Monitoring Groundwater Concentrations of Pesticides in Sensitive Areas with High Agricultural Use
Study 228 - Well Network Sampling - Annual Update 2022

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INTRODUCTION

This update summarizes the annual results of pesticide concentrations detected in a network of primarily domestic wells, with a few used partially or exclusively for irrigation, monitored for more than 20 years throughout California's San Joaquin Valley. The Well Network is located throughout Fresno and Tulare counties, in areas vulnerable to groundwater contamination and high agricultural use of pesticides based on historical monitoring (Well Inventory Database) and reported pesticide use (Pesticide Use Reporting) data. In 2022, the California Department of Pesticide Regulation's (DPR) Groundwater Protection Program (GWPP) analyzed groundwater samples from 59 wells for pesticide residues using the Triazine Screen and the Multi-Analyte Screen. Eleven wells were also analyzed for pesticides and degradates with the Metolachlor Screen in areas with higher use reported of the active ingredient.

Background

In 1999, DPR initiated the Well Network Study to monitor potential changes in groundwater pesticide concentrations due to new regulations with enforceable management practices designed to minimize pesticide movement to groundwater (Garretson, 1999; Davalos, 2021). When this study was initiated, the selected wells had been previously sampled by DPR and had residues of simazine, bromacil, or diuron. Wells in the Well Network continued to be sampled for at least some triazine pesticides annually. Due to the vulnerability of the study area, the Well Network has also served as an experimental area to monitor for additional pesticides that have the potential to contaminate groundwater.

Troiano et al. (2013) reported a statistical analysis of data collected from 2000 to 2012 in the Well Network, along with a full description of this study, including characterization of the conditions of the vulnerable areas, pesticide use, and the required mitigation measures. Annual summaries of study results have been reported since 2008. More recently, the annual summaries have included a trend analysis of changing pesticide and pesticide degradate residue concentrations since either 1999 or the first year an analyte was sampled for. The analysis in Troiano et al. (2013) and the tables included in the

annual summaries suggest that DPR's regulatory actions have resulted in measurable decreases in both detection frequencies and well water concentrations for many regulated pesticides (Davalos, 2021; Garretson, 1999; Troiano et al., 2013).

This summary of the 2022 Well Network monitoring presents the data in the following order:

- Sampling locations: **Figure 1**, Table 1, and Table 2
- Pesticides and degradates analyzed: Table 3 through Table 6
- Monitoring results: Table 7 through Table 11
- Historical data: Table 12 through Table 14
- QA/QC results: Table 15 through Table 16

GWPP scientists would like to express their gratitude to the volunteers who have generously allowed us to sample their wells for over 20 years. Their participation has been crucial for monitoring emerging groundwater pesticide contaminants and establishing trends—work that could not have been accomplished without their participation. We would also like to acknowledge Jennifer Davalos, a former coworker who provided planning, logistics, volunteer communication and results gathering for the 2022 monitoring season.

METHODS

Sampling Methods

DPR's GWPP scientists conducted the study according to the protocol (Davalos, 2021) and followed the standard operating procedures (SOPs) for collecting samples (Kocis, 2022). Sampling occurred between May 16, 2022, and June 29, 2022.

Study Area

The Well Network's well locations are in areas susceptible to pesticide movement to groundwater within Fresno and Tulare counties (Figure 1, Table 1, and Table 2). Areas vulnerable to groundwater contamination from agricultural use of pesticides are characterized by coarse soils that are susceptible to pesticides leaching through the soil into groundwater or by hardpan soils vulnerable to pesticide runoff into sensitive areas with conduits to groundwater (www.cdpr.ca.gov/environmental-monitoring/groundwater/). To regulate pesticide use in vulnerable soil areas of California, DPR designated certain one-square-mile sections of land that were determined to be sensitive to the movement of pesticides to groundwater as Groundwater Protection Areas (GWPAs). In GWPAs, pesticides and their degradates listed in California Code of Regulations, Title 3, Section 6800(a) are regulated to mitigate their movement to groundwater. Three types of GWPAs are designated, leaching, runoff and sections with a combined leaching and runoff. The GWPAs surrounding the Well Network are shown in Figure 1. GWPAs, sections, vulnerability and regulations are described in the 2022 annual well sampling report, Sampling for Pesticide Residues in California Well Water.

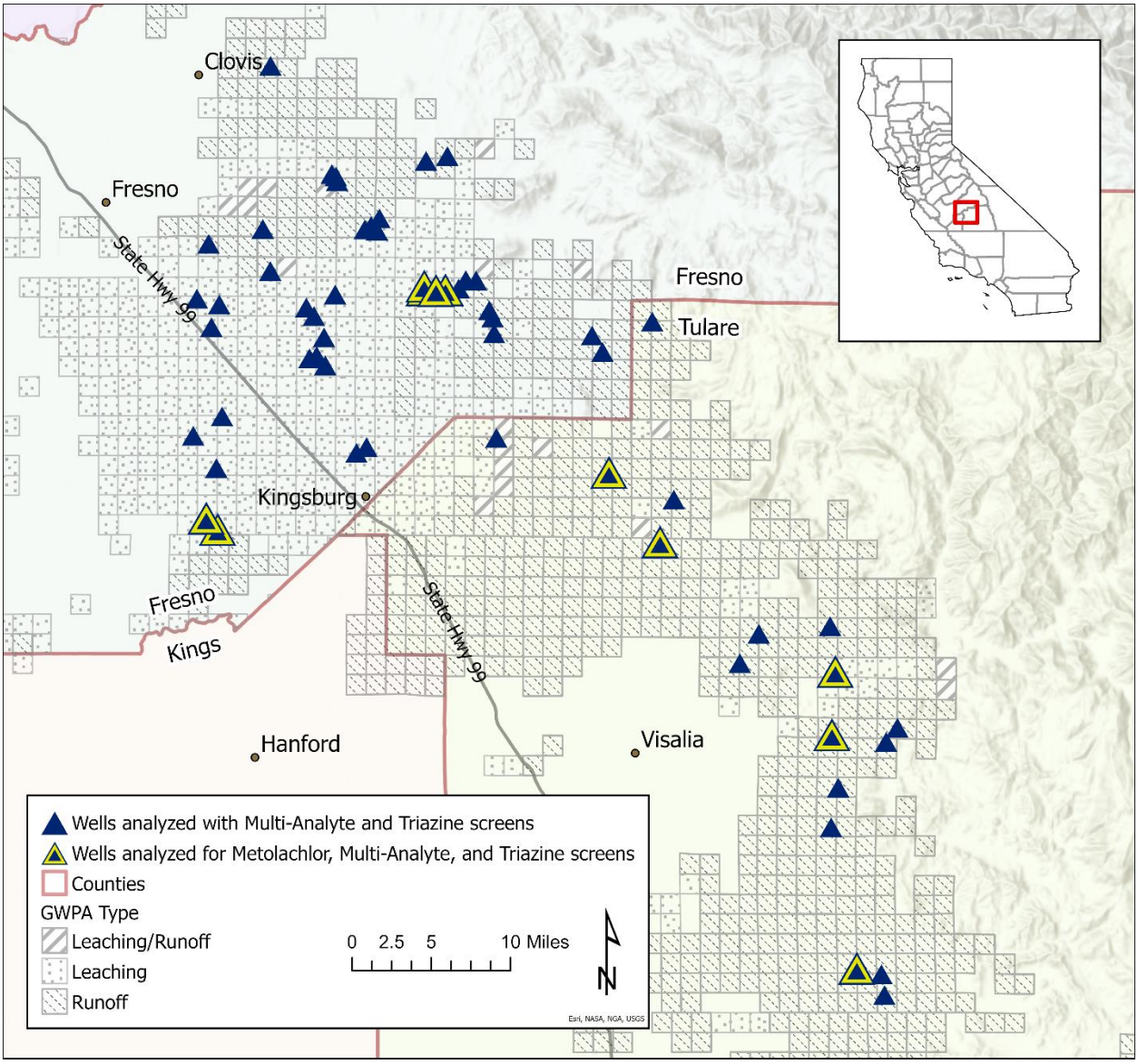

Figure 1. Location of the Well Network wells in Fresno and Tulare counties and display of GWPAs.

Wells Sampled

Fifty-nine wells (Table 1 and Table 2) in the Well Network were sampled in 2022. Not all wells in the Well Network are sampled every year due to changes in participation, wells going dry, and new wells being drilled to replace decommissioned wells. For this reason, well numbers used by DPR to differentiate sampling locations are not consecutive.

Table 1. Well locations in Fresno County.

Well Number	Township/Range-Section
1	13S/21E-01
2	13S/22E-33
3	13S/23E-28
4	13S/23E-32
5	14S/21E-13
7	14S/21E-21
8	14S/21E-13
12	14S/22E-03
13	14S/22E-12
14	14S/22E-13
15	14S/22E-14
16	14S/22E-14
19	14S/23E-34
20*	14S/23E-32
20B*	14S/23E-32
21*	14S/23E-33
22	14S/23E-34
23B	14S/23E-35
24	15S/21E-03
25	15S/21E-05
26	15S/21E-09
28	15S/21E-34
30A	15S/22E-05
32	15S/22E-09
35	15S/22E-16
36	15S/22E-20
37	15S/22E-21
43	15S/23E-02
44	15S/23E-02
45	15S/23E-12
47	15S/24E-14
50	16S/21E-05
52	16S/21E-16
53A*	16S/21E-33
54*	16S/21E-34
56	16S/22E-11
57	16S/22E-11
89	13S/22E-33
90	15S/22E-05
92*	14S/23E-33
94	15S/24E-10
95	14S/22E-33

Table 2. Well locations in Tulare County.

Well Number	Township/Range-Section
49	15S/25E-05
58	16S/23E-01
59A*	16S/24E-14
61	16S/25E-21
63A*	17S/25E-05
65	17S/26E-26
68*	18S/26E-02
69	18S/26E-06
71*	18S/26E-23
72	18S/27E-21
73	18S/27E-29
74	19S/26E-01
75A	19S/26E-14
80*	20S/26E-24
84	20S/27E-20
86	20S/27E-32
96	17S/26E-29

*Wells analyzed with the Metolachlor Screen

Analytical Methods

The CDFA Center for Analytical Chemistry analyzed samples using the Triazine Screen analytical method EM 62.9, revision 5 (CDFA, 2020), the Multi-Analyte Screen analytical method EMON-SM-05-032, revision 2 (CDFA, 2022a), and eleven well samples with the Metolachlor Screen analytical method EMON-SM-034A, revision 2 (CDFA, 2022b). These methods are highly specific and have been determined by DPR to provide unequivocal identification of the chemicals analyzed (Aggarwal, 2020; 2022a; 2022b). The reporting limit (RL) for each analyte ranged from 0.01 ppb (µg/L) to 0.05 ppb (µg/L) (Table 3 through Table 6). The Metolachlor Screen includes three analytes analyzed by Liquid Chromatography Mass Spectrometry (LC/MS) (Table 3), the Triazine Screen includes 14 analytes analyzed by LC/MS (Table 4), and the Multi-Analyte Screen includes 14 analytes by Gas Chromatography Mass Spectrometry (GC/MS) and 38 analytes by LC/MS (Table 5 and Table 6).

In 2022, groundwater samples from 59 wells were analyzed using the Triazine and Multi-Analyte Screens. A subset of eleven wells were collocated with areas of high use of metolachlor. Samples from this subset of wells were also analyzed for pesticide and pesticide degradate residues on the Metolachlor Screen.

Table 3. Metolachlor method detection limits (MDL) and reporting limits (RL) in ppb (µg/L).

Analyte	MDL	RL
S-Metolachlor	0.0114	0.05
Metolachlor ESA	0.0327	0.05
Metolachlor OXA	0.0321	0.05

Table 4. Triazine Screen method detection limits (MDL) and reporting limits (RL) in ppb (µg/L).

Analyte	MDL	RL
ACET*	0.00580	0.03
Atrazine	0.00316	0.02
Bromacil	0.00241	0.02
DACT*	0.00235	0.05
DEA*	0.00226	0.02
Diuron	0.00241	0.02
DSMN*	0.00181	0.01
Hexazinone	0.00197	0.01
Metribuzin	0.00238	0.05
Norflurazon	0.00252	0.02
Prometon	0.00240	0.02
Prometryn	0.00265	0.05
Simazine	0.00286	0.02
Tebuthiuron	0.00236	0.05

*Acronyms are ACET = Deethyl-simazine or Deisopropyl-atrazine (degradate of atrazine and simazine), DACT = Diaminochlorotriazine (degradate of simazine), DEA = Deethyl-atrazine (degradate of atrazine), DSMN = Desmethylnorflurazon (degradate of norflurazon).

Table 5. Multi-Analyte Screen method detection limits (MDL) and reporting limits (RL) in ppb (µg/L).

Analyte	MDL	RL
Clomazone	0.00799	0.05
Dichloran	0.01103	0.05
Dichlobenil	0.00678	0.03
Disulfoton	0.01040	0.05
Ethoprophos	0.00506	0.03
Fonofos	0.00616	0.03
Malathion	0.00691	0.03
Parathion ethyl	0.00646	0.03
Parathion methyl	0.00655	0.03
Phorate	0.00521	0.03
Piperonyl butoxide	0.00785	0.03
Prometryn	0.00738	0.03
Propanil	0.00836	0.05
Triallate	0.00638	0.03

Table 6. Multi-Analyte Screen method detection limits (MDL) and reporting limits (RL) in ppb (µg/L).

Analyte	MDL	RL
Alachlor	0.00920	0.03
Atrazine	0.00286	0.02
Azinphos-methyl	0.01440	0.05
Azoxystrobin	0.00584	0.02
Bensulide	0.00571	0.02
Bromacil	0.00393	0.02
Carbaryl	0.00323	0.02
Carbofuran	0.00393	0.02
Chlorantraniliprole	0.00345	0.02
Cyprodinil	0.00427	0.02
Diazinon	0.01050	0.03
Dimethenamid	0.00490	0.02
Dimethoate	0.00330	0.02
Diuron	0.00484	0.02
Ethofumesate	0.00845	0.03
Fenamiphos	0.01070	0.03
Fludioxonil	0.00892	0.03
Flutriafol	0.00298	0.02
Imidacloprid	0.00323	0.02
Isoxaben	0.00493	0.02
Linuron	0.00697	0.02
Mefenoxam/metalaxyl*	0.00295	0.02
Methiocarb	0.00710	0.02
Metolachlor	0.01660	0.02
Methomyl	0.00301	0.02
Methoxyfenozide	0.00628	0.03
Metribuzin	0.00414	0.02
Napropamide	0.00462	0.02
Norflurazon	0.00550	0.02
Oryzalin	0.01140	0.05
Prometon	0.00245	0.02
Propiconazole	0.00424	0.02
Pyraclostrobin	0.00210	0.02
Simazine	0.00279	0.02
Tebuthiuron	0.00524	0.02
Thiamethoxam	0.00386	0.02
Thiobencarb	0.00245	0.02
Uniconazole	0.01370	0.05

*Mefenoxam and metalaxyl are stereoisomers and cannot be analytically distinguished.

RESULTS

Results in Table 7 through Table 11 will be entered into DPR's Well Inventory Database (DPR, 2024).

Metolachlor Screen

The monitoring results for the eleven wells sampled for Metolachlor Screen analytes are shown in Table 7. This subset of wells was selected due to their location in high-use areas. No residues of metolachlor or the degradates were detected in the eleven wells sampled.

Triazine Screen

The monitoring results for the 59 wells sampled for Triazine Screen analytes are shown in Table 8 and Table 9. The selected wells were in GWPAs, with 26 in leaching GWPAs and 33 in runoff GWPAs. Almost all wells (55 out of 59) had detections in the samples collected and analyzed of one or more pesticides or degradates on the Triazine Screen. All analytes were detected in at least one well, except metribuzin and prometryn. All detected analytes except hexazinone are 6800(a) pesticides and degradates on the groundwater protection list and regulated in GWPAs. Hexazinone was determined not to pollute at concentrations detected by DPR (Reardon, 2011).

Multi-Analyte Screen

The monitoring results for the 59 wells sampled for Multi-Analyte Screen analytes are shown in Table 10 and Table 11. Table 10 includes the quantifiable and estimated trace detections for pesticides that are unique to the Multi-Analyte Screen. Key findings include:

<u>Analytes with Quantifiable Detections</u>

The following 6 pesticides were detected at or above the RL concentrations in at least one of the wells sampled (Table 10):

- Chlorantraniliprole
- Fludioxonil
- Flutriafol
- Imidacloprid
- Mefenoxam/metalaxyl
- Methoxyfenozide

<u>Analytes with Trace Detections</u>

- Thiamethoxam was only detected at trace concentrations in one well sampled (Table 10).

<u>Analytes Not Detected</u>

The following 37 analytes were not detected in any of the samples collected:

Alachlor, azinphos-methyl, azoxystrobin, bensulide, carbaryl, carbofuran, clomazone, cyprodinil, diazinon, dichlobenil, dichloran, dimethenamid, dimethoate, disulfoton, ethofumesate, ethoprophos, fenamiphos, fonofos, isoxaben, linuron, malathion, methiocarb, methomyl, metolachlor, napropamide, oryzalin, parathion ethyl, parathion methyl, phorate, piperonyl butoxide, prometryn, propanil, propiconazole, pyraclostrobin, thiobencarb, triallate, and uniconazole.

Previous detections of imidacloprid were provided as evidence for the formal review process required by the Pesticide Contamination Prevention Act (Davalos, 2022). As per sections 13149 and 13150 of the California Food and Agricultural Code of the Pesticide Contamination Prevention Act, in cases where a pesticide's active ingredient, specified ingredient, or degradation product is initially detected and confirmed in groundwater as a result of legal agricultural use, the law necessitates a formal review to assess whether the pesticide's usage can continue and, if so, under what condition. After formal review, imidacloprid was found not to pollute or threaten to pollute groundwater at concentrations detected in California (Henderson, 2022). DPR will continue to monitor for imidacloprid in groundwater.

Several pesticides detected in the Well Network are being evaluated through ongoing studies:

- Fludioxonil: Currently under investigation as part of a separate study (Kocis, 2020).
- Mefenoxam/metalaxyl: Under evaluation in a small-scale study.
- Methoxyfenozide, chlorantraniliprole, and flutriafol: Their detection in 2021 prompted statewide sampling for the three analytes in high use areas (Afyuni and Nordmark, 2022), as well as the decision to analyze all wells in the Well Network with the Multi-Analyte Screen in 2022.

Replicate Analyses in Both Triazine and Multi-Analyte Screens

A comparison of results from common analytes between the Triazine and Multi-Analyte Screens are shown in Table 11. The common analytes are atrazine, bromacil, diuron, norflurazon, prometon, simazine, and tebuthiuron. The results are generally similar between the two analytical methods, with minor differences, especially at lower concentrations. This indicates that the methods are consistent in detecting and quantifying the analytes. Only five detection comparisons showed variances exceeding the 30% relative percent difference. Differences arise between trace detections, where one method identifies trace concentrations while the other does not, typically because of differing detection limits. Other discrepancies could be due to differences in sensitivity of the two methods.

Summary of Previous Years' Monitoring Results

Metolachlor Screen

Wells in the Well Network were not previously analyzed using the Metolachlor Screen. The parent metolachlor, but not the degradates, is included in the Multi-analyte Screen, which has been used for all or some sites in the Well Network since 2014. In 2015, a trace of the parent was detected; however, all samples have been ND since that time.

Triazine Screen

Triazine Screen results from 1999 through 2022 are presented in Table 12 and Table 13 as the percent of wells with detections above the RL and the means of those detections. A comprehensive report similar to Troiano, et al. (2013) is currently being drafted to evaluate long-term trends.

Multi-Analyte Screen

An overview of the Multi-Analyte Screen detections from 2014 through 2022 is presented in Table 14, not including analytes reported on the Triazine Screen. The Multi-Analyte Screen method has been updated in recent years to add new analytes. Results vary year to year depending on the version of the method used and the number of wells analyzed using this method.

Table 7. Metolachlor Screen from 2022. Concentrations in ppb (µg/L).

Well Number	S-Metolachlor	Metolachlor ESA	Metolachlor OXA
20	ND	ND	ND
20B	ND	ND	ND
21	ND	ND	ND
53A	ND	ND	ND
54	ND	ND	ND
59A	ND	ND	ND
63A	ND	ND	ND
68	ND	ND	ND
71	ND	ND	ND
80	ND	ND	ND
92	ND	ND	ND

ND = not detected (below the method detection limit listed in Table 3)

Table 8. Triazine Screen sampling results from 2022 (part 1). Concentrations in ppb (µg/L).

Well Number	ACET	Atrazine	Bromacil	DACT	DEA	Diuron	DSMN
1	Trace (0.0198)	ND	ND	**0.0716**	ND	Trace (0.00306)	ND
2	**0.0419**	ND	ND	Trace (0.0300)	ND	Trace (0.00625)	Trace (0.00800)
3	**0.0450**	ND	ND	**0.0572**	ND	ND	**0.133**
4	**0.219**	**0.0247**	**1.22**	**0.516**	**0.0218**	Trace (0.0168)	**0.557**
5	**0.218**	ND	ND	**0.461**	Trace (0.00720)	ND	**0.241**
7	**0.0780**	ND	0.0156	**0.203**	Trace (0.00450)	Trace (0.00649)	ND
8	**0.150**	Trace (0.00685)	Trace (0.0113)	**0.195**	**0.0217**	**0.0279**	**0.0132**
12	**0.273**	ND	**0.328**	**0.301**	Trace (0.00239)	**0.0380**	**0.0172**
13	**0.101**	ND	**0.160**	**0.214**	ND	**0.0228**	**0.192**
14	ND	ND	ND	ND	ND	ND	ND
15	**0.0434**	ND	ND	**0.0967**	ND	Trace (0.0110)	**0.0912**
16	**0.105**	ND	ND	**0.248**	ND	**0.0250**	**0.245**
19	**0.120**	ND	ND	**0.137**	ND	Trace (0.00598)	**0.184**
20	Trace (0.0107)	ND	ND	Trace (0.00357)	ND	ND	ND
20B	ND	ND	ND	ND	ND	ND	ND
21	ND	ND	ND	Trace (0.00364)	ND	ND	Trace (0.00883)
22	**0.140**	ND	ND	**0.373**	ND	ND	**0.0732**
23B	**0.133**	ND	**0.0689**	**0.256**	ND	**0.0302**	**0.134**
24	ND	ND	ND	Trace (0.00850)	ND	ND	**0.113**
25	**0.0588**	ND	ND	Trace (0.0477)	ND	ND	**0.0297**
26	Trace (0.00943)	ND	ND	Trace (0.0206)	ND	ND	**0.0366**
28	Trace (0.00787)	ND	ND	Trace (0.0146)	ND	ND	ND
30A	**0.166**	ND	ND	**0.238**	Trace (0.00746)	**0.0219**	**0.0236**
32	**0.160**	ND	ND	**0.242**	ND	ND	**0.312**
35	**0.103**	ND	ND	**0.151**	ND	**0.0274**	**0.0953**
36	ND	ND	ND	Trace (0.0108)	ND	ND	Trace (0.00746)
37	**0.0368**	ND	Trace (0.00312)	**0.0516**	ND	Trace (0.00557)	**0.0992**
43	**0.138**	ND	ND	**0.0965**	ND	Trace (0.00265)	**0.0486**
44	**0.0837**	ND	**0.127**	**0.0979**	ND	**0.0241**	**0.0200**
45	Trace (0.0226)	ND	ND	Trace (0.0456)	ND	**0.0379**	**0.113**
47	**0.398**	Trace (0.00816)	**0.0265**	**0.789**	**0.0523**	Trace (0.00979)	**0.0200**
49	**0.663**	ND	ND	**3.44**	Trace (0.00883)	ND	**0.267**
50	ND	ND	ND	ND	ND	ND	ND

Well Number	ACET	Atrazine	Bromacil	DACT	DEA	Diuron	DSMN
52	**0.0476**	ND	ND	**0.0932**	ND	ND	**0.0114**
53A	ND	ND	ND	ND	ND	ND	ND
54	Trace (0.0218)	ND	ND	Trace (0.0420)	ND	ND	ND
56	**0.274**	ND	ND	**0.633**	ND	ND	ND
57	**0.118**	ND	ND	**0.211**	ND	ND	**0.0185**
58	Trace (0.00923)	ND	ND	Trace (0.00657)	ND	ND	Trace (0.00906)
59A	**0.352**	Trace (0.0185)	**0.655**	**0.707**	**0.0411**	**0.0341**	**1.90**
61	**0.392**	ND	**1.01**	**1.77**	Trace (0.0188)	**0.0357**	**0.0219**
63A	Trace (0.00844)	Trace (0.00887)	ND	Trace (0.0265)	Trace (0.0108)	Trace (0.00844)	ND
65	Trace (0.0266)	ND	ND	**0.0515**	ND	ND	ND
68	ND	ND	ND	ND	ND	ND	ND
69	**0.413**	ND	**0.289**	**2.01**	Trace (0.00472)	**0.0369**	ND
71	**0.364**	ND	**0.895**	**1.01**	Trace (0.00606)	**0.0213**	**1.00**
72	**0.639**	Trace (0.00364)	Trace (0.00957)	**1.74**	**0.0239**	Trace (0.0111)	**0.0358**
73	**0.116**	Trace (0.00386)	ND	**1.06**	**0.0394**	Trace (0.00738)	**0.0499**
74	**0.709**	ND	**0.479**	**1.26**	Trace (0.0154)	**0.0357**	**0.0289**
75A	**0.785**	ND	**0.401**	**0.799**	Trace (0.00617)	**0.0348**	Trace (0.00698)
80	**0.307**	ND	**0.129**	**1.03**	Trace (0.00496)	0.0200	Trace (0.00401)
84	**0.203**	Trace (0.0105)	**4.39**	**0.565**	**0.0233**	**0.0339**	Trace (0.00243)
86	**0.442**	Trace (0.00512)	ND	**2.88**	**0.0326**	Trace (0.00500)	ND
89	**0.0504**	ND	**0.0216**	**0.0696**	ND	Trace (0.0188)	**0.0708**
90	**0.125**	**0.0507**	**0.0242**	**0.163**	**0.111**	**0.0392**	**0.0158**
92	**0.270**	ND	ND	**0.262**	Trace (0.00266)	**0.0478**	**0.145**
94	**0.527**	ND	Trace (0.0190)	**3.35**	Trace (0.00499)	Trace (0.00630)	**0.553**
95	ND	ND	ND	Trace (0.00767)	ND	ND	ND
96	**0.479**	ND	**0.288**	**2.12**	Trace (0.00567)	**0.0273**	**0.0289**

ND = not detected (below the method detection limit listed in Table 4).

Table 9. Triazine Screen sampling results from 2022 (part 2). Concentrations in ppb (µg/L).

Well Number**	Hexazinone	Metribuzin	Norflurazon	Prometon	Prometryn	Simazine	Tebuthiuron	Propazine %*
1	ND	ND	ND	ND	ND	ND	ND	75.6
2	ND	ND	Trace (0.00291)	ND	ND	**0.0327**	ND	91.9
3	ND	ND	Trace (0.00777)	ND	ND	**0.0492**	ND	80.1
4	ND	ND	**0.562**	Trace (0.0130)	ND	**0.0545**	ND	76.4
5	ND	ND	Trace (0.00684)	ND	ND	**0.0734**	ND	82.2
7	ND	ND	ND	ND	ND	Trace (0.0132)	ND	82.5
8	Trace (0.00304)	ND	Trace (0.00410)	ND	ND	**0.0645**	ND	78.8
12	ND	ND	ND	ND	ND	**0.0218**	ND	89.3
13	ND	ND	**0.132**	ND	ND	**0.0275**	ND	75.8
14	ND	ND	ND	ND	ND	ND	ND	76.7
15	ND	ND	Trace (0.0174)	ND	ND	**0.0419**	ND	87.4
16	ND	ND	**0.0797**	ND	ND	**0.0606**	ND	82.7
19	ND	ND	**0.0251**	ND	ND	**0.0440**	ND	70.7
20	ND	ND	ND	ND	ND	Trace (0.0131)	ND	84.0
20B	ND	ND	ND	ND	ND	Trace (0.00333)	ND	80.1
21	ND	ND	ND	ND	ND	Trace (0.00331)	ND	78.0
22	ND	ND	Trace (0.00348)	ND	ND	**0.0724**	ND	76.1
23B	ND	ND	Trace (0.0119)	ND	ND	**0.0259**	ND	79.1
24	ND	ND	Trace (0.0150)	ND	ND	Trace (0.00363)	ND	83.7
25	ND	ND	ND	ND	ND	**0.0364**	ND	82.0
26	ND	ND	ND	ND	ND	Trace (0.00585)	ND	75.2
28	ND	ND	ND	ND	ND	Trace (0.00964)	ND	74.1
30A	ND	ND	**0.0547**	ND	ND	**0.0679**	ND	69.8
32	ND	ND	**0.153**	ND	ND	**0.0508**	ND	80.2
35	ND	ND	**0.0297**	Trace (0.0101)	ND	**0.0674**	ND	79.1
36	ND	ND	ND	Trace (0.00290)	ND	**0.0221**	ND	83.7
37	ND	ND	**0.0401**	ND	ND	**0.0243**	ND	81.1
43	ND	ND	**0.0281**	ND	ND	**0.0633**	ND	77.9
44	ND	ND	Trace (0.00658)	ND	ND	**0.0359**	ND	79.4
45	ND	ND	**0.0244**	Trace (0.00390)	ND	Trace (0.00858)	ND	78.9
47	Trace (0.00243)	ND	ND	ND	ND	**0.0250**	ND	76.8
49	ND	ND	Trace (0.0189)	ND	ND	**0.0640**	ND	77.7
50	ND	ND	ND	ND	ND	ND	ND	85.1
52	ND	ND	ND	ND	ND	**0.0403**	ND	73.6

Well Number**	Hexazinone	Metribuzin	Norflurazon	Prometon	Prometryn	Simazine	Tebuthiuron	Propazine %*
53A	ND	ND	ND	ND	ND	ND	ND	80.9
54	ND	ND	ND	**0.0297**	ND	**0.0351**	ND	81.5
56	ND	ND	ND	ND	ND	**0.0701**	ND	76.7
57	ND	ND	ND	ND	ND	**0.0357**	ND	72.7
58	ND	ND	ND	ND	ND	Trace (0.0199)	ND	91.4
59A	ND	ND	**0.553**	ND	ND	**0.0202**	ND	77.2
61	ND	ND	Trace (0.00855)	ND	ND	**0.0512**	ND	82.1
63A	ND	ND	ND	ND	ND	ND	ND	76.7
65	ND	ND	ND	ND	ND	Trace (0.00988)	Trace (0.00295)	88.6
68	ND	ND	ND	ND	ND	ND	ND	85.4
69	ND	ND	ND	ND	ND	**0.0343**	ND	84.5
71	ND	ND	**0.265**	ND	ND	**0.0519**	ND	73.3
72	ND	ND	**0.0215**	ND	ND	**0.0639**	ND	84.2
73	ND	ND	ND	ND	ND	Trace (0.00566)	ND	80.3
74	ND	ND	**0.0356**	ND	ND	**0.0733**	ND	84.7
75A	ND	ND	Trace (0.00575)	ND	ND	**0.0662**	ND	79.2
80	ND	ND	ND	ND	ND	Trace (0.0179)	ND	73.5
84	ND	ND	ND	ND	ND	Trace (0.0186)	ND	85.5
86	ND	ND	ND	ND	ND	**0.0358**	ND	72.4
89	ND	ND	Trace (0.0108)	ND	ND	**0.0349**	ND	78.0
90	**0.0352**	ND	Trace (0.0142)	Trace (0.00307)	ND	**0.0696**	Trace (0.0161)	79.2
92	ND	ND	**0.0569**	ND	ND	**0.0485**	ND	79.0
94	ND	ND	**0.135**	ND	ND	**0.0334**	ND	82.3
95	ND	ND	ND	ND	ND	ND	ND	86.8
96	ND	ND	**0.0331**	ND	ND	**0.0244**	ND	92.9

ND = not detected (below the method detection limit listed in Table 4).

*Propazine was added as a surrogate for QA/QC purposes.

**Well numbers used by DPR to differentiate sampling locations are not consecutive for reasons including changes in participation and wells going dry.

Table 10. Sampling results for 2022 of the seven analytes with detections in at least one well that are unique to the Multi-Analyte Screen (CDFA, 2022a). Concentrations in ppb (µg/L). Thirty-seven analytes were not detected in any well and are not shown in this table.

Well Number	Analytes Unique to the Multi-Analyte Screen with Detections in at Least One Well						
	Chlorantraniliprole	**Fludioxonil**	**Flutriafol**	**Imidacloprid**	**Mefenoxam/Metalaxyl***	**Methoxyfenozide**	**Thiamethoxam**
1	ND	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	Trace (0.0137) **	ND	ND	ND
3	ND	ND	ND	Trace (0.0117)	ND	ND	ND
4	ND	ND	ND	Trace (0.00477)	Trace (0.00587)	ND	ND
5	ND	ND	ND	**0.0699**	ND	ND	ND
7	ND	ND	ND	ND	ND	ND	ND
8	ND	ND	ND	ND	ND	ND	ND
12	ND	ND	ND	ND	ND	ND	ND
13	ND	ND	ND	Trace (0.00824)	ND	ND	ND
14	ND	ND	ND	ND	ND	ND	ND
15	Trace (0.0110)	ND	ND	**0.102**	ND	ND	ND
16	ND	ND	ND	**0.044**	ND	ND	ND
19	**0.220**	ND	**0.0754**	ND	ND	**0.162**	ND
20	**0.0445**	ND	ND	Trace (0.00435)	ND	ND	ND
20B	**0.0820**	ND	ND	**0.0388****	ND	Trace (0.0137)	Trace (0.0164)
21	Trace (0.00724)	ND	ND	**0.0242**	ND	ND	ND
22	**0.0978****	ND	**0.209**	Trace (0.00950) **	ND	**0.229**	ND
23B	ND	ND	ND	**0.0720**	ND	ND	ND
24	ND	ND	ND	**0.0668**	ND	ND	ND
25	ND	ND	ND	Trace (0.00384)	ND	ND	ND
26	ND	ND	ND	**0.0368**	ND	ND	ND
28	ND	ND	ND	ND	ND	ND	ND
30A	ND	**0.484**	ND	ND	ND	**0.122**	ND
32	ND	ND	ND	ND	ND	ND	ND
35	ND	ND	ND	ND	ND	ND	ND
36	ND	ND	ND	Trace (0.00772)	Trace (0.0100)	ND	ND
37	ND	ND	ND	ND	ND	ND	ND
43	ND	ND	ND	ND	ND	ND	ND
44	ND	ND	ND	ND	ND	ND	ND
45	ND	ND	ND	ND	ND	ND	ND
47	ND	ND	ND	ND	ND	ND	ND
49	ND	ND	ND	ND	ND	ND	ND

Well Number	Analytes Unique to the Multi-Analyte Screen with Detections in at Least One Well						
	Chlorantraniliprole	Fludioxonil	Flutriafol	Imidacloprid	Mefenoxam/Metalaxyl*	Methoxyfenozide	Thiamethoxam
50	ND	ND	ND	ND	ND	ND	ND
52	ND	ND	ND	ND	ND	ND	ND
53A	ND	ND	ND	ND	ND	ND	ND
54	ND	ND	ND	**0.0304**	Trace (0.00371)	ND	ND
56	ND	ND	ND	ND	ND	ND	ND
57	ND	ND	ND	ND	ND	ND	ND
58	ND	ND	ND	ND	ND	ND	ND
59A	ND	ND	ND	ND	ND	ND	ND
61	ND	ND	ND	ND	ND	ND	ND
63A	ND	ND	ND	ND	ND	ND	ND
65	ND	ND	ND	ND	ND	ND	ND
68	Trace (0.00355)	ND	ND	ND	ND	ND	ND
69	ND	ND	ND	ND	ND	ND	ND
71	ND	ND	ND	ND	ND	ND	ND
72	ND	ND	ND	ND	ND	ND	ND
73	ND	ND	ND	ND	ND	ND	ND
74	ND	ND	ND	ND	ND	ND	ND
75A	ND	ND	ND	ND	ND	ND	ND
80	ND	ND	ND	ND	ND	ND	ND
84	ND	ND	ND	ND	ND	ND	ND
86	ND	ND	ND	ND	ND	ND	ND
89	ND	ND	ND	ND	ND	ND	ND
90	ND	ND	ND	ND	ND	ND	ND
92	ND	ND	ND	ND	ND	ND	ND
94	ND	ND	ND	Trace (0.00330)	ND	ND	ND
95	ND	ND	ND	Trace (0.00646)	ND	ND	ND
96	ND	ND	ND	ND	**0.173**	ND	ND

ND = not detected (below the method detection limit listed in Table 5 and Table 6).

*Mefenoxam and metalaxyl are stereoisomers and cannot be analytically distinguished.

**Replicate sample is reported because it was higher.

Table 11. Comparison of 2022 results for replicate analyses in the Multi-Analyte and Triazine Screens. Concentrations in ppb (µg/L). The table includes results for the seven analytes detected out of the nine analytes analyzed in both methods.

Well Number	Analytes in Both the Multi-Analyte and Triazine Screens*													
	Atrazine		Bromacil		Diuron		Norflurazon		Prometon		Simazine		Tebuthiuron	
	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine
1	ND	ND	ND	ND	ND	Trace (0.00306)	ND	ND	ND	ND	ND	ND	ND	ND
2	ND	ND	ND	ND	Trace (0.00598)**	Trace (0.00625)	ND	Trace (0.00291)	ND	ND	**0.0364****	**0.0327**	ND	ND
3	ND	ND	ND	ND	ND	ND	Trace (0.00885)	Trace (0.00777)	ND	ND	**0.0571**	**0.0492**	ND	ND
4	**0.0280**	**0.0247**	**1.35**	**1.22**	Trace (0.0190)	Trace (0.0168)	**0.769**	**0.562**	Trace (0.0152)	Trace (0.0130)	**0.0698**	**0.0545**	ND	ND
5	ND	ND	ND	ND	ND	ND	Trace (0.00812)	Trace (0.00684)	ND	ND	**0.0951**	**0.0734**	ND	ND
7	ND	ND	Trace (0.0195)	Trace (0.0156)	Trace (0.00729)	Trace (0.00649)	ND	ND	ND	ND	Trace (0.0143)**	Trace (0.0132)	ND	ND
8	Trace (0.00890)	Trace (0.00685)	Trace (0.0145)	Trace (0.0113)	**0.0386**	**0.0279**	Trace (0.00664)	Trace (0.00410)	ND	ND	**0.0846**	**0.0645**	ND	ND
12	ND	ND	**0.376**	**0.328**	**0.0455**	**0.0380**	ND	ND	ND	ND	**0.0264****	**0.0218**	ND	ND
13	ND	ND	**0.202**	**0.160**	**0.0312**	**0.0228**	**0.176**	**0.132**	ND	ND	**0.0349**	**0.0275**	ND	ND
14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
15	ND	ND	ND	ND	Trace (0.0148)	Trace (0.0110)	Trace (0.0192)	Trace (0.0174)	ND	ND	**0.0532**	**0.0419**	ND	ND
16	ND	ND	ND	ND	**0.0287**	**0.0250**	**0.0942**	**0.0797**	ND	ND	**0.0704**	**0.0606**	ND	ND
19	ND	ND	ND	ND	Trace (0.00828)	Trace (0.00598)	**0.0365**	**0.0251**	ND	ND	**0.0605**	**0.0440**	ND	ND
20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Trace (0.0156)	Trace (0.0131)	ND	ND
20B	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Trace (0.00507)	Trace (0.00333)	ND	ND
21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Trace (0.00517)	Trace (0.00331)	ND	ND

Well Number	Analytes in Both the Multi-Analyte and Triazine Screens*													
	Atrazine		Bromacil		Diuron		Norflurazon		Prometon		Simazine		Tebuthiuron	
	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine
22	ND	ND	ND	ND	ND	ND	ND	Trace (0.00348)	ND	ND	**0.0887****	**0.0724**	ND	ND
23B	ND	ND	**0.0743**	**0.0689**	**0.0304**	**0.0302**	Trace (0.0125)	Trace (0.0119)	ND	ND	**0.0293**	**0.0259**	ND	ND
24	ND	ND	ND	ND	ND	ND	Trace (0.0158)	Trace (0.0150)	ND	ND	Trace (0.00398)	Trace (0.00363)	ND	ND
25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.0493****	**0.0364**	ND	ND
26	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Trace (0.00862)	Trace (0.00585)	ND	ND
28	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Trace (0.0126)	Trace (0.00964)	ND	ND
30A	ND	ND	ND	ND	**0.0334**	**0.0219**	**0.0782**	**0.0547**	ND	ND	**0.0933**	**0.0679**	ND	ND
32	ND	ND	ND	ND	ND	ND	**0.191**	**0.153**	ND	ND	**0.0563**	**0.0508**	ND	ND
35	ND	ND	ND	ND	**0.0355**	**0.0274**	**0.0323**	**0.0297**	Trace (0.0125)	Trace (0.0101)	**0.0784**	**0.0674**	ND	ND
36	ND	ND	ND	ND	ND	ND	ND	ND	ND	Trace (0.00290)	**0.0267**	**0.0221**	ND	ND
37	ND	ND	ND	Trace (0.00312)	Trace (0.00515)	Trace (0.00557)	**0.0404**	**0.0401**	ND	ND	**0.0259**	**0.0243**	ND	ND
43	ND	ND	ND	ND	ND	Trace (0.00265)	**0.0363**	**0.0281**	ND	ND	**0.0759**	**0.0633**	ND	ND
44	ND	ND	**0.163**	**0.127**	**0.0304**	**0.0241**	Trace (0.00881)	Trace (0.00658)	ND	ND	**0.0383**	**0.0359**	ND	ND
45	ND	ND	ND	ND	**0.0477**	**0.0379**	**0.0323**	**0.0244**	Trace (0.00467)	Trace (0.00390)	Trace (0.01060)	Trace (0.00858)	ND	ND
47	Trace (0.0104)	Trace (0.00816)	**0.0317**	**0.0265**	Trace (0.0119)	Trace (0.00979)	ND	ND	ND	ND	**0.0301**	**0.0250**	ND	ND
49	ND	ND	ND	ND	ND	ND	**0.0206**	Trace (0.0189)	ND	ND	**0.0733**	**0.0640**	ND	ND
50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
52	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.0590**	**0.0403**	ND	ND

Well Number	Analytes in Both the Multi-Analyte and Triazine Screens*													
	Atrazine		Bromacil		Diuron		Norflurazon		Prometon		Simazine		Tebuthiuron	
	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine
53A	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
54	ND	ND	ND	ND	ND	ND	ND	ND	**0.0334**	**0.0297**	**0.0388**	**0.0351**	ND	ND
56	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.0850****	**0.0701**	ND	ND
57	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.0437**	**0.0357**	ND	ND
58	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	**0.0230**	Trace (0.0199)	ND	ND
59A	**0.0222****	Trace (0.0185)	**0.837**	**0.655**	**0.0401****	**0.0341**	**0.720**	**0.553**	ND	ND	**0.0277**	**0.0202**	ND	ND
61	ND	ND	**0.906**	**1.01**	**0.0346**	**0.0357**	Trace (0.00728)	Trace (0.00855)	ND	ND	**0.0496**	**0.0512**	ND	ND
63A	Trace (0.00977)	Trace (0.00887)	ND	ND	Trace (0.0114)	Trace (0.00844)	ND	ND	ND	ND	ND	ND	ND	ND
65	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Trace (0.0114)	Trace (0.00988)	ND	Trace (0.00295)
68	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
69	ND	ND	**0.344**	**0.289**	**0.0442**	**0.0369**	ND	ND	ND	ND	**0.0420**	**0.0343**	ND	ND
71	ND	ND	**0.919****	**0.895**	**0.0265**	**0.0213**	**0.303****	**0.265**	ND	ND	**0.0642****	**0.0519**	ND	ND
72	Trace (0.00389)	Trace (0.00364)	Trace (0.0120)	Trace (0.00957)	Trace (0.0137)	Trace (0.0111)	**0.0233**	**0.0215**	ND	ND	**0.0752**	**0.0639**	ND	ND
73	Trace (0.00461)	Trace (0.00386)	ND	ND	Trace (0.00749)	Trace (0.00738)	ND	ND	ND	ND	Trace (0.00717)	Trace (0.00566)	ND	ND
74	ND	ND	**0.532**	**0.479**	**0.0370**	**0.0357**	**0.0328**	**0.0356**	ND	ND	**0.0758**	**0.0733**	ND	ND
75A	ND	ND	**0.488**	**0.401**	**0.0420**	**0.0348**	Trace (0.00661)	Trace (0.00575)	ND	ND	**0.0823**	**0.0662**	ND	ND
80	ND	ND	**1.05**	**0.129**	**0.0250****	0.0200	**0.321**	ND	ND	ND	**0.0598**	Trace (0.0179)	ND	ND
84	Trace (0.0120)	Trace (0.0105)	**4.76**	**4.39**	**0.0414**	**0.0339**	ND	ND	ND	ND	**0.0249**	Trace (0.0186)	ND	ND

Well Number	Analytes in Both the Multi-Analyte and Triazine Screens*													
	Atrazine		Bromacil		Diuron		Norflurazon		Prometon		Simazine		Tebuthiuron	
	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine	Multi-Analyte	Triazine
86	Trace (0.00679)	Trace (0.00512)	ND	ND	Trace (0.00697)	Trace (0.00500)	ND	ND	ND	ND	**0.0463**	**0.0358**	ND	ND
89	ND	ND	Trace (0.0191)	**0.0216**	Trace (0.0171)	Trace (0.0188)	Trace (0.0104)	Trace (0.0108)	ND	ND	**0.0288**	**0.0349**	ND	ND
90	**0.0588**	**0.0507**	**0.0286**	**0.0242**	**0.0472**	**0.0392**	Trace (0.0157)	Trace (0.0142)	Trace (0.00349)	Trace (0.00307)	**0.0775**	**0.0696**	**0.0219**	Trace (0.0161)
92	ND	ND	ND	ND	**0.0639****	**0.0478**	**0.0742**	**0.0569**	ND	ND	**0.0623**	**0.0485**	ND	ND
94	ND	ND	**0.0221**	Trace (0.0190)	Trace (0.00768)	Trace (0.00630)	**0.189**	**0.135**	ND	ND	**0.0435**	**0.0334**	ND	ND
95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	Trace (0.00310)	ND	ND	ND
96	ND	ND	**0.301****	**0.288**	**0.0323**	**0.0273**	**0.0357**	**0.0331**	ND	ND	**0.0283**	**0.0244**	ND	ND

ND = not detected (below the method detection limit listed in Table 4 through Table 6)

*The following two analytes were duplicated in both screens but were not detected in any of the samples: metribuzin, prometryn

**Replicate sample is reported because it was higher

Table 12. Yearly percent (%) of wells with detections above the reporting limit (RL) for each analyte on the Triazine Screen.

Year	ACET	Atrazine	Bromacil	DACT	DEA	Diuron	DSMN	Hexazinone	Norflurazon	Prometon	Simazine
1999	94.7	5.3	40	85.3	8	60	NA	0	17.3	1.3	86.7
2000	89.2	4.1	37.8	89.2	4.1	50	NA	1	17.6	1.4	82.4
2001	94.4	4.2	39.4	85.9	8.5	59.2	NA	1.4	22.5	1.4	85.9
2002	94.3	4.3	38.6	88.6	12.9	64.3	NA	0	15.7	1.4	92.9
2003	88.9	4.2	40.3	86.1	9.7	61.1	NA	0	20.8	1.4	86.1
2004	86.8	4.4	33.8	85.3	8.8	57.4	44.1	0	25	1.5	80.9
2005	88.2	4.4	33.8	75	5.9	54.4	45.6	0	23.5	1.5	70.6
2006	83.3	4.5	37.9	83.3	7.6	51.5	44	0	22.7	1.5	72.7
2007	85.5	2.9	31.9	85.5	5.8	46.4	44.9	0	29	1.4	76.8
2008	85.3	4.4	33.8	85.3	5.9	50	44	0	20.6	1.5	69.1
2009	88.2	2.9	30.9	85.3	4.4	45.6	47.1	0	20.6	1.5	60.3
2010	80.9	2.9	29.4	85.3	4.4	38.2	50	1.5	27.9	1.5	63.2
2011	76.5	4.4	30.9	79.4	5.9	32.4	52.9	1.5	27.9	0	55.9
2012	82.4	2.9	25	80.9	4.4	36.8	50	0	27.9	0	58.8
2013	76.1	1.5	26.9	83.6	6	13.4	41.8	0	20.9	0	58.2
2014	75	3.1	31.3	79.7	6.3	15.6	45.3	1.6	21.9	1.6	57.8
2015	76.2	1.6	23.8	84.1	3.2	9.5	34.9	0	19	1.6	49.2
2016	78.7	1.6	26.2	82	3.3	16.4	41	0	21.3	1.6	50.8
2017	60.7	1.6	23	70.5	1.6	6.6	36.1	0	21.3	0	39.3
2018	57.4	1.6	23	65.6	4.9	4.9	36.1	0	21.3	0	36.1
2019	61.7	1.7	20	63.3	1.7	1.7	35	0	13.3	0	31.7
2020	59.3	1.7	22	67.8	3.4	6.8	35.6	0	16.9	0	39.0
2021*	61.7	1.7	23.3	65.0	8.3	28.3	60.0	3.3	26.7	1.7	63.3
2022	69.5	3.4	30.5	69.5	15.3	33.9	61.0	1.7	28.8	1.7	66.1
Mean	79.0	3.1	30.6	79.6	6.3	35.2	44.7	0.5	22.1	1.1	63.9
SD	11.8	1.3	6.4	8.2	3.3	21.0	7.7	0.9	4.3	0.7	17.3

NA = Not analyzed - DSMN was not included in the analysis until 2004. Metribuzin and prometryn were included in 2021 but were not detected.

*Higher number of detections beginning in 2021 was due to the lower RLs for the analytical methods.

Table 13. Yearly mean concentrations above the reporting limit (RL) in ppb (µg/L) for each analyte on the Triazine Screen.

Year	ACET	Atrazine	Bromacil	DACT	DEA	Diuron	DSMN	Hexazinone	Norflurazon	Prometon	Simazine
1999	0.48	0.08	0.96	0.82	0.11	0.35	NA	ND	0.16	0.07	0.13
2000	0.47	0.08	1.31	0.75	0.13	0.35	NA	0.07	0.14	0.06	0.11
2001	0.5	0.1	1.12	0.97	0.13	0.33	NA	0.05	0.11	0.1	0.12
2002	0.58	0.08	0.85	1.08	0.09	0.31	NA	ND	0.28	0.09	0.13
2003	0.55	0.11	0.99	0.89	0.12	0.31	NA	ND	0.18	0.08	0.14
2004	0.5	0.12	1.12	0.85	0.15	0.28	0.22	ND	0.21	0.09	0.10
2005	0.38	0.1	0.95	0.66	0.17	0.25	0.25	ND	0.24	0.09	0.10
2006	0.42	0.09	0.88	0.82	0.13	0.28	0.27	ND	0.23	0.06	0.10
2007	0.40	0.07	0.85	0.80	0.1	0.26	0.26	ND	0.13	0.06	0.10
2008	0.38	0.07	0.81	0.68	0.1	0.21	0.25	ND	0.24	0.07	0.09
2009	0.39	0.07	0.79	0.67	0.12	0.2	0.23	ND	0.21	0.06	0.09
2010	0.41	0.11	0.83	0.70	0.15	0.17	0.27	0.05	0.19	0.09	0.10
2011	0.4	0.09	0.82	0.71	0.15	0.12	0.23	0.07	0.19	ND	0.09
2012	0.39	0.09	0.65	0.82	0.12	0.1	0.24	ND	0.19	ND	0.09
2013	0.39	0.08	0.82	0.75	0.08	0.13	0.25	ND	0.19	ND	0.09
2014	0.35	0.10	0.67	0.68	0.06	0.13	0.26	ND	0.20	0.1	0.08
2015	0.32	0.06	0.64	0.69	0.12	0.13	0.22	ND	0.19	0.11	0.08
2016	0.36	0.08	0.71	0.90	0.14	0.07	0.24	ND	0.18	0.09	0.08
2017	0.24	0.07	0.83	0.85	0.12	0.06	0.19	ND	0.11	ND	0.07
2018	0.28	0.08	0.59	0.87	0.09	0.08	0.24	ND	0.13	ND	0.07
2019	0.25	0.08	0.38	0.72	0.16	0.08	0.19	ND	0.13	ND	0.07
2020	0.24	0.09	1.24	0.77	0.1	0.07	0.24	ND	0.15	ND	0.07
2021	0.24	0.06	0.53	0.76	0.05	0.03	0.18	0.03	0.13	0.07	0.05
2022	0.25	0.04	0.58	0.73	0.04	0.03	0.19	0.04	0.13	0.03	0.05
Mean	0.38	0.08	0.83	0.79	0.11	0.18	0.23	0.05	0.18	0.08	0.09
SD	0.099	0.018	0.224	0.104	0.034	0.108	0.028	0.016	0.045	0.020	0.023

Table 14. Summary of wells with Multi-Analyte Screen detections (other than Triazine analytes) from 2014 through 2022. Concentrations in ppb (µg/L).

Well #	Township/ Range-Section	Analyte	Sample Year								
			2014	2015	2016	2017	2018	2019	2020	2021**	2022
2	13S/22E-33	Imidacloprid	ND	ND	ND	ND	Trace	Trace	ND	0.024**	Trace
3	13S/23E-28	Imidacloprid	ND	ND	ND	ND	ND	ND	-	-	Trace
4	13S/23E-32	Imidacloprid	ND	ND	ND	Trace	ND	ND	-	-	Trace
5	14S/21E-13	Imidacloprid	ND	ND	ND	Trace	Trace	Trace	ND	Trace	0.0699
13	14S/22E-12	Imidacloprid	ND	ND	ND	ND	ND	ND	-	-	Trace
15	14S/22E-14	Imidacloprid	ND	ND	ND	0.066	0.091	0.085	0.106	0.126	0.102
16	14S/22E-14	Imidacloprid	ND	ND	ND	ND	ND	ND	-	-	0.0440
18	14S/22E-31	Imidacloprid	0.059	0.665	-	-	-	-	-	-	-
20	14S/23E-32	Imidacloprid	-	ND	ND	ND	ND	ND	-	-	Trace
20B	14S/23E-32	Imidacloprid	-	-	-	-	-	-	-	-	0.0388***
21	14S/23E-33	Imidacloprid	-	0.065	ND	ND	ND	ND	-	-	0.0242
22	14S/23E-34	Imidacloprid	-	0.120	0.080	0.090	Trace	Trace	-	Trace	Trace***
23	14S/23E-35	Imidacloprid	-	0.218	0.209	0.534	0.536	0.470	0.073	-	-
23B	14S/23E-35	Imidacloprid	-	-	-	-	-	-	-	0.0253***	0.0720
24	15S/21E-03	Imidacloprid	ND	ND	ND	Trace	Trace	Trace	0.112	0.088	0.0668
25	15S/21-05	Imidacloprid	ND	ND	ND	ND	ND	ND	-	-	Trace
26	15S/21E-09	Imidacloprid	Trace	0.051	0.072	0.167	0.053	ND	-	0.0348	0.0368
29	15S/22E-03	Imidacloprid	ND	Trace	ND	5.970	0.095	Trace	0.053	0.046**	-
36	15S/22E-20	Imidacloprid	ND	ND	ND	ND	ND	ND	-	-	Trace
47	15S/24E-14	Imidacloprid	-	ND	0.644	ND	ND	ND	-	ND	ND
48	15S/24E-36	Imidacloprid	-	ND	Trace	Trace	-	-	-	-	-
54	16S/21E-34	Imidacloprid	-	ND	ND	ND	ND	ND	-	-	0.0304
94	15S/24E-10	Imidacloprid	-	ND	ND	ND	ND	ND	-	-	Trace
95	14S/22E-33	Imidacloprid	ND	ND	ND	ND	ND	ND	-	-	Trace
37	15S/22E-21	Oryzalin	Trace	ND	ND	ND	ND	ND	-	-	ND
44	15S/23E-02	Oryzalin	-	Trace	ND	ND	ND	ND	-	-	ND
4	13S/23E-32	Mefenoxam/Metalaxyl*	ND	ND	ND	ND	ND	ND	-	-	Trace
29	15S/22E-03	Mefenoxam/Metalaxyl*	ND	Trace	ND	ND	ND	ND	ND	Trace	-
36	15S/22-20	Mefenoxam/Metalaxyl*	ND	ND	ND	ND	ND	ND	-	-	Trace
54	16S/21E-34	Mefenoxam/Metalaxyl*	-	ND	ND	ND	ND	ND	-	-	Trace
96	27S/26E-30	Mefenoxam/Metalaxyl*	-	-	-	-	-	-	-	-	0.173
74	19S/26E-01	Metolachlor	-	Trace	ND	ND	ND	ND	-	-	ND
30A	15S/22E-05	Fludioxonil	-	ND	Trace	0.066	0.165	0.380	0.333	0.316***	0.484
4	13S/23E-32	Propanil	ND	ND	ND	0.060	ND	ND	-	-	ND
19	14S/23E-34	Methoxyfenozide	-	-	-	-	-	-	-	-	0.162
20B	14S/23-32	Methoxyfenozide	-	-	-	-	-	-	-	-	Trace
22	14S/23E-34	Methoxyfenozide	-	-	-	-	-	-	-	0.201	0.229
26	15S/21E-09	Methoxyfenozide	-	-	-	-	-	-	-	Trace**	ND
29	15S/22E-03	Methoxyfenozide	-	-	-	-	-	-	-	Trace	-
30A	15S/22E-05	Methoxyfenozide	-	-	-	-	-	-	-	0.0872***	0.122
15	14S/22E-14	Chlorantraniliprole	-	-	-	-	-	-	-	Trace	Trace
19	14S/23E-34	Chlorantraniliprole	-	-	-	-	-	-	-	-	0.220
20	14S/23E-32	Chlorantraniliprole	-	-	-	-	-	-	-	-	0.0445
20B	14S/23-32	Chlorantraniliprole	-	-	-	-	-	-	-	-	0.0820

Well #	Township/ Range-Section	Analyte	Sample Year								
			2014	2015	2016	2017	2018	2019	2020	2021**	2022
21	14S/23-33	Chlorantraniliprole	-	-	-	-	-	-	-	-	Trace
22	14S/23E-34	Chlorantraniliprole	-	-	-	-	-	-	-	0.266	0.0978***
68	18S/26E-02	Chlorantraniliprole	-	-	-	-	-	-	-	-	Trace
19	14S/23E-34	Flutriafol	-	-	-	-	-	-	-	-	0.0754
22	14S/23E-34	Flutriafol	-	-	-	-	-	-	-	0.226	0.209
20B	14S/23-32	Thiamethoxam	-	-	-	-	-	-	-	-	Trace

ND = Not detected (below the method detection limit listed in Table 5 and Table 6).
Trace = result is < RL but > MDL
[-] = Not sampled because the well was not available for sampling, or not analyzed because the analyte was not part of the method. Some analytes (e.g., methoxyfenozide, chlorantraniliprole, and flutriafol) were not analyzed for until 2021.
*Mefenoxam and metalaxyl are stereoisomers and cannot be analytically distinguished.
**RL from 2014–2020 was 0.05 ppb; from 2021–2022 the RL was 0.02 ppb for chlorantraniliprole, imidacloprid, flutriafol, and mefenoxam, and 0.03 ppb for fludioxonil and methoxyfenozide.
***Replicate sample is reported because it was higher.

QUALITY CONTROL RESULTS

Laboratory and field quality control were conducted according to the Chemistry Laboratory Quality Control SOP (Peoples, 2019) and the results are summarized in Table 15. All quality control (QC) results are available upon request.

Matrix Spikes

Metolachlor Screen

Two total matrix spikes were analyzed with two sets of samples using the Metolachlor Screen. All analytes were spiked at 0.1 ppb. The mean recoveries for the three analytes ranged from 88.1 to 97.7%. The standard deviation of the recoveries ranged from 0.4 to 3.4%. Recovery of all six analytes was within control limits.

Triazine Screen

Twenty total matrix spikes were analyzed in duplicate for the Triazine Screen. All analytes were spiked at 0.2 ppb. The mean recoveries for the 14 analytes and the propazine surrogate analyte ranged from 80.3 to 87.2%. The standard deviation of the recoveries ranged from 4.0 to 6.3%. Five out of 280 total spiked analytes were beyond the upper control limits. The propazine surrogate recoveries were within the control limits in both the continuing QC and in the 59 samples analyzed (Table 9).

Multi-Analyte Screen

For the Multi-Analyte Screen, matrix spikes were extracted and split to be analyzed along with sets of samples for both the LC/MS and GC/MS instruments. Eleven matrix spikes were analyzed along with the eleven sets of samples using LC/MS, with all analytes spiked at 0.2 ppb. The mean recoveries for the 38 analytes ranged from 74.2 to 103%. The standard deviation of the recoveries ranged from 9.0 to 22.2%. Out of 418 spiked analytes on the LC/MS screen, 99 were found to be outside the control limits. The CDFA Laboratory evaluates recoveries to control limits established when the method was developed but does not evaluate recoveries to ongoing control limits. The CDFA Laboratory and the Environmental Monitoring

Branch Quality Assurance Officer conducted a detailed review of the QC data and the associated sample results and determined that the recoveries outside of control limits in the spiked sample sets do not significantly impact the reported data.

Thirteen matrix spikes were analyzed along with sets of samples using GC/MS for the Multi-Analyte Screen. All analytes were spiked at 0.1 ppb. The mean recoveries for the 14 analytes ranged from 81.2 to 114%. The standard deviation of the recoveries ranged from 9.7 to 39.7%. Two out of the 182 spiked analytes on the GC/MS screen were beyond the upper control limits.

Blind Spikes

A blind spike consists of analyte-free groundwater (matrix-blank sample) fortified with the chosen analytes and spiked by a chemist other than the chemist extracting and analyzing that screen. The Environmental Monitoring Branch Quality Assurance Officer submitted the blind spike to the laboratory disguised as a field sample according to the SOP (Ganapathy, 2005). One metolachlor, three triazine, and three multi-analyte blind spikes were submitted throughout the study period (Table 15). Results are presented based on the blind spikes prepared by the laboratory. Of the 26 analytes spiked, recoveries of 24 analytes (92.3%) were within the control limits, while recoveries of two analytes were outside the control limits. All blind spike results are presented in Table 16.

Laboratory and Field Blanks

A laboratory matrix blank and deionized water field blanks were part of the QAQC for this study as described in Davalos, 2021 and Peoples, 2019. All laboratory and field blanks had no detections (Table 15).

Table 15. Laboratory and field quality control (QC) summary.

QC Type	Metolachlor Screen	Triazine Screen	Multi-Analyte LC/MS Screen	Multi-Analyte GC/MS Screen	Total Number	QC Summary
Continuing QC matrix spikes	2	20	11	13	46	Of 886 spiked analytes, 106 were outside control limits: Five on the Triazine Screen, 99 on the LC/MS Screen, and two on the GC/MS Screen
Blind spikes	1	3	2	1	7	Two out of 26 spiked analytes were outside the control limits
Laboratory matrix blanks	2	10	11	13	36	All non-detect
Field blanks	1	6	36	42	85	All non-detect

Table 16. Blind spike levels and recoveries.

Analysis Date	Analysis	Analyte	Spike Level (ppb)	Result (ppb)	% Recovery	Control limit exceeded*
6/30/2022	Triazine**	Atrazine	0.15	0.127	84.7	no
		Bromacil	0.15	0.134	89.3	no
		Diuron	0.15	0.138	92.0	no
		Hexazinone	0.15	0.128	85.3	no
		Norflurazon	0.1	0.0901	90.1	no
6/23/2022	Multi-Analyte (LC/MS)	Azoxystrobin	0.15	0.155	103	no
		Flutriafol	0.15	0.168	112	no
		Imidacloprid	0.15	0.174	116	no
		Methoxyfenozide	0.15	0.137	91.3	no
		Chlorantraniliprole	0.15	0.135	90.0	no
7/27/2022	Triazine	ACET	0.1	0.0925	92.5	no
		Bromacil	0.15	0.125	83.3	no
		Norflurazon	0.1	0.0852	85.2	no
		Simazine	0.2	0.182	91.0	no
7/29/2022	Triazine	DACT	0.15	0.138	92.0	no
		Diuron	0.1	0.108	108	**YES**
		Hexazinone	0.05	0.0446	89.2	no
		Prometon	0.1	0.0996	99.6	**YES**
8/10/2022	Multi-Analyte (LC/MS & GC/MS)	Methoxyfenozide	0.2	0.166	83.0	no
		Mefenoxam	0.1	0.098	98.0	no
		Imidacloprid	0.15	0.169	113	no
		Metolachlor	0.15	0.148	98.7	no
		Dichlobenil	0.1	0.071	71.0	no
6/29/2022	Metolachlor	Metolachlor	0.15	0.127	84.7	no
		Metolachlor ESA	0.15	0.146	97.3	no
		Metolachlor OXA	0.15	0.137	91.3	no

*Control limits are available in the analytical methods (CDFA, 2020; 2022a; 2022b).

**DPR requested DEA and prometon in place of bromacil and norflurazon; however, the laboratory was out of DEA and prometon standards and switched these analytes to bromacil and norflurazon.

REFERENCES

References not currently available on the web can be requested through Next Request at https://cdprca.nextrequest.com/

Afyuni, M. and C. Nordmark. 2022. Protocol for Groundwater Protection List Monitoring for Methoxyfenozide, Chlorantraniliprole, and Flutriafol in High Use, Vulnerable Areas. Available at: www.cdpr.ca.gov/report/study-333-protocol-for-groundwater-protection-list-monitoring-for-methoxyfenozide-chlorantraniliprole-and-flutriafol-in-high-use-vulnerable-areas/ (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

Aggarwal, V. 2022a. Memorandum to Carissa Ganapathy. The Qualification of Method EMON-SM-05-032 Revision 2 as Unequivocal According to Criteria in the Pesticide Contamination Prevention Act. Available at: www.cdpr.ca.gov/report/the-qualification-of-method-emon-sm-05-032-as-unequivocal-according-to-criteria-in-the-pesticide-contamination-prevention-act-2/ (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

Aggarwal, V. 2022b. Memorandum to Carissa Ganapathy. The Qualification of Method EMON-SM-05-034A Revision 2 as Unequivocal According to Criteria in the Pesticide Contamination Prevention Act. Available at: www.cdpr.ca.gov/report/the-qualification-of-method-emon-sm-05-034a-as-unequivocal-according-to-criteria-in-the-pesticide-contamination-prevention-act/ (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

Aggarwal, V. 2020. Memorandum to Carissa Ganapathy. The Qualification of Method EM 62.9 as Unequivocal According to Criteria in the Pesticide Contamination Prevention Act. Available at: www.cdpr.ca.gov/report/the-qualification-of-method-em-62-9-as-unequivocal-according-to-criteria-in-the-pesticide-contamination-prevention-act/ (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

CDFA. 2022a. EMON-SM-05-032, Revision 2. Determination of 53 Pesticides in Groundwater by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS) and Gas Chromatography Tandem Mass Spectrometry (GC/MS/MS). Available at: www.cdpr.ca.gov/report/determination-of-53-pesticides-in-groundwater-by-liquid-chromatography-tandem-mass-spectrometry-lc-ms-ms-and-gas-chromatography-tandem-mass-spectrometry-gc-ms-ms/ (verified March 10, 2025). California Department of Food and Agriculture, Sacramento, California.

CDFA. 2022b. EMON-SM-05-034A, Revision 2. Analysis of S-Metolachlor, Metolachlor ESA, and Metolachlor OXA in Well Water. Available at: https://www.cdpr.ca.gov/report/analysis-of-s-metolachlor-metolachlor-esa-and-metolachlor-oxa-in-well-water-2/ (verified March 10, 2025). California Department of Food and Agriculture, Sacramento, California.

CDFA. 2020. EM 62.9, Revision 5. Determination of Atrazine, Bromacil, Diuron, Hexazinone, Metribuzin, Norflurazon, Prometon, Prometryn, Simazine, Deethyl Atrazine (DEA), Deisopropyl Atrazine (ACET), Diamino Chlorotraizine (DACT), Desmethyl Norflurazon (DSMN), Tebuthiuron and the Metabolites Tebuthiuron-104, Tebuthiuron-106, Tebuthiuron-107 and Tebuthiuron-108 in Well Water by MCX extraction and Liquid Chromatography - triple quadrupole mass spectrometry. Available at: www.cdpr.ca.gov/report/determination-of-atrazine-bromacil-diuron-hexazinone-metribuzin-norflurazon-prometon-prometryn-simazine-deethyl-atrazine-dea-deisopropyl-atrazine-acet-diamino-chlorotraizine-dact-des/ (verified March 10, 2025). California Department of Food and Agriculture, Sacramento, California.

Davalos, J. 2021. Protocol for Monitoring the Concentration of Detected Pesticides in Wells Located in Highly Sensitive Areas. Available at: www.cdpr.ca.gov/report/study-228-protocol-for-monitoring-the-concentration-of-detected-pesticides-in-wells-located-in-highly-sensitive-areas-well-network-study/ (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

Davalos, J. 2022. Memorandum to Minh Pham. Summary of Imidacloprid Groundwater Detections in 2021. Available at: www.cdpr.ca.gov/report/summary-of-imidacloprid-groundwater-detections-in-2021/ (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

DPR. 2024. Well Inventory Database. Data for 2022 will be available in late-2024 at: calpip.cdpr.ca.gov/wellInventoryDatabase.cfm (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

Ganapathy, C. 2005. SOP QAQC008.00. Preparation of Blind Matrix Spikes. Available at: www.cdpr.ca.gov/report/standard-operating-procedure-preparation-of-blind-matrix-spikes/ (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

Garretson, C. 1999. Protocol for Monitoring the Concentration of Detected Pesticides in Wells Located in Highly Sensitive Areas. Study 182 [Changed to Study 228]. Available at: https://www.cdpr.ca.gov/report/protocol-for-monitoring-the-concentration-of-detected-pesticides-in-wells-located-in-highly-sensitive-areas/ (verified March 12, 2025). California Department of Pesticide Regulation, Sacramento, California.

Henderson, J. 2022. Memorandum to Karen Morrison. Direction's Decision in Response to the Pesticide Registration and Evaluation Committee's Subcommittee Findings and Recommendations Regarding Imidacloprid in Groundwater. Available at: www.cdpr.ca.gov/report/directors-decision-in-response-to-the-pesticide-registration-and-evaluation-committees-subcommittee-findings-and-recommendations-regarding-imidacloprid-in-groundwater/ (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

Kocis, T. 2020. Study 328: Protocol for Follow-up Groundwater Monitoring of Fludioxonil. Available at: www.cdpr.ca.gov/report/study-328-protocol-for-follow-up-groundwater-monitoring-of-fludioxonil/ (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

Kocis, T. 2022. Obtaining Well Water Samples. Available at: www.cdpr.ca.gov/report/obtaining-well-water-samples/ (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

Peoples, S. 2019. SOP QAQC001.01. Chemistry Laboratory Quality Control. Available at: www.cdpr.ca.gov/report/standard-operating-procedure-chemistry-laboratory-quality-control/ (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

Reardon, C. 2011. Memorandum to Chuck Andrews. Director's Response Concerning Detections of Hexazinone Pursuant to Assembly Bill 2021. Available at: www.cdpr.ca.gov/report/directors-response-concerning-detections-of-hexazinone-pursuant-to-assembly-bill-2021/ (verified March 10, 2025). California Department of Pesticide Regulation, Sacramento, California.

Troiano, J., C. Garretson, A. DaSilva, J. Marade, and T. Barry. 2013. Pesticide and Nitrate Trends in Domestic Wells where Pesticide Use Is Regulated in Fresno and Tulare Counties, California. Journal of Environmental Quality. doi:10.2134/jeq2013.06.0219. Available at: acsess.onlinelibrary.wiley.com/doi/full/10.2134/jeq2013.06.0219 (verified March 10, 2025).