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

Study 297. Surface Water Monitoring for Pesticides in Agricultural Areas of California, 2015

Xin Deng, Ph.D.
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1. INTRODUCTION

Surface water monitoring for pesticides in agricultural areas of California is one of the California Department of Pesticide Regulation's (CDPR's) key environmental monitoring projects. This project was initiated in 2008 with a long-term goal of collecting data to better assess potential impacts of pesticides from agricultural runoff on California aquatic environments. Project findings help guide CDPR in development and implementation of regulatory and non-regulatory mitigation activities. In the last seven years, the monitoring activities had focused on areas with heavy pesticide uses. Those areas including watershed drainages in Monterey, Santa Barbara, San Luis Obispo, Riverside and Imperial Counties were identified as high priority areas representative of CDPR's long-term surface water monitoring efforts (Starner 2010, 2013; Deng 2014). To assess potential impacts of pesticide runoff on aquatic environments, monitoring sites were selected at agricultural ditches, drains, tributaries and mainstreams of the major watersheds. In 2015 Study 297 will continue collecting agricultural runoff samples at the sites established in previous years (Table 1). In order to conduct the statewide monitoring effectively and better use limited resources, CDPR developed a Pesticide Prioritization Model that automates the process of identifying potential monitoring candidates (Luo et al. 2013, 2014, 2015). The Model generates a ranked list of pesticides based on uses from the CDPR Pesticide Use Reporting Database (CDPR 2014) and toxicological values from US EPA Aquatic Life Benchmarks (US EPA 2015). The Model then provides recommendations for pesticides to monitor based on physical-chemical properties and monitoring data from previous years. A new component was recently added to the Model that allows for aggregation of pesticide use data at the watershed level (Luo et al. 2015). The watershed-based prioritization approach was applied to help refine the pesticide priority list for monitoring in 2015.

2. OBJECTIVE

The goal of the project is to assess long-term trends of pesticide contamination in agricultural runoff and the potential impacts of the runoff to aquatic environments. Results of the assessment will provide information to managers to make mitigation responses to potential risks of pesticide contamination in aquatic environments. Objectives of the project are as follows:

1) Identify sampling sites in watersheds of high pesticide uses;
2) Annually prioritize pesticide monitoring candidates;
3) Determine occurrences and measure chemical concentrations of high priority pesticides in runoff samples;
4) Analyze chemistry data to evaluate potential impacts on aquatic environments.

3. PERSONNEL

The study will be conducted by staff from the Environmental Monitoring Branch, Surface Water Protection Program, under the general direction of Kean S. Goh Ph.D., Environmental Program Manager I. Key personnel are listed below:

Project Leader:	Xin Deng, Ph.D.
Field Coordinator:	Kevin Kelley
Review Scientist:	Yuzhou Luo, Ph.D.
Statistician:	Dan Wang, Ph.D.
Laboratory Liaison:	Sue Peoples
Analytical Chemistry:	Center for Analytical Chemistry, California Department of Food and Agriculture (CDFA)

Questions concerning this monitoring project should be directed to Xin Deng, Senior Environmental Scientist, at (916) 445-2506 or by email at xdeng@cdpr.ca.gov.

4. SELECTION OF PESTICIDES FOR MONITORING

The pesticides determined for monitoring were prioritized following the procedures described in the Monitoring Prioritization Model (Luo et al. 2013, 2014). Previously, the prioritization scheme used aggregated pesticide use data in geographic scales at the state or county levels. A new function recently added allows for aggregating pesticide uses at the watershed scale (Luo et al. 2015). The function may help more accurately identify pesticides with high uses within specific watersheds. The watershed-based prioritization model uses 12-digit hydrologic units on the USGS Watershed Boundary Database (http://viewer.nationalmap.gov/viewer/nhd.html?p=nhd) to define the watershed boundary. It then aggregates the total use of each pesticide within the watershed and adjusts the total use by factoring in its dissipation as a function of travel time. The model was applied to generate ranked lists for major watersheds for Study 297. Pesticides were then screened to produce final monitoring lists following the general criteria below:

a. Pesticides with final ranking scores ≥ 9 were reported in the priority lists for the major watersheds for further consideration (Table 2-5). Pesticides with a final ranking score < 9 were considered to be low priority due to their low use and/or low toxicity. Therefore, they were excluded from the priority lists.

b. Pesticides with use scores ≥ 3 in the priority lists will be monitored. Pesticides that are not in the priority lists or have use scores < 3 may be monitored because they will be concurrently analyzed with analytical groups that contain pesticides in the final monitoring list.
c. Additional considerations for inclusion or exclusion are described in the Prioritization Model Phase II report (Luo et.al.2014). Historical monitoring data in the same watershed, persistence and other physical-chemical properties are additional factors to help decide a final list for monitoring. Reasons for excluding specific pesticides that are in the priority lists are explained briefly in the footnotes of Tables 2-5.

5. STUDY PLAN

5.1. Imperial and Riverside County

Ambient monitoring will be conducted in Imperial and Riverside Counties in March and in Imperial County in October. Five monitoring sites were selected within the Palo Verde Outfall Drainage near the border of Imperial and Riverside County (Figure 1). In Imperial County, nine monitoring sites have been established within the watersheds of Alamo and New Rivers in previous years (Figure 2). Detailed information for the location of each site is listed in Table 1.

The priority lists for monitoring in each watershed in March were generated using the average use data from January to March in 2010-2012 (Table 2). For Alamo and New Rivers, only the drainage areas and use data in the US territory were accounted for the prioritization. The prioritization identified high uses of phorate insecticide and 2,4-D herbicide in Palo Verde Outfall Drain, and high use of atrazine herbicide and methomyl insecticide in Alamo and New Rivers. Those pesticides were not monitored in previous years and will be added to the final monitoring list for respective watershed in March. Chlorothalonil fungicide had been monitored in previous years but had no detections in any watershed, and also the chemical is not recommended for monitoring by the prioritization model. It will be excluded from the monitoring list (Tables 2 and 6).

The priority lists for monitoring in each watershed in October were generated using the average use data from August to October in 2010-2012 (Table 3). Monitoring will not be conducted in the Palo Verde Outfall Drainage in October due to relatively low pesticide uses. The prioritization identified high uses of methoxyfenozide and methomyl insecticides in Alamo and New Rivers. Those pesticides were not monitored in 2014 and will be added to the final monitoring list. Pyrethroid insecticides will be kept on the final monitoring list despite their relative low use scores because several pyrethroids were detected in previous years. Diazinon was monitored in 2014 and will be excluded from the final monitoring list due to its low use (Tables 3 and 6).

5.2. Monterey County

Ambient monitoring will be conducted in Monterey County monthly from April to September. Eleven monitoring sites had been established within the watersheds of Salinas River and Tembladero Slough in previous years (Figure 3). Detailed information for the location of each site is listed in Table 1.

The priority lists for monitoring in each watershed were generated using the average pesticide use data from April to September in 2010-2012 (Table 4). Paraquat dichloride herbicide, oxydemeton-methyl insecticide, and cyprodinil and fenamidone fungicides that had not been monitored in previous years are now in the priority lists. Paraquat dichloride and oxydemeton-methyl will be included in the final monitoring list once their analytical methods are validated. Currently, analytical methods for cyprodinil and fenamidone are not available; thus, the two pesticides will not be monitored for Study 297. Oxyfluorfen herbicide had been monitored in previous year with moderate detection frequencies and will be monitored in Salinas River. Diacylhydrazine insecticides, strobilurin fungicides and chlorothalonil herbicides were monitored in previous years but are no longer on the priority lists. Those groups will be excluded from the final monitoring list (Tables 4 and 6).

5.3. Santa Barbara and San Luis Obispo County

Ambient monitoring will be conducted in Santa Barbara and San Luis Obispo Counties in May, July and September. Five monitoring sites had been established within the watersheds of Orcutt Creek and Oso Flaco Creek in previous years (Figure 4). Detailed information for the location of each site is listed in Table 1.

The priority lists for monitoring in each watershed were generated using the average use data from April to September in 2010-2012 (Table 5). Methomyl and pyrethroid insecticides were monitored in the watersheds in 2014 but did not appear on current priority lists. Those pesticides will be excluded from monitoring (Tables 5 and 6).

6. SAMPLING METHOD

6.1. Water Sampling and Sample Transport

Water samples will be collected as grab samples directly into 1-liter amber glass bottles sealed with Teflon-lined lids. Samples will be transported and stored on wet ice or refrigerated at 4^{o}C until extraction for chemical analysis. CDPR 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.

6.2. Field Measurements

Dissolved oxygen, pH, specific conductivity, turbidity and water temperature will be measured *in situ* during each sampling event with an YSI EXO1 multi-parameter water quality Sonde (Doo and He 2008).

7. CHEMICAL ANALYSES

Chemical analyses will be performed by the Center for Analytical Chemistry, California Department of Food and Agriculture, Sacramento, CA. Nine analyte groups with 32 chemicals will be analyzed. Method detection limits and reporting limits for each chemical are given in Table 7. Quality control will be conducted in accordance with the Standard Operating Procedure QAQC001.00 (Segawa 1995). Laboratory QA/QC will follow CDPR guidelines and will consist of laboratory blanks, matrix spikes, matrix spike duplicates, surrogate spikes, and blind spikes (Segawa 1995). Laboratory blanks and matrix spikes will be included in each extraction set.

8. DATA ANALYSIS

Concentrations of pesticides in water will be reported as micrograms per liter (µg/L) / parts per billion (ppb) or nanograms per liter (ng/L) / parts per trillion (ppt). Resulting data will be analyzed and reported as appropriate, potentially including the following:
Comparison of pesticide concentrations to aquatic toxicity benchmarks, water quality limits and other toxicity data (CCVRWQCB 2012, US EPA 2015); spatial analysis of data in order to identify correlations between observed pesticide concentrations and region-specific pesticide uses and geographical features; assessment of multiple years of data to characterize patterns and trends in detection frequencies; assessment of results to determine potential additional monitoring in regions with similar pesticide use patterns.

9. TIMETABLE

Field Sampling:	March 2015 — October 2015
Chemical Analysis:	March 2015 — December 2015
Draft Report:	June 2016
Data Entry into SURF:	January 2016 — June 2016

10. BUDGET

The estimated total cost for chemical analyses is $ 277,530 (Table 8).

11. REFERENCES

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http://www.cdpr.ca.gov/docs/emon/pubs/protocol/study262protocol.pdf

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Table 1. Sampling Site Information for Study 290 in 2015.

Site ID	Site Location	County	Watershed	Latitude	Longitude	Site Type
Imp_Garst	Alamo River at Garst Road	Imperial	Alamo River	33.199	-115.59696	Receiving Water
Imp_Holtville	Holtville Main Drain at HWY115	Imperial	Alamo River	32.9309	-115.40611	Ag Drain
Imp_Malva	Malva Drain nr. Park Avenue	Imperial	Alamo River	33.0518	-115.48862	Ag Drain
Imp_Young	Vail Drain nr Young Road	Imperial	New River	33.1328	-115.66646	Ag Drain
Imp_Verde	Verde Drain at Bonds Corner Road	Imperial	Alamo River	32.7555	-115.33697	Ag Drain
Imp_Clark	Palo Verde Outfall Drain (PVOD2) - Colorado River Region - SWAMP station code 715CPVOD2	Imperial	Palo Verde Drain	33.428	-114.73	Receiving Water
Imp_Rutherford	Alamo River at Rutherford Rd (upstream of Imperial State Wildlife Area)	Imperial	Alamo River	33.0447	-115.48829	Receiving Water
Imp_Butte	Salton Sea at Obsidian Butte	Imperial	Salton Sea	33.1747	-115.64069	Receiving Water
Imp_Rice3	Rice Drain III at Weinert Road	Imperial	New River	32.8691	-115.651	Ag Drain
Imp_NewRiv27	New River at HWY S27/Keystone Road	Imperial	New River	32.9136	-115.60646	Receiving Water
Imp_OFD78	Outfall Drain at HWY78	Imperial	Palo Verde Drain	33.3613	-114.72299	Ag Drain
Sal_Rec3	Reclamation Ditch site 3	Monterey	Salinas River	36.6592	-121.61567	Receiving Water
Sal_SanJon	Rec Ditch at San Jon Road	Monterey	Tembladero Slough	36.7049	-121.70506	Receiving Water
Sal_Davis	Salinas River at Davis Road	Monterey	Salinas River	36.647	-121.70219	Receiving Water
Sal_Monte	Salinas River at Del Monte Road	Monterey	Salinas River	36.7319	-121.7824	Receiving Water
Sal_Dunes	Old Salinas R. at Monterey Dunes Way	Monterey	Old Salinas River	36.7719	-121.78971	Receiving Water

Table 1. (continued)

Site ID	Site Location	County	Watershed	Latitude	Longitude	Site Type
Sal_Molera	Tembladero Sl. at Molera Road	Monterey	Tembladero Slough	36.7721	-121.78763	Receiving Water
Sal_Haro	Tembladero Slough at Haro Street	Monterey	Tembladero Slough	36.7596	-121.75433	Receiving Water
Sal_Quail	Quail Creek at HWY 101, btwn Spence and Potter Roads (trib. to Salinas R.)	Monterey	Salinas River	36.6092	-121.56269	Receiving Water
Sal_Hartnell	Alisal Creek at Hartnell Rd	Monterey	Salinas River	36.6435	-121.57836	Receiving Water
Sal_Chualar	Chualar Creek at Chualar River Rd., ca. 1.2 mi. from HWY 101 (trib. to Salinas R.)	Monterey	Salinas River	36.5584	-121.52964	Receiving Water
Sal_Blanco	Blanco Drain at Cooper Rd, ca 0.2 mi. S of Nashua Rd, drains to Salinas River	Monterey	Salinas River	36.6987	-121.73517	Ag Drain
Riv_LG	Palo Verde Lagoon (LG1) - Colorado River Region - SWAMP station code 715CPVLG1	Riverside	Palo Verde Drain	33.436	-114.7162	Receiving Water
Riv_PVL	Palo Verde Lagoon @ 35th Avenue	Riverside	Palo Verde Drain	33.4559	-114.70551	Receiving Water
Riv_South	South End Drain @Palo Verde Lagoon	Riverside	Palo Verde Drain	33.4562	-114.70501	Receiving Water
SM_OFC	Oso Flaco Creek @ OFL Road	San Luis Obispo	Oso Flaco Creek	35.0164	-120.58755	Receiving Water
SM_Solomon	Solomon Creek @ HWY 1	Santa Barbara	Orcutt Creek	34.9414	-120.5742	Receiving Water
SM_Orcutt	Orcutt Creek @ Main Street	Santa Barbara	Orcutt Creek	34.9576	-120.63244	Receiving Water
SM_Brown	Orcutt Creek @ Brown Road	Santa Barbara	Orcutt Creek	34.9339	-120.55793	Receiving Water
SM_Simas	Green Valley Creek @ Simas Road	Santa Barbara	Orcutt Creek	34.9423	-120.5563	Receiving Water

Table 2. Pesticide Prioritization for Surface Water Monitoring in Palo Verde Outfall Drain, Alamo River and New River in Imperial and Riverside Counties. Ranking of Pesticides Based on Average Use Data from January to March in 2010-2012.

Palo Verde Drain, Drainage Area = 778 km^2				
Chemical	**Use score**	**Tox score**	**Final score**	**Monitoring inclusion**
Phorate	4	5	20	Yes
Pendimethalin	5	4	20	Yes
Trifluralin	5	4	20	Yes
Chlorpyrifos	3	6	18	Yes
Atrazine	2	8	16	No[1]
Malathion	3	5	15	Yes
λ-cyhalothrin	2	7	14	No[1]
Aldicarb	3	4	12	No[3]
Dimethoate	4	3	12	Yes
Paraquat dichloride	2	5	10	No[1]
2,4-D	3	3	9	Yes
Alamo River, Drainage Area = 1264 km^2				
Chemical	**Use score**	**Tox score**	**Final score**	**Monitoring inclusion**
Atrazine	3	8	24	Yes
Chlorpyrifos	4	6	24	Yes
Malathion	4	5	20	Yes
Pendimethalin	5	4	20	Yes
Trifluralin	5	4	20	Yes
Bromoxynil octanoate	4	4	16	No[2]
λ-cyhalothrin	2	7	14	No[1]
Permethrin	2	6	12	No[1]
Maneb	3	4	12	No[2]
Chlorothalonil	3	4	12	No[2, 4]
Methomyl	3	4	12	Yes
Dimethoate	4	3	12	Yes
Cypermethrin	2	5	10	No[1]
Oxyfluorfen	2	5	10	No[1]
Mancozeb	3	3	9	No[2]

Table 2. (continued)

New River, Drainage Area = 1729 km^2				
Chemical	**Use score**	**Tox score**	**Final score**	**Monitoring inclusion**
Atrazine	3	8	24	Yes
Malathion	4	5	20	Yes
Pendimethalin	5	4	20	Yes
Trifluralin	5	4	20	Yes
Chlorpyrifos	3	6	18	Yes
Chlorothalonil	4	4	16	No[2,4]
Bromoxynil octanoate	4	4	16	No[2]
λ-cyhalothrin	2	7	14	No[1]
Methomyl	3	4	12	Yes
Dimethoate	4	3	12	Yes
Oxyfluorfen	2	5	10	Yes
Mancozeb	3	3	9	No[2]

Notes for exclusion:

1) Low use, use score <3;
2) Short persistence defined by the prioritization model;
3) Low-risk use patterns or low-risk application methods defined by the prioritization model;
4) No detection in previous years.

Table 3. Pesticide Prioritization for Surface Water Monitoring in Palo Verde Drain, Alamo River and New River in Imperial and Riverside Counties. Ranking of Pesticides Based on Average Use Data from August to October in 2010-2012.

Palo Verde Drain, Drainage Area = 778 km^2				
Pesticide	**Use score**	**Tox score**	**Final score**	**Monitoring inclusion**
Chlorpyrifos	3	6	18	Monitoring not be conducted in this drainage due to relatively low pesticide uses and budget restraints
Tribufos	4	4	16	
Cyfluthrin	2	6	12	
Bifenthrin	2	6	12	
Pendimethalin	3	4	12	
Fenpropathrin	2	5	10	
Methoxyfenozide	3	3	9	
Alamo River, Drainage Area = 1264 km^2				
Pesticide	**Use score**	**Tox score**	**Final score**	**Monitoring inclusion**
Chlorpyrifos	5	6	30	Yes
Atrazine	2	8	16	No[1]
Pendimethalin	4	4	16	Yes
Permethrin	2	6	12	Yes
Esfenvalerate	2	6	12	Yes
Methomyl	3	4	12	Yes
Trifluralin	3	4	12	Yes
Cypermethrin	2	5	10	Yes
Oxyfluorfen	2	5	10	Yes
Malathion	2	5	10	Yes
Bensulide	5	2	10	Yes
Methoxyfenozide	3	3	9	Yes
Imidacloprid	3	3	9	Yes
Benefin	3	3	9	No[3]

Table 3. (continued)

New River, Drainage Area = 1729 km^2				
Pesticide	**Use score**	**Tox score**	**Final score**	**Monitoring inclusion**
Chlorpryrifos	4	6	24	Yes
Methomyl	4	4	16	Yes
Diquat dibromide	3	5	15	No[2]
Permethrin	2	6	12	Yes
Pendimethalin	3	4	12	Yes
Trifluralin	3	4	12	Yes
Diazinon	2	5	10	No[1]
Cypermethrin	2	5	10	Yes
Malathion	2	5	10	Yes
Paraquat dichloride	2	5	10	No[1]
Bensulide	5	2	10	Yes
Methoxyfenozide	3	3	9	Yes
Imidacloprid	3	3	9	Yes

Notes for exclusion:

1) Low use, use score <3;
2) Low bio-availability in water-sediment system defined by the prioritization methodology;
3) No detection in previous years.

Table 4. Pesticide Prioritization for Surface Water Monitoring in Salinas River and Tembladero Slough in Monterey County. Ranking of Pesticides Based on Average Use Data from April to September in 2010-2012.

Salinas River, Drainage Area = 11082 km^2				
Pesticide	**Use score**	**Tox score**	**Final score**	**Monitoring inclusion**
Malathion	4	5	20	Yes
Permethrin	3	6	18	Yes
Chlorpyrifos	3	6	18	Yes
Methomyl	4	4	16	Yes
Diazinon	3	5	15	Yes
Paraquat dichloride	3	5	15	Pending[5]
Mancozeb	5	3	15	No[2]
λ-cyhalothrin	2	7	14	Yes
Naled	2	6	12	No[3]
Maneb	3	4	12	No[2]
Oxyfluorfen	2	5	10	Yes
Bensulide	5	2	10	Yes
Captan	3	3	9	No[2]
Cyprodinil	3	3	9	No[4]
Imidacloprid	3	3	9	Yes
Oxydemeton-methyl	3	3	9	Pending[5]
Tembladero Slough, Drainage Area = 291 km^2				
Pesticide	**Use score**	**Tox score**	**Final score**	**Monitoring inclusion**
Malathion	5	5	25	Yes
Permethrin	3	6	18	Yes
Naled	3	6	18	No[3]
Maneb	4	4	16	No[2]
Methomyl	4	4	16	Yes
Mancozeb	5	3	15	No[2]
Bifenthrin	2	6	12	No[1]
Chlorpyrifos	2	6	12	Yes
Captan	4	3	12	No[2]
Diazinon	2	5	10	No[1]
Carbaryl	2	5	10	No[1]
Fenamidone	3	3	9	No[4]
Oxydemeton-methyl	3	3	9	Pending[5]

Notes for exclusion:

1) Low use, use score <3;
2) Short persistence defined by the prioritization methodology;

3) Low soil runoff potential defined by the prioritization methodology;
4) Analytical method not currently available;
5) Inclusion for monitoring depends on the timing in validating the analytical method.

Table 5. Pesticide Prioritization for Surface Water Monitoring in Orcutt Creek and Oso Flaco Creek in Santa Barbara and San Luis Obispo Counties. Ranking of Pesticides Based on Average Use Data from April to September in 2010-2012.

Orcutt Creek, Drainage Area = 301 km^2				
Pesticide	**Use score**	**Tox score**	**Final score**	**Monitoring inclusion**
Malathion	5	5	25	Yes
Chlorpyrifos	3	6	18	Yes
Naled	3	6	18	No[3]
Maneb	4	4	16	No[2]
Oxyfluorfen	3	5	15	Yes
Captan	5	3	15	No[2]
Permethrin	2	6	12	No[1]
Pyraclostrobin	3	4	12	Yes
Chlorothalonil	3	4	12	No[1,5]
Trifluralin	3	4	12	Yes
Imidacloprid	4	3	12	Yes
Mancozeb	4	3	12	No[2]
Fenpropathrin	2	5	10	No[1]
Oso Flaco Creek, Drainage Area = 51 km^2				
Pesticide	**Use score**	**Tox score**	**Final score**	**Monitoring inclusion**
Malathion	5	5	25	Yes
Naled	4	6	24	No[3]
Thiram	4	4	16	No[4]
Captan	5	3	15	No[2]
Chlorpyrifos	2	6	12	Yes
Maneb	3	4	12	No[2]
Pyraclostrobin	3	4	12	Yes
Fenpropathrin	2	5	10	No[1]
Oxyfluorfen	2	5	10	No[1]
Mancozeb	3	3	9	No[2]

Notes for exclusion:
1) Low use, use score <3;
2) Short persistence defined by the prioritization methodology;
3) Low soil runoff potential defined by the prioritization methodology;
4) Low bio-availability in water-sediment system defined by the prioritization methodology;
5) No detection in previous years.

Table 6. Final Monitoring Lists for Analytes or Analyte Groups in Imperial, Monterey, Santa Barbara and San Luis Obispo Counties from March to October, 2015.

Screen Group*	March	April-September	May, July, September	October
	Imperial PVOD**	Monterey	Santa Barbara San Luis Obispo	Imperial
AZ	X			
2,4-D	X			
DA				X
DN/OX	X	X	X	X
DZ		X		
IMD/BEN		X	X	X
ME	X	X		X
OP	X	X	X	X
Oxydemeton -methyl		Pending		
Paraquat dichloride		Pending		
PY		X		X
STR			X	

* AZ = Atrizine + Degradates; DA = Diacylhydrazines; DN/OX = Dinitroanilines & Oxyfluorfen; DZ = Diazinon; IMD/BEN = Imidacloprid & Bensulide; ME = Methomyl; OP = Organophosphates; PY = Pyrethroids; STR = Strobilurin

**Palo Verde Outfall Drain

Table 7. Reporting Limit and Method Detection Limit for Pesticides Monitored in the Agricultural Areas of California, 2015.

Chemical Group	**Chemical**	**Method Detection Limit (µg/L)**	**Reporting Limit (µg/L)**
Atrazine (AZ)	Atrazine	0.015	0.05
2,4-D	2,4-D	0.015	0.05
Dinitroanilines and Oxyfluorfen (DN/OX)	Benfluralin	0.015	0.05
	Ethalfluralin	0.017	0.05
	Oryzalin	0.021	0.05
	Oxyfluorfen	0.023	0.05
	Pendimethalin	0.19	0.05
	Prodiamine	0.02	0.05
	Trifluralin	0.015	0.05
Diacylhydrazines (DA)	Methoxyfenozide	0.00641	0.05
	Tebufenozide	0.00573	0.05
Imidacloprid and Bensulide (IMD/BEN)	Imidacloprid	0.0101	0.05
	Bensulide	0.0198	0.04
Methomyl (ME)	Methomyl	0.0011	0.05
Organophosphates (OP)	Chlorpyrifos	0.01024	0.01
	Diazinon	0.01093	0.01
	Dimethoate	0.01202	0.04
	Malathion	0.00935	0.02
	Methidathion	0.01136	0.05
	Phorate	0.00959	0.05
Pyrethroids (PY)	Bifenthrin	0.00091	0.001
	Lambda-cyhalothrin	0.00174	0.002
	Permethirn (cis)	0.00105	0.002
	Permethrin (trans)	0.00105	0.005
	Cyfluthrin	0.00146	0.002
	Cypermethrin	0.00154	0.005
	Fenvalerate/esfenvalerate	0.00166	0.005
Strobilurins (STR)	Azoxystrobin	0.0225	0.05
	Kresoxim-methyl	0.0190	0.05
	Pyraclastrobin	0.0207	0.05
	Trifloxystrobin	0.0172	0.05

Table 8. Monitoring Schedules and Budget in Imperial, Riverside, Monterey, Santa Barbara (SB) and San Luis Obispo (SLO) Counties from March to October, 2015.

Analyte Group*	March	April	May	June	July	August	September	October	Total Number of Samples	QC Samples	Cost per sample	Total Cost per Analyte Group
	Imperial Riverside	Monterey	Monterey SB and SLO	Monterey	Monterey SB and SLO	Monterey	Monterey SB and SLO	Imperial				
AZ	9	–	–	–	–	–	–	–	9	1	540	5400
2,4-D	5	–	–	–	–	–	–	–	5	1	540	3240
DA	–	–	–	–	–	–	–	9	9	1	720	7200
DN/OX	14	7	5	7	5	7	5	9	59	6	840	54600
DZ	–	–	7	–	7	–	7	–	21	2	510	11730
IMD/BEN	–	11	12	11	12	11	12	9	78	8	720	61920
ME	9	11	–	11	–	11	–	9	51	5	480	26880
OP	14	11	12	11	12	11	12	9	92	9	600	60600
PY	–	–	7	–	7	–	7	9	30	3	960	31680
STR	–	–	5	–	5	–	5	–	15	2	840	14280
Grand Total	**51**	**40**	**48**	**40**	**48**	**40**	**48**	**54**	**369**	**38**	–	**$277,530**

* AZ = Atrizine + Degradates; DA = Diacylhydrazines; DN/OX = Dinitroanilines & Oxyfluorfen; DZ = Diazinon; IMD/BEN = Imidacloprid & Bensulide; ME = Methomyl; OP = Organophosphates; PY = Pyrethroids; STR = Strobilurin

Figure 1. Monitoring Sites in Palo Verde Outfall Drain in Imperial and Riverside Counties.

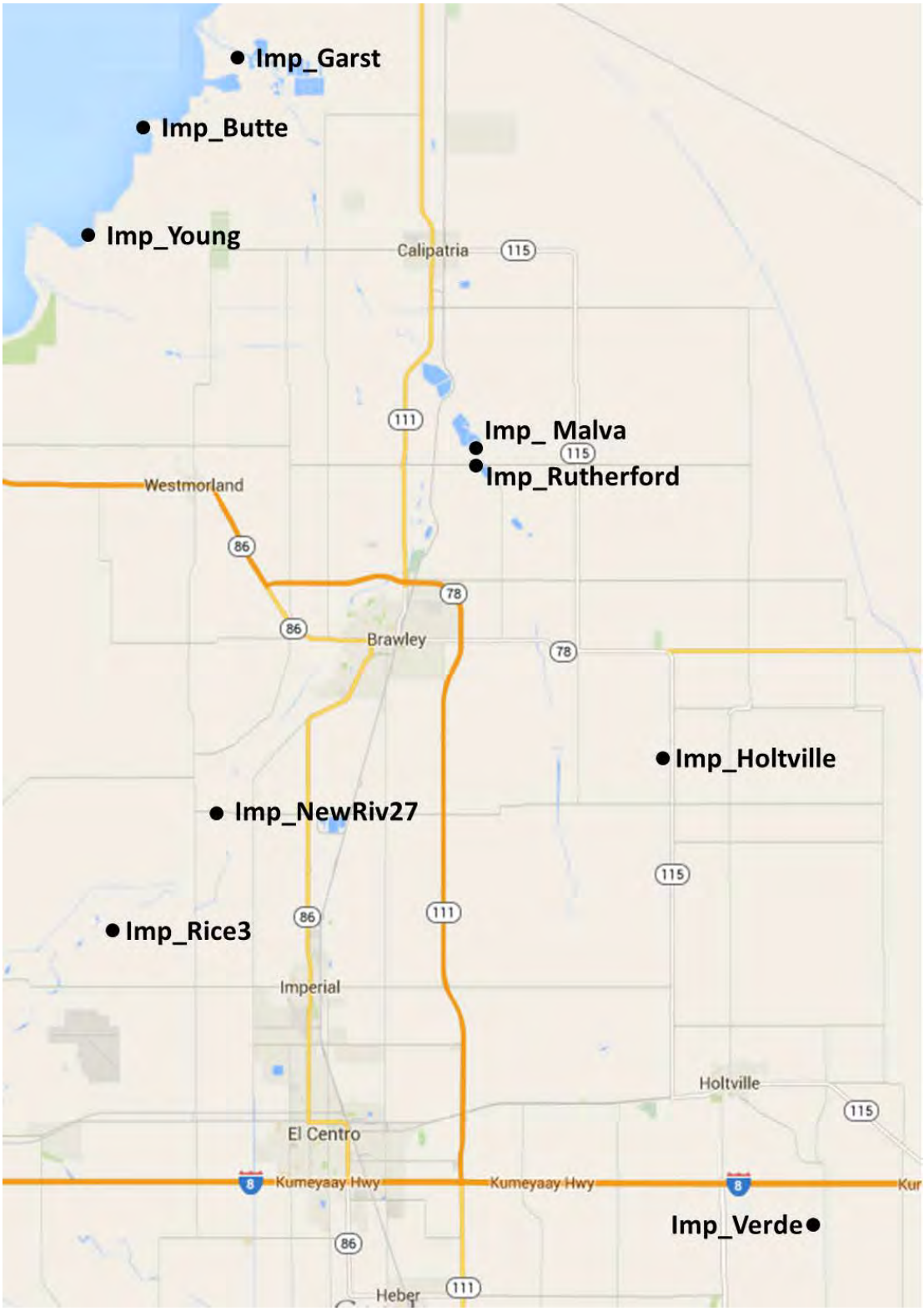

Figure 2. Monitoring Sites in Alamo River and New River in Imperial County.

Figure 3. Monitoring Sites in Salinas River and Tembladero Slough in Monterey County.

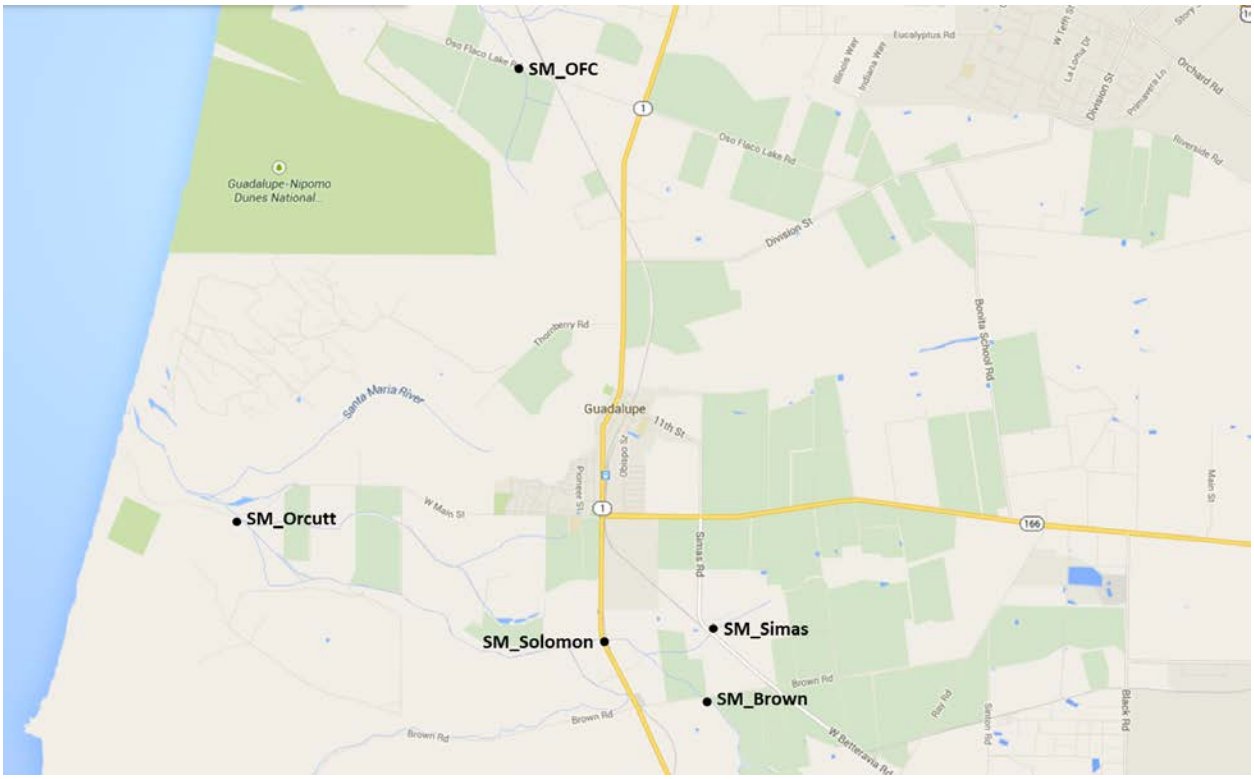

Figure 4. Monitoring Sites in Orcutt Creek and Oso Flaco Creek in Santa Barbara and San Luis Obispo Counties.