth01400.pdf.

Ensminger, M. 2018. Study 299: Monitoring in urban areas in Northern California (FY2018/2019). https://www.cdpr.ca.gov/docs/emon/pubs/protocol/study299_ensminger_urban_study_fy2018-19.pdf.

Ensminger, M. 2019. Pesticide monitoring in urban areas of Northern California (FY2019/2020). https://www.cdpr.ca.gov/docs/emon/pubs/protocol/study299_monitoring.pdf.

Gan, J., S. Bondarenko, L. Oki, D. Haver, and J.X. Li. 2012. Occurrence of fipronil and its biologically active derivatives

in urban residential runoff. Environmental Science and Technology 46:1489-1495.
Goh, K.S. 2010. Total suspended solids analysis. https://www.youtube.com/watch?v=bs0I-jkZ658&index=4&list=PL6E5EB26821530A26.
Goh, K.S. 2011. Total organic carbon analysis for sediment samples. https://www.youtube.com/watch?v=G8plNBgyHF8
Goodell, K. 2016. Sediment TOC analysis using Shimadzu TOC-Vcsn and SSM-5000A. http://cdpr.ca.gov/docs/emon/pubs/sops/meth013.pdf.
He, L. 2008. Study 249. Statewide urban pesticide use and water quality monitoring. https://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/protocol/study249protocol.pdf.
Holmes, R.W., Anderson, B. S., Phillips, B. M., Hunt, J. W., Crane, D. B., Mekebri, A., Connor, V. (2008). Statewide investigation of the role of pyrethroid pesticides in sediment toxicity in California's urban waterways. Environ. Sci. Technol., 42, 7003-7009.
Jones, D. 1999. California Department of Pesticide Regulation SOP QAQC004.01: Transporting, packaging, and shipping samples from the field to the warehouse or laboratory. http://www.cdpr.ca.gov/docs/emon/pubs/sops/qaqc0401.pdf.
Jones, D. 2000. Instructions for operating ISCO® samplers when collecting surface water. https://www.cdpr.ca.gov/docs/emon/pubs/sops/eqwa005.pdf.
Kelley, K. 2007. Pilot monitoring of pesticides residues in urban creeks of Sacramento County. http://cdpr.ca.gov/docs/emon/pubs/protocol/study247protocol.pdf.
Lao, W., Tsukada, D., Greenstein, D. J., Bay, S. M., Maruya, K. A. (2010). Analysis, occurrence, and toxic potential of pyrethroids, and fipronil in sediments from an urban estuary. Environ. Toxicol. Chem., 29, 843-851.
Luo, Y. 2015. SWMP (Surface Water Monitoring Prioritization Model). https://www.cdpr.ca.gov/docs/emon/surfwtr/sw_models.htm.
Luo, Y, M. Ensminger, R. Budd, D. Wang, X. Deng. 2017. Methodology for prioritizing areas of interest for surface water monitoring in urban receiving waters of California. http://cdpr.ca.gov/docs/emon/pubs/anl_methds/luo_aol_determination_final.pdf.
Mamola, M. 2005. California Department of Pesticide Regulation SOP FSWA016.00: Collecting sediment samples for pesticide analysis. http://www.cdpr.ca.gov/docs/emon/pubs/sops/fswa016.pdf.
Moran, K. 2008. Urban pesticide use trends annual report 2008. http://www.tdcenvironmental.com/resources/UP3UseTrendsReport2008.pdf.
Osienski, K., E. Lisker, R. Budd. 2010. Surveys of pesticide products sold in retail stores in Northern and Southern California, 2010. https://www.cdpr.ca.gov/docs/emon/surfwtr/swanalysismemo/retail_memo_final.pdf.
Peoples, S. 2019. California Department of Pesticide Regulation. SOP QAQC001.01: Chemistry laboratory quality control. https://www.cdpr.ca.gov/docs/emon/pubs/sops/qaqc00101.pdf
SWRCB. 2020.SPOT, stream pollution trends monitoring program. https://www.waterboards.ca.gov/water_issues/programs/swamp/spot/.
UC ANR. 2020. Fipronil labels have new restrictions. https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=27509
USEPA. 2017a. Environmental hazard and general labeling for pyrethroids and synergized pyrethrins non-agricultural outdoor products. https://www.epa.gov/ingredients-used-pesticide-products/environmental-hazard-and-general-labeling-pyrethroid-and.
USEPA. 2017b. Label amendment. https://www3.epa.gov/pesticides/chem_search/ppls/007969-00210-20170410.pdf.
USEPA. 2017c. Label amendment. https://www3.epa.gov/pesticides/chem_search/ppls/053883-00279-20171108.pdf.
USEPA. 2020. Aquatic life benchmarks and ecological risk assessments for registered pesticides. https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/aquatic-life-benchmarks-and-ecological-risk.
USGS. 2020a. Water sources of the United States. Hydrological unit maps. https://water.usgs.gov/GIS/huc.html.
USGS. 2020b. National Water Information System: Web interface, current conditions for California: streamflow. http://waterdata.usgs.gov/ca/nwis/current/?type=flow.
Weston, D. P. & Jackson, C. J. 2009. Use of engineered enzymes to identify organophosphate and pyrethroid-related toxicity in toxicity identification evaluations. Environ. Sci. Technol., 43, 5514-5520.
Weston, D.P. and M.J. Lydy. 2014. Toxicity of the insecticide fipronil and its degradates to benthic macroinvertebrates of urban streams. Environmental Science and Technology 48:1290-1297.

Table 1. Water and sediment monitoring for WY 2022/2023. For monitoring site information, see Appendix 2. For chemical screen information, see Appendices 6 and 7.

| Site | Analytical Screen* | "Second" Dry 2022 | First Storm 2022 | Second Storm 2023 | First Dry 2023 | Second Dry 2023 | Exploratory Event | Total Samples |
|---|---|---|---|---|---|---|---|---|
| ARC_ARC | DN, LC, PYW, PX | 4 | 4 | 4 | 4 | 4 | 0 | 20 |
| FOL2 | DN, LC, PYS, PYW, PX | 5 | 4 | 4 | 5 | 5 | 0 | 23 |
| MIN_MR | DN, LC, PYW, PX | 4 | 4 | 4 | 4 | 4 | 0 | 20 |
| PGC010 | DN, LC, PYS, PYW, PX | 5 | 4 | 4 | 5 | 5 | 0 | 23 |
| PGC019/022 | DN, LC, PYS, PYW, PX | 5 | 4 | 4 | 5 | 5 | 0 | 23 |
| PGC058 | DN, LC, PYW, PX | 4 | 4 | 4 | 4 | 4 | 0 | 20 |
| GUA_TRM | DN, LC, PYW, PX | 4 | 4 | 4 | 4 | 4 | 0 | 20 |
| SLC_LA | DN, LC, PYW, PX | 4 | 4 | 4 | 4 | 4 | 0 | 20 |
| SLV_KNG | DN, LC, PYS, PYW, PX | 5 | 4 | 4 | 4 | 5 | 0 | 22 |
| SRC_JD | DN, LC, PYS, PYW, PX | 5 | 4 | 4 | 4 | 5 | 0 | 22 |
| WAL_CA | DN, LC, PYW, PX | 4 | 4 | 4 | 4 | 4 | 0 | 20 |
| Exploratory (up to 8 sites) | DN, LC, PYW, PX | 0 | 0 | 0 | 0 | 0 | 32 | 32 |
| QC (Dup) | DN, LC, PYS, PYW, PX | 5 | 4 | 4 | 5 | 5 | 0 | 23 |
| QC (FMS/FMSD) | PYW | 0 | 0 | 0 | 2 | 2 | 0 | 4 |
| Total | DN, LC, PYS, PYW, PX | 54 | 48 | 48 | 54 | 56 | 32 | 292 |

* **DN**, dinitroaniline herbicides, oxyfluorfen, and chlorfenapyr; **LC**, liquid chromatography multi-analyte; **PY**, pyrethroid (water and sediment); **PX**, phenoxy/synthetic auxin herbicides.

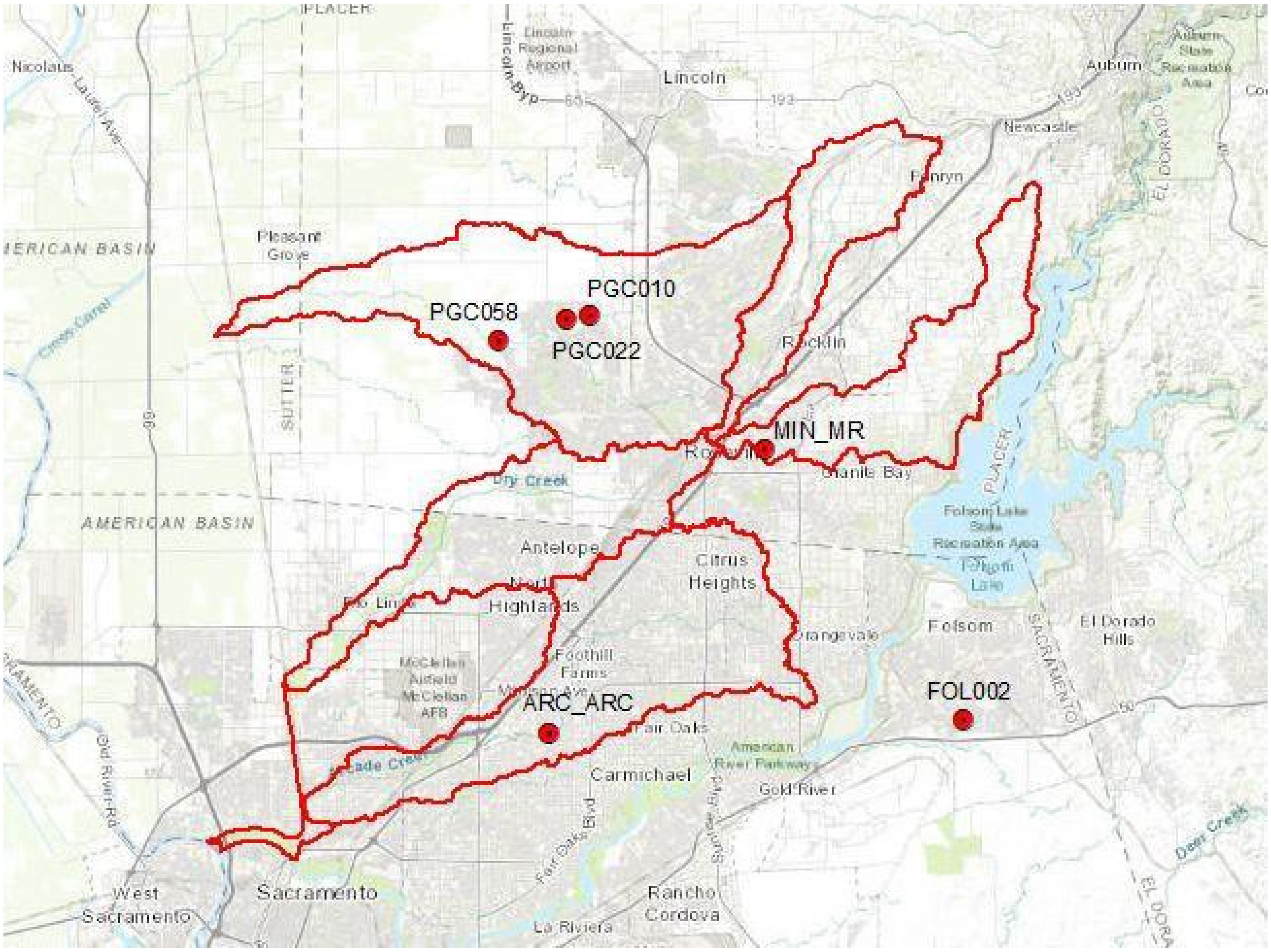


Figure 1. Sacramento area monitoring sites (red dots) and top HUC12 watersheds for WY 2022/2023.


Figure 2. San Francisco Bay area monitoring sites and top HUC12 watersheds for WY 2022/2023.

**Appendix 1.** HUC12 selection for Northern California. Monitored HUC12 watersheds contain a double asterisk (**) next to the HUC12 name. See Appendix 2 for site codes and HUC12 information. For area, SAC = Sacramento area, SFB = San Francisco Bay area, and SJD = San Joaquin Delta.

| HUC4 | HUC8 | HUC8 Rank | HUC12 | HUC12 name | Type | Area | CDPR Site Code |
|---|---|---|---|---|---|---|---|
| 1802 | 18020111 | 1 | 180201110102 | Miners Ravine** | Mainstem | SAC | MIN_MR |
| 1802 | 18020111 | 1 | 180201110105 | Gibson Lake-Dry Creek | Mainstem | SAC | |
| 1802 | 18020111 | 1 | 180201110303 | Lower Steelhead Creek | Mainstem | SAC | |
| 1802 | 18020111 | 1 | 180201110103 | Antelope Creek | Tributary | SAC | |
| 1802 | 18020111 | 1 | 180201110302 | Arcade Creek** | Tributary | SAC | ARC_ARC |
| 1802 | 18020111 | 1 | 180201110105 | Gibson Lake-Dry Creek | Tributary | SAC | |
| 1802 | 18020161 | 2 | 180201610102 | Dutch Ravine-Auburn Ravine | Mainstem | SAC | |
| 1802 | 18020161 | 2 | 180201610302 | Pleasant Grove Creek** | Tributary | SAC | PGC010 PGC019 PGC022 PGC058 |
| 1802 | 18020161 | 2 | 180201610101 | Orchard Creek | Tributary | SAC | |
| 1802 | 18020161 | 2 | 180201610102 | Dutch Ravine-Auburn Ravine | Tributary | SAC | |
| 1805 | 18050001 | 3 | 180500010204 | Walnut Creek-Frontal Suisin Bay Estuaries** | Mainstem | SFB | WAL_CA |
| 1805 | 18050001 | 3 | 180500010203 | Pine Creek | Tributary | SFB | |
| 1805 | 18050001 | 3 | 180500010204 | Walnut Creek-Frontal Suisin Bay Estuaries | Tributary | SFB | |
| 1805 | 18050001 | 3 | 180500010301 | Kirker Creek-Frontal Suisun Bay Estuaries | Tributary | SFB | |
| 1805 | 18050003 | 4 | 180500030304 | Guadalupe River** | Mainstem | SFB | GUA_TRM |
| 1805 | 18050003 | 4 | 180500030202 | Metcalfe Canyon-Coyote Creek | Mainstem | SFB | |
| 1805 | 18050003 | 4 | 180500030201 | Silver Creek** | Tributary | SFB | SLV_KNG |
| 1805 | 18050003 | 4 | 180500030302 | Canoas Creek | Tributary | SFB | |
| 1805 | 18050003 | 4 | 180500030304 | Guadalupe River | Tributary | SFB | |
| 1805 | 18050004 | 5 | 180500040502 | South San Ramon Creek** | Mainstem | SFB | SRC_JD |
| 1805 | 18050004 | 5 | 180500040802 | San Lorenzo Creek** | Mainstem | SFB | SLC_LA |
| 1805 | 18050004 | 5 | 180500040203 | Lower Arroyo Las Positas | Mainstem | SFB | |
| 1805 | 18050004 | 5 | 180500040501 | Alamo Creek | Tributary | SFB | |
| 1805 | 18050004 | 5 | 180500040502 | South San Ramon Creek | Tributary | SFB | |
| 1805 | 18050004 | 5 | 180500040805 | Sausal Creek-Frontal San Francisco Bay Estuaries | Tributary | SFB | |
| 1802 | 18020163 | 6 | 180201630404 | Lower Morrison Creek | Mainstem | SAC | |
| 1802 | 18020163 | 6 | 180201630404 | Lower Morrison Creek | Tributary | SAC | |

| HUC4 | HUC8 | HUC8 Rank | HUC12 | HUC12 name | Type | Area | CDPR Site Code |
|---|---|---|---|---|---|---|---|
| 1802 | 18020163 | 6 | 180201630401 | Elder Creek | Tributary | SAC | |
| 1802 | 18020163 | 6 | 180201630701 | Lake Greenhaven-Sacramento River | Tributary | SAC | |
| 1805 | 18050002 | 7 | 180500021001 | Angel Island-San Francisco Bay Estuaries | Mainstem | SFB | |
| 1805 | 18050002 | 7 | 180500020303 | Lower Sonoma Creek | Mainstem | SFB | |
| 1805 | 18050002 | 7 | 180500020205 | Lower Napa River | Mainstem | SFB | |
| 1805 | 18050002 | 7 | 180500020702 | Pinole Creek-Frontal San Pablo Bay Estuaries | Tributary | SFB | |
| 1805 | 18050002 | 7 | 180500020904 | Cerrito Creek-Frontal San Francisco Bay Estuaries | Tributary | SFB | |
| 1805 | 18050002 | 7 | 180500020401 | American Canyon Creek-Frontal San Pablo Bay Estuaries | Tributary | SFB | |
| 1804 | 18040003 | 8 | 180400030702 | Lower Marsh Creek | Mainstem | SJD | |
| 1804 | 18040003 | 8 | 180400030303 | McLeod Lake-Mormon Slough | Mainstem | SJD | |
| 1804 | 18040003 | 8 | 180400030803 | Dutch Slough-Big Break | Mainstem | SJD | |
| 1804 | 18040003 | 8 | 180400030702 | Lower Marsh Creek | Tributary | SJD | |
| 1804 | 18040003 | 8 | 180400030803 | Dutch Slough-Big Break | Tributary | SJD | |
| 1804 | 18040003 | 8 | 180400030907 | Markley Canyon-San Joaquin River | Tributary | SJD | |

**SWMP Model Parameters:** Use pattern: Urban; PUR Data 2018-2020; Toxicity Data (acute and chronic): USEPA Aquatic Life Benchmarks/Supplemented by Benchmark Equivalent; Max. number of top pesticides for reporting: 100;
**SWMP AOI/POI Determination:** Study Domain by HUC4: 8 Northern HUC4s; POI Selection: All AI with final score ≥ 9 (41 AI selected); HUC8 Analysis: All (105 HUC8s selected); HUC12 Analysis: 3 HUC12s per selected HUC8;

**Appendix 2.** Sampling site details for WY 2022/2023. For site type, SD = storm drain outfall; MS = mainstem creek or river. PGC022 sediment sampling will be downstream of the union of PGC021 and PGC022 (reported as PGC019). If there is no measurable runoff at PGC058, water will be collected at PGC040 (38.79857, -121.34802) to be consistent with previous years.

| Site Code | Site Type | Sample Type | Description | City | HUC12/Name | Latitude GPS Coordinates (NAD83) | Longitude GPS Coordinates (NAD83) |
|---|---|---|---|---|---|---|---|
| PGC010 | SD | Water Sediment | Outfall at Diamond Woods Circle | Roseville | 180201610302 Pleasant Grove Creek | 38.80477 | -121.32733 |
| PGC022 | SD | Water | Outfall at Opal and Northpark Drive | Roseville | 180201610302 Pleasant Grove Creek | 38.802599 | -121.338787 |
| PGC019 | SD | Sediment | Combination of outfalls at Opal and Northpark Drive (this site may also substitute for PGC022 if limited runoff) | Roseville | 180201610302 Pleasant Grove Creek | 38.80248 | -121.3386 |
| PGC058 | MS | Water | near Hayden Pkwy and Blue Oaks Blvd | Roseville | 180201610302 Pleasant Grove Creek | 38.79477 | -121.37251 |
| ARC_ARC | MS | Water | Arcade Creek at American River College | Sacramento | 180201110302 Arcade Creek | 38.645293 | -121.347359 |
| FOL2 | SD | Water Sediment | Outfall at Brock Circle | Folsom | 180201110201 Upper American River (Alder Creek) | 38.6503 | -121.14494 |
| MIN_MR | MS | Water | Miner’s Ravine at Orvietto Drive (tentative Miner’s Ravine site) | Roseville | 180201110102 Miner’s Ravine | 38.752947 | -121.241557 |
| WAL_CA | MS | Water | Walnut Creek near Concord Avenue | Concord | 180500010204 Walnut Creek | 37.980630 | -122.0516 |
| SLC_LA | MS | Water | San Lorenzo Creek at Lorenzo Avenue | San Leandro | 180500040802 San Lorenzo | 37.684572 | -122.139337 |
| SRC_JD | MS | Water Sediment | South San Ramon Creek at Johnson Drive | Pleasanton | 180500040502 South San Ramon Creek | 37.700976 | -121.919837 |
| GUA_TRM | MS | Water | Guadalupe River at Trimble Road | San Jose | 180500030304 Guadalupe River | 37.38062 | -121.93802 |
| SLV_KNG | MS | Water Sediment | Silver Creek at McKee Road and King Road | San Jose | 180500030201 Silver Creek | 37.35815 | -121.861192 |

**Appendix 3.** Priority pesticides for the Sacramento area based on acute and chronic toxicity values. Listed, pesticides with priorities greater or equal to the priority score of 9, with a "TRUE" monitoring recommendation from SWMP (based on acute toxicity). Priority model does not include homeowner pesticide use. Screen codes: DN, dinitroaniline herbicides, oxyfluorfen, and chlorfenapyr; LC, liquid chromatography multi-analyte; PY, pyrethroid; PX, phenoxy/synthetic auxin herbicides. For method information, see our analytical methods page. For pesticides with an analytical method but not monitored, see Appendix 5.

| Pesticide | CDFA Screen* | 2018-2020 Average Use (lb ai) | Use Score | Benchmark (µg/L) | Tox Score | Final Score | Monitored? |
|---|---|---|---|---|---|---|---|
| Bifenthrin | PY | 8671.4 | 5 | 0.00005 | 8 | 40 | Y |
| Cypermethrin | PY | 1736.7 | 4 | 0.00005 | 8 | 32 | Y |
| Imidacloprid | LC | 4659.3 | 4 | 0.01 | 7 | 28 | Y |
| Permethrin | PY | 4089.2 | 4 | 0.0033 | 7 | 28 | Y |
| Fipronil | LC | 1614.2 | 4 | 0.01 | 6 | 24 | Y |
| Deltamethrin | PY | 1164.8 | 3 | 0.000026 | 8 | 24 | Y |
| Cyfluthrin | PY | 710.5 | 3 | 0.00012 | 8 | 24 | Y |
| Chlorantraniliprole | LC | 7703.9 | 5 | 3.02 | 4 | 20 | Y |
| Dithiopyr | None | 4590.5 | 4 | 6.11 | 4 | 16 | N |
| Pendimethalin | DN | 3771.7 | 4 | 5.2 | 4 | 16 | Y |
| Prodiamine | DN | 1637.8 | 4 | 1.5 | 4 | 16 | Y |
| Lambda-cyhalothrin | PY | 129.6 | 2 | 0.00004 | 8 | 16 | Y |
| Esfenvalerate | PY | 94.6 | 2 | 0.0000309 | 8 | 16 | Y |
| Diuron | LC | 486.1 | 3 | 0.13 | 5 | 15 | Y |
| Isoxaben | LC | 996.5 | 3 | 10 | 4 | 12 | Y |
| Chlorfenapyr | DN | 655.5 | 3 | 2.91 | 4 | 12 | Y |
| Clothianidin | LC | 120.2 | 2 | 0.05 | 6 | 12 | Y |
| Oxadiazon | LC | 75.8 | 2 | 0.88 | 5 | 10 | Y |
| Sulfometuron-methyl | None | 63.6 | 2 | 0.45 | 5 | 10 | N |
| Triclopyr, butoxyethyl ester | PX | 1289.8 | 3 | 26 | 3 | 9 | Y |
| Oryzalin | LC | 956.9 | 3 | 13 | 3 | 9 | Y |
| PCNB | None | 794.6 | 3 | 13 | 3 | 9 | N |
| Propiconazole | LC | 606.8 | 3 | 15 | 3 | 9 | Y |
| Tebuthiuron | LC | 593.3 | 3 | 50 | 3 | 9 | Y |

**Appendix 4.** Priority pesticides for San Francisco Bay area sampling sites based on acute and chronic toxicity values. Listed, pesticides with priorities greater or equal to the priority score of 9, with a "TRUE" monitoring recommendation from SWMP (based on acute toxicity). Priority model does not include homeowner pesticide use. Screen codes: DN, dinitroaniline herbicides, oxyfluorfen, and chlorfenapyr; LC, liquid chromatography multi-analyte; PY, pyrethroid; PX, phenoxy/synthetic auxin herbicides; GLY, glufosinate-ammonium. For method information, see our analytical methods page. For pesticides with an analytical method but not monitored, see Appendix 5.

| Pesticide | CDFA Screen* | 2018-2020 Average Use (lb ai) | Use Score | Benchmark (µg/L) | Tox Score | Final Score | Monitored? |
|---|---|---|---|---|---|---|---|
| Bifenthrin | PY | 5629.5 | 5 | 0.00005 | 8 | 40 | Y |
| Imidacloprid | LC | 2815.1 | 4 | 0.01 | 7 | 28 | Y |
| Fipronil | LC | 5242 | 4 | 0.01 | 6 | 24 | Y |
| Lambda-cyhalothrin | PY | 1288.4 | 3 | 0.00004 | 8 | 24 | Y |
| Cyfluthrin | PY | 954.4 | 3 | 0.00012 | 8 | 24 | Y |
| Deltamethrin | PY | 806.4 | 3 | 0.000026 | 8 | 24 | Y |
| Permethrin | PY | 1483.8 | 3 | 0.0033 | 7 | 21 | Y |
| Pendimethalin | DN | 5103.1 | 4 | 5.2 | 4 | 16 | Y |
| Prodiamine | DN | 3121.6 | 4 | 1.5 | 4 | 16 | Y |
| Dithiopyr | None | 2124.9 | 4 | 6.11 | 4 | 16 | N |
| Esfenvalerate | PY | 120.8 | 2 | 0.0000309 | 8 | 16 | Y |
| Cypermethrin | PY | 111 | 2 | 0.00005 | 8 | 16 | Y |
| Diuron | LC | 810 | 3 | 0.13 | 5 | 15 | Y |
| Triclopyr, butoxyethyl ester | PX | 4534.9 | 4 | 26 | 3 | 12 | Y |
| PCNB | None | 1874.5 | 4 | 13 | 3 | 12 | N |
| Chlorfenapyr | DN | 898.7 | 3 | 2.91 | 4 | 12 | Y |
| 2,2-dibromo-3-nitrilopropionamide | None | 844.7 | 3 | 10 | 4 | 12 | N |
| Isoxaben | LC | 568.6 | 3 | 10 | 4 | 12 | Y |
| Pyriproxyfen | LC | 146.2 | 2 | 0.01 | 6 | 12 | Y |
| Oxadiazon | LC | 359.4 | 2 | 0.88 | 5 | 10 | Y |
| Spinosad | None | 112.5 | 2 | 0.6 | 5 | 10 | N |
| Oxyfluorfen | DN | 103.8 | 2 | 0.33 | 5 | 10 | Y |
| Sulfometuron-methyl | None | 60.8 | 2 | 0.45 | 5 | 10 | N |
| Glufosinate-ammonium | GLY | 1080.7 | 3 | 72 | 3 | 9 | N |
| Polixetonium chloride | None | 1006.2 | 3 | 15 | 3 | 9 | N |
| Oryzalin | LC | 865.8 | 3 | 13 | 3 | 9 | Y |
| Propiconazole | LC | 645.1 | 3 | 15 | 3 | 9 | Y |

## Appendix 5. SWMP selected pesticides with a CDFA analytical method excluded from monitoring in Northern California

**GLUFOSINATE-AMMONIUM in the San Francisco Bay Area**

While an analytical method (GLY) exists, method revalidation is required before the lab can accept any environmental samples. We will look to collect samples once method revalidation is complete. All dominant products are registered with low-risk use patterns or low-risk application.

**Appendix 6.** Chemical analyses of pesticides in Northern California urban monitoring Study 329. CDFA will analyze all water samples. Specific methods can be found here.

| Analyte Screen (Method ID) | Pesticide | Reporting Limit (ng $L^{-1}$) | Method Detection Limit (ng $L^{-1}$) |
|---|---|---|---|
| Dinitroaniline (DN) (EMON-SM-05-006) | chlorfenapyr | 100 | 33.3 |
| | oxyfluorfen | 50 | 10 |
| | pendimethalin | 50 | 12 |
| | prodiamine | 50 | 12 |
| | trifluralin | 50 | 14 |
| LC-multi analyte (LC) (EMON-SM-05-037) | abamectin | 20 | 4 |
| | acetamiprid | 20 | 4 |
| | atrazine | 20 | 4 |
| | azoxystrobin | 20 | 4 |
| | bensulide | 20 | 4 |
| | boscalid | 20 | 4 |
| | bromacil | 20 | 4 |
| | carbaryl | 20 | 4 |
| | chlorantraniliprole | 20 | 4 |
| | chlorpyrifos | 20 | 4 |
| | clothianidin | 20 | 4 |
| | cyprodinil | 20 | 4 |
| | desulfinyl fipronil | 10 | 4 |
| | desulfinyl fipronil amide | 10 | 4 |
| | diazinon | 20 | 4 |
| | diflubenzuron | 20 | 4 |
| | dimethoate | 20 | 4 |
| | diuron | 20 | 4 |
| | ethoprop | 20 | 4 |
| | etofenprox | 20 | 4 |
| | fenamidone | 20 | 4 |
| | fenhexamid | 20 | 4 |
| | fipronil | 10 | 4 |
| | fipronil amide | 10 | 4 |
| | fipronil sulfide | 10 | 4 |
| | fipronil sulfone | 10 | 4 |
| | fludioxonil | 20 | 4 |
| | hexazinone | 20 | 4 |
| | imidacloprid | 10 | 4 |
| | indoxacarb | 20 | 4 |
| | isoxaben | 20 | 4 |
| | kresoxim-methyl | 20 | 4 |
| | malathion | 20 | 4 |
| | methidathion | 20 | 4 |
| | methomyl | 20 | 4 |
| | methoxyfenozide | 20 | 4 |
| | metribuzin | 20 | 4 |
| | norflurazon | 20 | 4 |
| | oryzalin | 20 | 4 |
| | oxadiazon | 20 | 4 |
| | prometon | 20 | 4 |
| | prometryn | 20 | 4 |
| | propanil | 20 | 4 |

| Analyte Screen (Method ID) | Pesticide | Reporting Limit (ng $L^{-1}$) | Method Detection Limit (ng $L^{-1}$) |
|---|---|---|---|
| | propargite | 20 | 4 |
| | propiconazole | 20 | 4 |
| | pyraclostrobin | 20 | 4 |
| | pyriproxyfen | 15 | 4 |
| | quinoxyfen | 20 | 4 |
| | simazine | 20 | 4 |
| | s-metolachlor | 20 | 4 |
| | tebuconazole | 20 | 4 |
| | tebufenozide | 20 | 4 |
| | tebuthiuron | 20 | 4 |
| | thiabendazole | 20 | 4 |
| | thiacloprid | 20 | 4 |
| | thiamethoxam | 20 | 4 |
| | trifloxystrobin | 20 | 4 |
| Pyrethroid (PYW) (EMON-SM-05-022) | bifenthrin | 1 | 0.91 |
| | cyfluthrin | 2 | 1.46 |
| | cypermethrin | 5 | 1.54 |
| | deltamethrin/tralomethrin | 5 | 1.77 |
| | esfenvalerate/fenvalerate | 5 | 1.66 |
| | lambda-cyhalothrin | 2 | 1.74 |
| | permethrin cis | 2 | 1.05 |
| | permethrin trans | 5 | 1.05 |
| Phenoxy/Synthetic Auxin Herbicides (PX) EMON-SM-05-012) | 2,4-D | 50 | 15 |
| | dicamba | 50 | 17 |
| | MCPA | 50 | 22 |
| | triclopyr | 50 | 20 |

**Appendix 7.** Chemical analysis of pyrethroids in Northern California urban monitoring Study 329. CDFA will analyze sediment samples (Method EMON-SM 52-9 [PYS]). Specific methods can be found here.

| Pesticide | Method Detection Limit (ng $g^{-1}$ dry wt) | Reporting Limit (ng $g^{-1}$ dry wt) |
|---|---|---|
| Bifenthrin | 0.1083 | 1.0 |
| Cyfluthrin | 0.183 | 1.0 |
| Cypermethrin | 0.107 | 1.0 |
| Deltamethrin/Tralomethrin | 0.0661 | 1.0 |
| Esfenvalerate/Fenvalerate | 0.143 | 1.0 |
| Lambda-cyhalothrin | 0.1154 | 1.0 |
| Permethrin cis | 0.1159 | 1.0 |
| Permethrin trans | 0.1352 | 1.0 |