

TECHNICAL MEMORANDUM



DATE: January 13, 2020

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SUBJECT: **MID-TERM CUMULATIVE MONITORING SUMMARY REPORT ERRATA
FOR THE CENTRAL VALLEY PYRETHROID TMDL CONCENTRATION
GOAL UNIT CALCULATION IN THE NOVEMBER 18, 2019 CUMULATIVE
MONITORING SUMMARY REPORT**

This memorandum is an *errata* to the November 18, 2019 Cumulative Monitoring Summary Report prepared by Larry Walker Associates (LWA). The Sacramento Stormwater Quality Partnership (SSQP) then submitted the Cumulative Monitoring Summary Report to the Central Valley Regional Water Quality Control Board and the United States Environmental Protection Agency (USEPA) as Appendix MP-6 of the SSQP's December 3, 2019 Mid-Term Report.

Errata

The revised Appendix MP-6 Cumulative Monitoring Summary Report is submitted as a separate annotated document accompanying this technical memorandum and the specific location of the errata are provide in **Table 1** and included in Attachment A.

The CGU values in the November 18, 2019 Cumulative Monitoring Summary Report were calculated using a Microsoft Excel-based sample linkage between pyrethroid concentrations and their associated organic carbon concentrations. A subset of sample linkages was inadvertently broken, and several CGU calculations were not correctly adjusted lower. The revised figures report CGU calculations with corrected linkages. Additional sample screening was also performed to remove duplicate samples and samples without available linked organic carbon data.

The corrections are limited to four figures showing the calculated CGU observed at SSQP urban runoff discharge and urban tributary monitoring characterization stations in the Cumulative Monitoring Summary Report.

The corrected calculations and amended figures do not change findings related to exceedances in any SSQP receiving water or urban runoff discharge, though the corrections all *decrease* CGU values.

Table 1. Summary and Location of Errata to Cumulative Monitoring Summary Report (Appendix MP-6 to the Mid-Term Report)

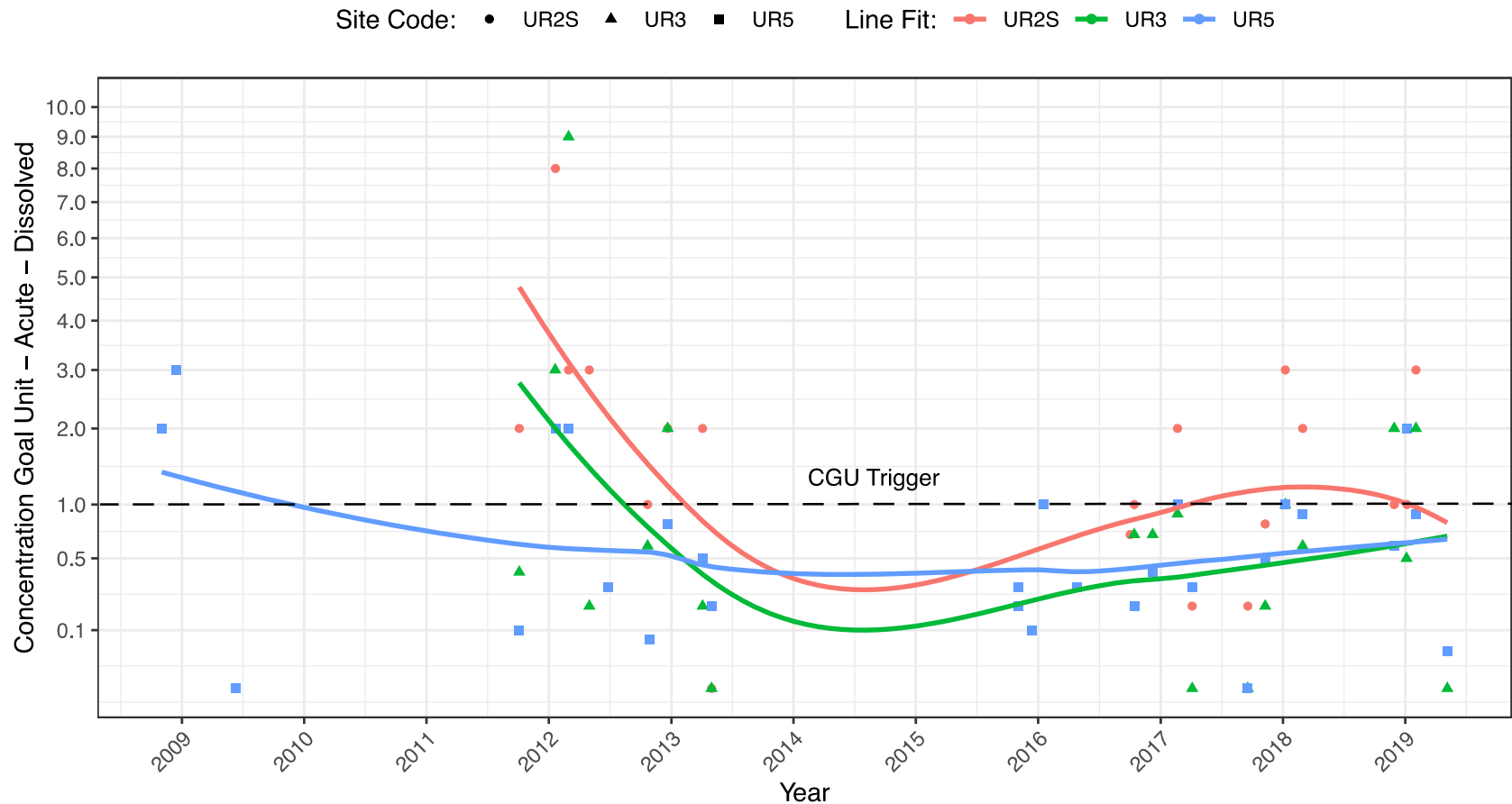
Change No.	Cumulative Monitoring Summary Report Page No.	Cumulative Monitoring Summary Report Figure No.	Description of Changes
1	29	11	Pyrethroid-organic carbon linking corrections for reported CGU calculations. Minor adjustments to urban runoff discharge sample inclusion. Formatting changes.
2	30	12	
3	57	23	Minor adjustments to urban tributary sample inclusion. Formatting changes.
4	58	24	

Concentration Goal Unit Tool

To prevent future data linking and calculation errors LWA developed the SSQP CGU Tool to perform data processing steps for the SSQP database outputs, perform sample linking, calculate CGU, and perform error checking and reporting. The SSQP CGU Tool can be used for SSQP data compiled before and after SSQP incorporation of California Environmental Data Exchange Network (CEDEN) data compilation standards in 2014. The SSQP CGU Tool was used to develop the revised figures below and referenced in **Table 1**.

Attachment A

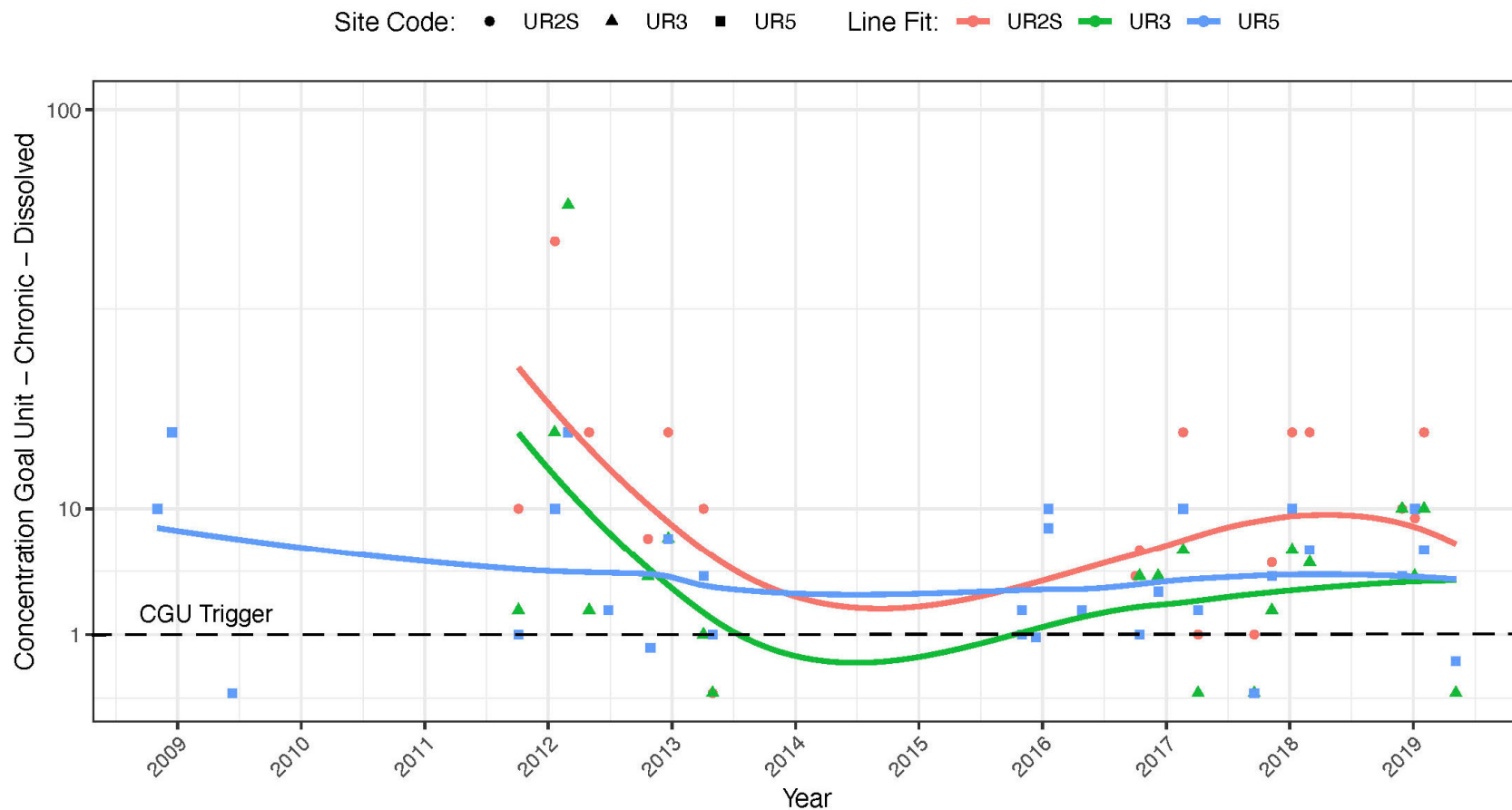
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Notes: UR2S = Strong Ranch Slough; UR3 = Sump 111; UR5 = North Natomas Detention Basin No. 4 Outlet; Response variable (CGU) scale is square root transformed.

Figure 11. Dissolved Acute Concentration Goal Unit at Current Urban Runoff Discharge Monitoring Characterization Stations (2008-2019)

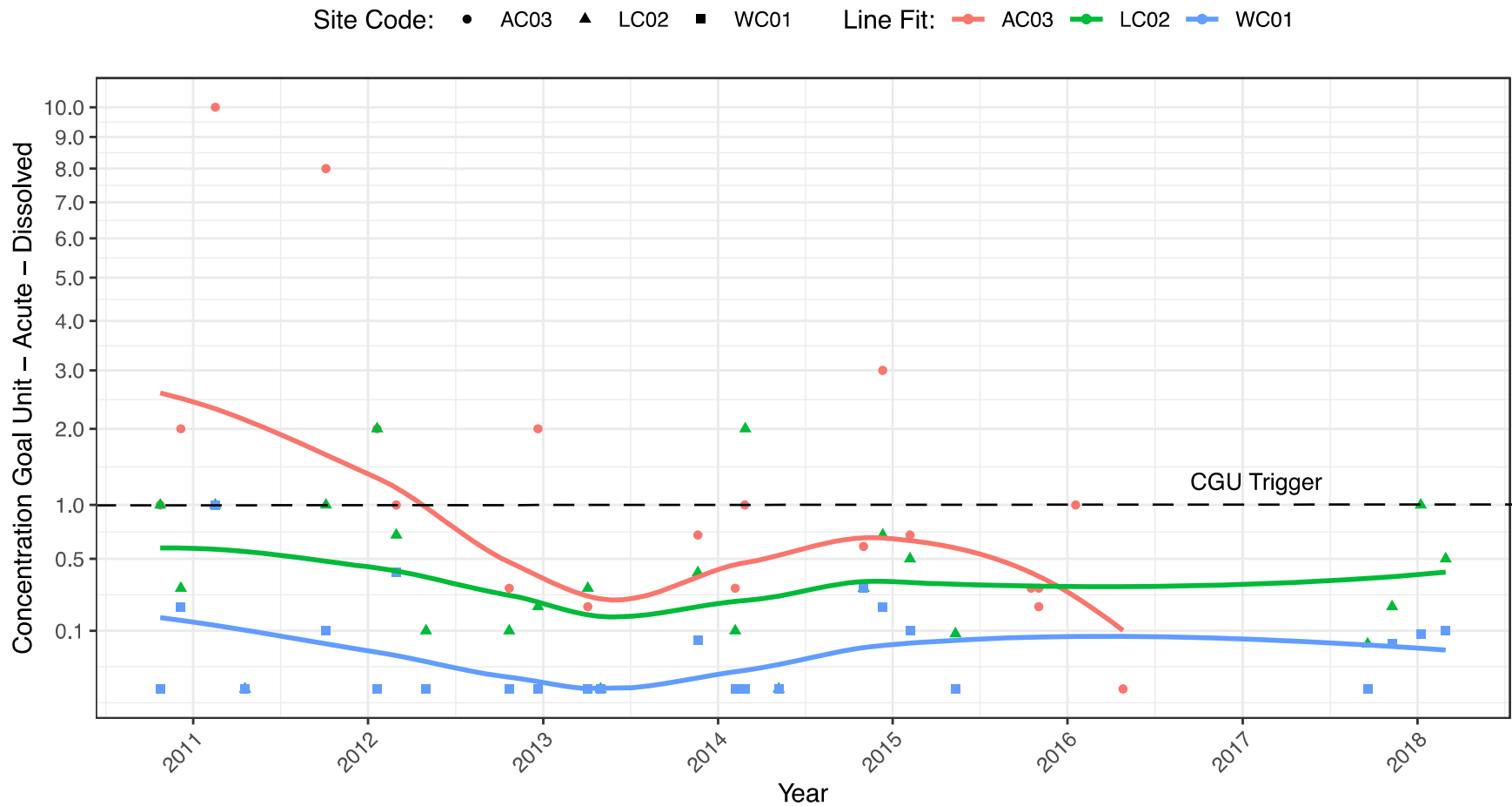
Errata No. 1 – December 30, 2019



Notes: UR2S = Strong Ranch Slough; UR3 = Sump 111; UR5 = North Natomas Detention Basin No. 4 Outlet; Response variable (CGU) scale is square root transformed.

Figure 12. Dissolved Chronic Concentration Goal Unit at Current Urban Runoff Discharge Monitoring Characterization Stations (2008-2019)

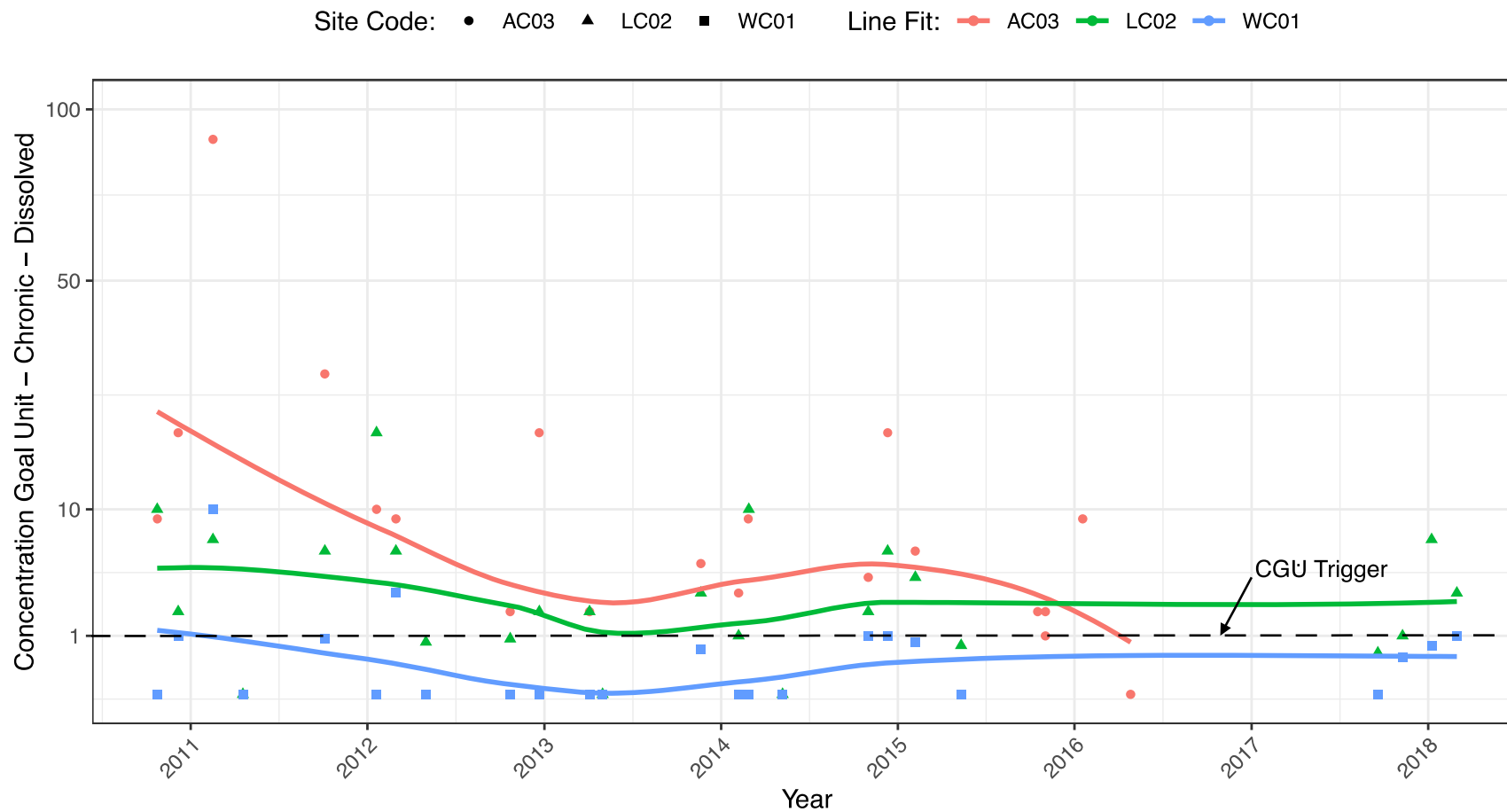
Errata No. 2 – December 30, 2019



Notes: AC03 = Arcade Creek at Watt; LC02 = Laguna Creek at West Stockton Boulevard; WC01 = Willow Creek at Blue Ravine Road; Response variable (CGU) scale is square root transformed.

Figure 23. Dissolved Acute Concentration Goal Unit at Current Urban Tributary Monitoring Characterization Stations (2010-2019)

Errata No. 3 – December 30, 2019



Notes: AC03 = Arcade Creek at Watt; LC02 = Laguna Creek at West Stockton Boulevard; WC01 = Willow Creek at Blue Ravine Road; Response variable (CGU) scale is square root transformed.

Figure 24. Dissolved Chronic Concentration Goal Unit at Current Urban Tributary Monitoring Characterization Stations (2010-2019)

Errata No. 4 – December 30, 2019

NOVEMBER 18, 2019

2016-2019

Sacramento Stormwater Quality Partnership Cumulative Monitoring Summary Report

Submitted to:
County of Sacramento
City of Sacramento
City of Citrus Heights
City of Elk Grove
City of Folsom
City of Galt
City of Rancho Cordova



Revised – December 30, 2019

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1 Introduction

All monitoring data collected by the Sacramento Stormwater Quality Partnership (Partnership) during the first three years of monitoring (2016-2019) under the General Permit for Central Valley Municipal Separate Storm Sewer Systems (MS4 General Permit)¹ are provided in this Cumulative Monitoring Summary Report (to fulfill the requirements for a Mid-Term Report).

This Cumulative Monitoring Summary Report provides a summary of the data collected, statistics and data visualizations for three of the Partnership's Priority Water Quality Constituents (PWQCs) – mercury, pyrethroids, and legacy organophosphate pesticide, and the electronic data submittal. Trash is the fourth PWQC but collected survey data are not included here as they will be reported by the Partnership's individual MS4 member agencies according to the schedules pending approval of the trash implementation plans. Additional data collected for programs not required by the MS4 General Permit are also included in this report. The complete water quality monitoring dataset for the Mid-Term Report period (October 2016 - October 2019) is provided as a separate data file, as part of the Mid-Term Report, that is formatted for California Environmental Data Exchange Network (CEDEN) or Stormwater Multiple Application and Report Tracking System (SMARTS) reporting when those databases are made available for these data types.

2 Summary of Data Collected

The MS4 General Permit requires that the previous permit monitoring requirements are applicable until the Monitoring Study Design and Stormwater Management Plan (SWMP) are approved by the Regional Water Board. The Partnership has historically referred to the SWMP document as the Stormwater Quality Improvement Plan (SQIP). The most recent applicable monitoring requirements are those incorporated by the 2015 Limited Term Permit, which refers to the 2008 National Pollutant Discharge Elimination System (NPDES) Permit, with modifications based on the Regional Water Board approved monitoring work plan that includes Delta Regional Monitoring Program (RMP) participation.² These approved modifications require participation in the Delta RMP, urban runoff discharge monitoring at three sites in two of three years, and urban tributary monitoring at three sites once per five years. The monitoring sites, events, and methods are briefly described in the following sections.

¹ Central Valley Regional Water Quality Control Board (Regional Water Board). *National Pollutant Discharge Elimination System Permit and Waste Discharge Requirements General Permit for Discharges from Municipal Separate Storm Sewer Systems* (MS4 General Permit). Order No. R5-2016-0040. NPDES No. CAS0085324. Adopted on June 23, 2016. Effective on October 1, 2016.
https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2016-0040_ms4.pdf

²Creedon, Pamela, Executive Officer. Central Valley Regional Water Quality Control Board. *Approval to Allow the Sacramento Area Stormwater Agencies to Reduce Local Water Quality Monitoring and Participate in the Delta Regional Monitoring Program*. Letter communication. August 3, 2015.

2.1.1 Monitoring Sites

The monitoring sites used by the Partnership to satisfy the MS4 General Permit until the Monitoring Study Design is approved were selected as locations representative of conditions in the Jurisdictional Runoff Area. The Partnership refers to “urban runoff discharge” characterization stations as locations representative of runoff that is captured from highly urbanized areas near to or just prior to discharge to a receiving water. The Partnership refers “urban tributary” monitoring locations as locations that representative of urban tributaries surface waters that receive some urban runoff from the Jurisdictional Runoff Area, but can also include flow contributions from non-urban areas or other discharges. The monitoring locations and tributary drainage areas considered in this Cumulative Summary Data Summary Report are shown in **Figure 1**. Details on the monitoring locations and historical data summaries are provided in the following urban runoff discharge and urban tributary sections.

2.1.2 Monitoring Events

A summary of data collected according to this approved Work Plan as well as additional sample collection is shown in **Table 1**. River monitoring requirements are met with the allowed in-lieu participation in the Delta RMP. Also with Delta RMP participation, urban tributary monitoring is required no more than once in a five year period. Because Arcade Creek was monitored in the 2015/2016 fiscal year, monitoring was only required at Willow Creek and Laguna Creek during the 2016-2019 period. Urban runoff discharge monitoring was performed in all three years to ensure that monitoring was performed in two of every three years. Further details on specific sample collection dates are provided in **Sections 3** and **5** for urban runoff discharge and urban tributary locations, respectively.

Table 1. Summary of Monitoring Completed During First Three Years of MS4 General Permit Applicability

Monitoring Period	River	Urban Tributary	Urban Runoff Discharge
2016/2017 FY	Delta RMP	Not required	3 Wet, 1 Dry
2017/2018 FY	Delta RMP	3 Wet, 1 Dry [1]	3 Wet, 1 Dry
2018/2019 FY	Delta RMP	Not required	3 Wet, 1 Dry

Notes:

[1] Willow Creek and Laguna Creek sites only. Sample collection at Arcade Creek previously conducted in the 2015/2016 fiscal year.

2.1.3 Monitoring Constituents and Methods

All samples for the Partnership urban runoff discharge and urban tributary monitoring programs are analyzed for the constituents specified in Table B of the Limited Term Permit and shown in **Table 2**. Site specific sampling procedures are specified in the Partnership’s Sampling and Analysis Plan (SAP), which is included as an attachment to the Quality Assurance Project Plan (QAPP).

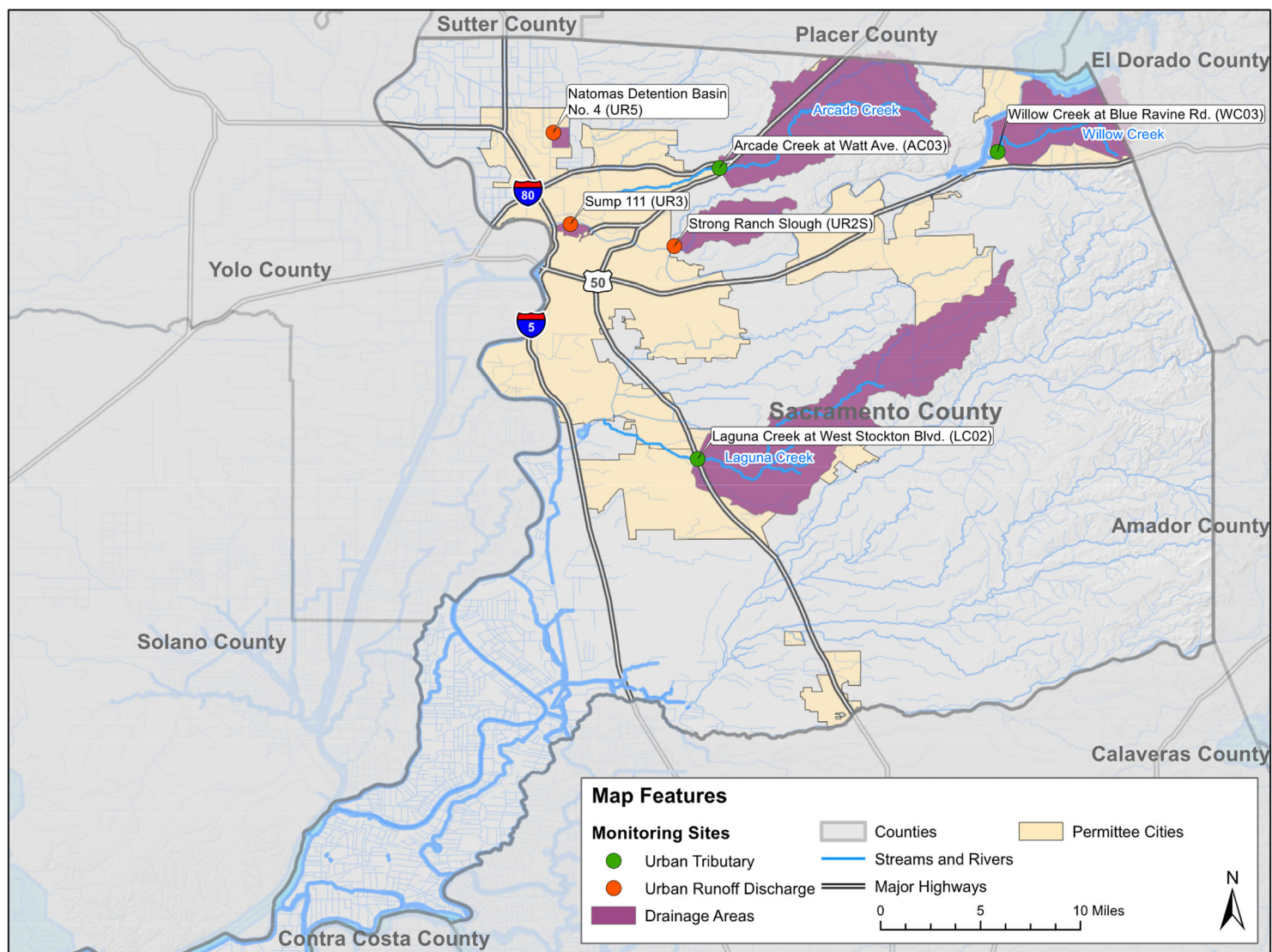


Figure 1. Sacramento County Surface Waters and Partnership Monitoring Drainages

Table 2. Constituent List and Standard Reporting Limitations for Permit Required Monitoring Activities

Constituent	Method	Units	Project Method Detection Limit	Project Reporting Limit
<i>Escherichia coli</i>	SM 9221 B&E	MPN/100mL	1	2
Fecal Coliform	SM 9221 B&E	MPN/100mL	1	2
Total Suspended Solids	SM 2540D	mg/L	1	2
Total Dissolved Solids	SM 2540C	mg/L	1	2
Suspended Sediment	ASTMD 3977-97	mg/L	2	3
Turbidity	EPA 180.1	mg/L	0.75	1.0
Conductivity	SM 2510B	mg/L	10	10
Total Organic Carbon	SM 5310B	mg/L	0.05	1.0
Dissolved Organic Carbon	SM 5310B	mg/L	0.05	1.0
Total Phosphorus (as P)	SM 4500-PE	mg/L	0.005	0.01
Total Kjeldahl Nitrogen	SM 4500-NH3C	mg/L	0.07	0.1
Nitrate + Nitrite (as N)	EPA 353.2	mg/L	0.02	0.1
Chemical Oxygen Demand	EPA 410.4	mg/L	20	50
Biochemical Oxygen Demand	SM 5210	mg/L	5	5
Alkalinity	SM 2320 B	mg/L	1.2	10
Conductivity	SM 2510B	mg/L	10	10
Methylmercury	EPA 1630	ng/L	0.02	0.05
Mercury, Total	EPA 1631	ng/L	0.2	0.5
Copper (Total and Dissolved)	EPA 200.8	µg/L	0.07	0.5
Iron (Total and Dissolved)	EPA 200.8	µg/L	1.0	2.0
Lead (Total and Dissolved)	EPA 200.8	µg/L	0.25	0.5
Zinc (Total and Dissolved)	EPA 200.8	µg/L	0.7	1.0
Total Hardness	EPA 130.2	mg/L	0.7	1.0
Total Purgeable Petroleum Hydrocarbon - Gasoline	SW846 5030	µg/L	4.7	50
Total Petroleum Hydrocarbon - Diesel and Motor Oil	EPA 8015M	µg/L	97	200
Organophosphate (OP) Pesticides	EPA 625	ng/L	1	5
Polycyclic aromatic hydrocarbons (PAHs)	EPA 625	ng/L	1	5
Pyrethroids + Diazinon + Chlorpyrifos + Fipronil	EPA 8270M	ng/L	0.1-2.0	1.5-15

3 Summary Statistics and Data Presentation Methods

Sections 3 and 5 include summary statistics and time series plots for the PWQCs at the urban runoff discharge and urban tributary locations, respectively, for both the midterm period (October 2016- October 2019) and the period of record.

Summary statistics have been calculated for the PWQCs using a regression on order statistics (ROS), which allows consideration of concentrations reported as “not detected” (ND) by distributing values for the ND results in the range between zero and the reporting limit according to the distribution observed for the detected values technique. The values assigned to ND results are only intended and used to calculate summary statistics and are generally not appropriate to use as specific values for other analyses or data presentation (e.g., time series plots).

Data for each of the PQWCs are visually represented using time series plots. These plots are intended for visual inspection rather than a specific assertion of any trend. To support visual inspection some additional information is provided. Annual average calculations are presented in cases where nearly all the data are reported as detected. When some small fraction of data are reported as ND, the reporting limit is used to calculate the annual mean value and the smoothed curve. The smoothed curve is fitted using a LOESS (LOcally WEighted Scatter-plot Smoother) technique and is not a robust statistical trend assessment, but intended to provide some context for the “scatterplot” results to inform the next steps of a more robust assessment for monitoring design or the End-Term Report. For the urban runoff discharge locations, the sites are pooled based on the age of development to better illustrate apparent differences between sites.

3.1 PYRETHROID CONCENTRATION GOAL UNIT CALCULATION

The concentration goal unit (CGU) is defined in the Central Valley Pyrethroid TMDL as the summation of the ratio of each of the six individual pyrethroids to the effect levels as shown in **Figure 2**. The Central Valley Pyrethroid TMDL allows use of a dissolved concentration calculation for use in the CGU. A CGU greater than one triggers management actions, but is not a wasteload allocation.

The dissolved concentration was calculated using the Central Valley Pyrethroid TMDL ambient partition coefficient and organic carbon concentration-based equation to estimate aquatic life exposure concentration as shown in **Equation 1**. The partition coefficients (K_{OC} and K_{DOC}) are empirically derived and specified for ambient water and wastewater effluent, but are not specified for urban runoff waters. For the calculations presented here, the ambient partition coefficients are used.

**Equation 1. Freely Dissolved Pyrethroid Concentration Calculation from Central Valley Pyrethroid
Total Maximum Daily Load**

$$C_{dissolved} = \frac{C_{total}}{1 + (K_{OC} \times [POC]) + (K_{DOC} \times [DOC])}$$

Where:

$C_{dissolved}$ = concentration of a an individual pyrethroid pesticide that is in the freely dissolved phase (ng/L),

C_{total} = total concentration of an individual pyrethroid pesticide in water (ng/L),

K_{OC} = organic carbon-water partition coefficient for the individual pyrethroid pesticide (L/kg), $[POC]$ = concentration of particulate organic carbon in the water sample (kg/L), which can be calculated as $[POC] = [TOC] - [DOC]$,

K_{DOC} = dissolved organic carbon-water partition coefficient (L/kg),

$[DOC]$ = concentration of dissolved organic carbon in the sample (kg/L).

Acute Pyrethroid Trigger

The acute additive pyrethroid pesticides numeric trigger is equal to one (1) acute additive concentration goal unit (CGU) not to be exceeded more than once in a three year period. The CGUs are calculated as the sum of individual measured pyrethroid concentration-to-acute concentration goal ratios, as defined in the following formula. For calculation of CGUs, available samples collected within the applicable averaging period for the numeric trigger will be used to determine exceedances of the trigger. Freely dissolved pyrethroid concentrations may be used in the numerator of each ratio if appropriate data are available, as described in the equation to calculate freely dissolved concentrations given above.

$$CGU_{acute} = \frac{C_{bif}}{ACG_{bif}} + \frac{C_{cyf}}{ACG_{cyf}} + \frac{C_{cyp}}{ACG_{cyp}} + \frac{C_{esf}}{ACG_{esf}} + \frac{C_{lcy}}{ACG_{lcy}} + \frac{C_{per}}{ACG_{per}}$$

Where:

C_{bif} = Average concentration of bifenthrin in ng/L from a 1-hour averaging period,
 C_{cyf} = Average concentration of cyfluthrin in ng/L from a 1-hour averaging period,
 C_{cyp} = Average concentration of cypermethrin in ng/L from a 1-hour averaging period,
 C_{esf} = Average concentration of esfenvalerate in ng/L from a 1-hour averaging period,
 C_{lcy} = Average concentration of lambda-cyhalothrin in ng/L from a 1-hour averaging period,
 C_{per} = Average concentration of permethrin in ng/L from a 1-hour averaging period,
 ACG_{bif} = Bifenthrin acute concentration goal of 0.8 ng/L,
 ACG_{cyf} = Cyfluthrin acute concentration goal of 0.8 ng/L,
 ACG_{cyp} = Cypermethrin acute concentration goal of 1 ng/L,
 ACG_{esf} = Esfenvalerate acute concentration goal of 2 ng/L,
 ACG_{lcy} = Lambda-cyhalothrin acute concentration goal of 0.7 ng/L,
 ACG_{per} = Permethrin acute concentration goal of 6 ng/L,
 CGU_{acute} = The sum of measured pyrethroid concentration-to-acute concentration goal ratios, rounded to one significant figure. A sum exceeding one (1) indicates an exceedance of the acute additive pyrethroid pesticides numeric trigger.

Chronic Pyrethroid Trigger

The chronic additive pyrethroid pesticides numeric trigger is equal to one (1) chronic additive concentration goal unit not to be exceeded more than once in a three year period. The chronic CGUs are calculated as the sum of individual measured pyrethroid concentration-to-chronic concentration goal ratios, as defined in the following formula. For calculation of CGUs, available samples collected within the applicable averaging period for the numeric trigger will be used to determine exceedances of the trigger. Freely dissolved pyrethroid concentrations may be used in the numerator of each ratio if appropriate data are available, as described in the equation to calculate freely dissolved concentrations given above.

$$CGU_{chronic} = \frac{C_{bif}}{CCG_{bif}} + \frac{C_{cyf}}{CCG_{cyf}} + \frac{C_{cyp}}{CCG_{cyp}} + \frac{C_{esf}}{CCG_{esf}} + \frac{C_{lcy}}{CCG_{lcy}} + \frac{C_{per}}{CCG_{per}}$$

Where:

C_{bif} = Average concentration of bifenthrin in ng/L from a 4-day averaging period,
 C_{cyf} = Average concentration of cyfluthrin in ng/L from a 4-day averaging period,
 C_{cyp} = Average concentration of cypermethrin in ng/L from a 4-day averaging period,
 C_{esf} = Average concentration of esfenvalerate in ng/L from a 4-day averaging period,
 C_{lcy} = Average concentration of lambda-cyhalothrin in ng/L from a 4-day averaging period,
 C_{per} = Average concentration of permethrin in ng/L from a 4-day averaging period,
 CCG_{bif} = Bifenthrin chronic concentration goal of 0.1 ng/L,
 CCG_{cyf} = Cyfluthrin chronic concentration goal of 0.2 ng/L,
 CCG_{cyp} = Cypermethrin chronic concentration goal of 0.3 ng/L,
 CCG_{esf} = Esfenvalerate chronic concentration goal of 0.3 ng/L,
 CCG_{lcy} = Lambda-cyhalothrin chronic concentration goal of 0.3 ng/L,
 CCG_{per} = Permethrin chronic concentration goal of 1 ng/L.

Figure 2. Central Valley Pyrethroid Total Maximum Daily Load Concentration Goal Unit Calculation

4 Urban Runoff Discharge Monitoring

The Partnership's urban runoff discharge monitoring characterizes MS4 discharges from Sacramento area mixed land use urban land areas developed before and after the implementation of water quality development standards in 1996. Strong Ranch Slough and Sump 111 drainage areas are characterized as those developed before 1996. The North Natomas Detention Basin No. 4 monitoring station is located at the outlet for a water quality detention basin that is representative of a type of basin required by the 1996 water quality development standards. The monitoring locations and tributary drainage area and development age are provided in **Table 3**. The North Natomas Detention Basin No. 5 discharge is considered representative of "new" development with the benefit of land use planning and regional water quality treatment. The Strong Ranch Slough and Sump 111 discharges are considered "old" development.

Table 3. 2016-2019 Urban Runoff Discharge Monitoring Location Drainage Area Characteristics

Drainage	Site ID Code	Drainage Area	Percent of Total Area		
			Pre-1996	Post-1996	Non-urban
Urban Runoff Characterization					
North Natomas Detention Basin No 4	UR5	440	0%	100%	0%
Strong Ranch Slough	UR2S	4,446	100%	0%	0%
Sump 111	UR3	452	100%	0%	0%

The Partnership conducted urban runoff (discharge) monitoring during fiscal years 2016/2017, 2017/2018, and 2018/2019. The Partnership collected urban runoff water column composite and grab samples for the constituents listed in Table B of the Partnership's 2015 Limited Term NPDES permit Monitoring and Reporting Program (MRP) requirements at three urban runoff locations (**Table 2**). For each fiscal year, samples were collected for one dry weather event and three wet weather events at each site (**Table 4**).

During the three fiscal years that this cumulative data report covers, a total of nine wet weather events and three dry weather events were conducted at each monitoring site. A complete report of all events and activities, including analytical results, were previously reported in the 2016/2017 and 2017/2018 *Urban Runoff Discharge Annual Monitoring Report Parts 1 and 2* (Part 2. Appendix E includes all lab reports). The 2018/2019 *Urban Runoff Discharge Annual Monitoring Report* is included with the 2018/2019 Regional Annual Mid-Term Report. The Urban Runoff Discharge Annual Monitoring Reports include time series plots for key representative constituents to visually identify apparent trends or significant year-to-year changes that may require additional investigation.

Table 4. 2016/2017 to 2018/2019 Urban Runoff Discharge Monitoring Events

Event Period	Event Type	Strong Ranch Slough (UR2S)	North Natomas Detention Basin No. 4 (UR5)	Sump 111 (UR3)
10/2/2016	Wet	■	[1]	[1]
10/14/2016	Wet	[2]	■	■
12/8/2016	Wet	■	■	■
2/20/2017	Wet	■	■	■
4/5/2017	Dry	■	■	■
9/19/2017	Dry	■	■	■
11/9/2017	Wet	■	■	■
1/8/2018	Wet	■	■	■
3/1/2018	Wet	■	■	■
11/29-30/2018	Wet	■	■	■
1/5-7/2019	Wet	■	■	■
2/2-3/2019	Wet	■	■	■
5/7-8/2019	Dry	■	■	■

Notes: ■ = sampling event completed

[1] Localized thunderstorms only provided enough runoff at Strong Ranch Slough.

[2] Monitoring only conducted at North Natomas Detention Basin No. 4 and Sump 111 sites, due to lack of runoff during the 10/2/2016 event.

4.1 MERCURY AND METHYLMERCURY

Summary statistics for mercury and methylmercury for the three urban runoff discharge monitoring sites, Strong Ranch Slough (UR2S), Sump 111 (UR3), and North Natomas Detention Basin No. 4 (UR5), are shown in tables **Table 5** through **Table 8**. Each set of tables includes a summary for data that was collected during the current permit term (October 2016 through October 2019) and the historical data set (1990 through 2019).

Time series plots for mercury and methylmercury in urban runoff discharge are provided in **Figure 3** and **Figure 4**. The best-fit smoothed trendline is shown to visually compare older and newer development age. Annual means and standard deviation for urban runoff discharge locations that represent older (Strong Ranch Slough [UR2S] and Sump 111 [UR3]) and newer development (North Natomas Detention Basin No. 4 [UR5]) are provided for this comparison. This development age comparison is provided because it was demonstrated as a key factor in the July 2019 Reasonable Assurance Analysis. Because methylmercury and total mercury reporting (quantification) limits have improved over the sample collection period, many values reported as ND occurred in the early part of the monitoring program, though some infrequent ND values are still reported. For the purpose of the data visualization in the figures below (annual means and smoothed lines), the reporting limit is substituted for any ND values.

Table 5. Urban Runoff Discharge Total Mercury (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
UR2S	Dry	3	100.0%	11.77	14.07	1.20	-4.15	27.68	7.16	100.96	18.78	3.20	28.0
	Wet	12	100.0%	26.53	21.94	0.83	14.11	38.94	20.69	78.88	23.86	6.80	80.0
	All	15	100.0%	23.57	21.07	0.89	12.91	34.24	16.73	87.65	24.51	3.20	80.0
UR3	Dry	5	100.0%	2.48	1.24	0.50	1.40	3.56	2.19	7.11	2.20	1.10	3.60
	Wet	11	100.0%	11.91	6.29	0.53	8.19	15.63	10.63	26.76	8.24	6.30	26.0
	All	16	100.0%	8.96	6.87	0.77	5.60	12.33	6.48	34.43	9.59	1.10	26.0
UR5	Dry	3	100.0%	0.95	0.27	0.28	0.65	1.25	0.92	1.87	0.54	0.67	1.20
	Wet	15	93.3%	3.40	1.29	0.38	2.75	4.05	3.20	6.27	1.79	2.10	6.30
	All	18	94.4%	2.94	1.56	0.53	2.22	3.67	2.49	7.79	2.42	0.67	6.30

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 6. Urban Runoff Discharge Total Mercury (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
UR2S	Dry	21	100.0%	9.95	18.02	1.81	2.24	17.66	5.67	19.9	6.10	3.07	84.0
	Wet	49	100.0%	84.0	193	2.30	29.9	138	34.7	220	57.66	1.70	1,138
	All	70	100.0%	61.8	165	2.67	23.1	100	20.1	189	42.38	1.70	1,138
UR3	Dry	26	88.5%	8.00	7.87	0.98	4.98	11.0	5.43	28.9	8.05	1.10	29.0
	Wet	71	78.9%	53.1	106	2.00	28.5	77.8	26.6	137	38.5	6.30	700
	All	97	81.4%	40.1	92.9	2.32	21.6	58.6	16.6	126	30.9	1.10	700
UR5	Dry	11	100.0%	1.54	0.84	0.55	1.04	2.03	1.36	3.52	1.09	0.67	3.07
	Wet	47	97.9%	4.17	2.90	0.70	3.34	5.00	3.60	8.59	2.62	1.62	18.2
	All	58	98.3%	3.66	2.84	0.77	2.93	4.39	2.96	9.03	2.80	0.67	18.2

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 7. Urban Runoff Discharge Total Methylmercury (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

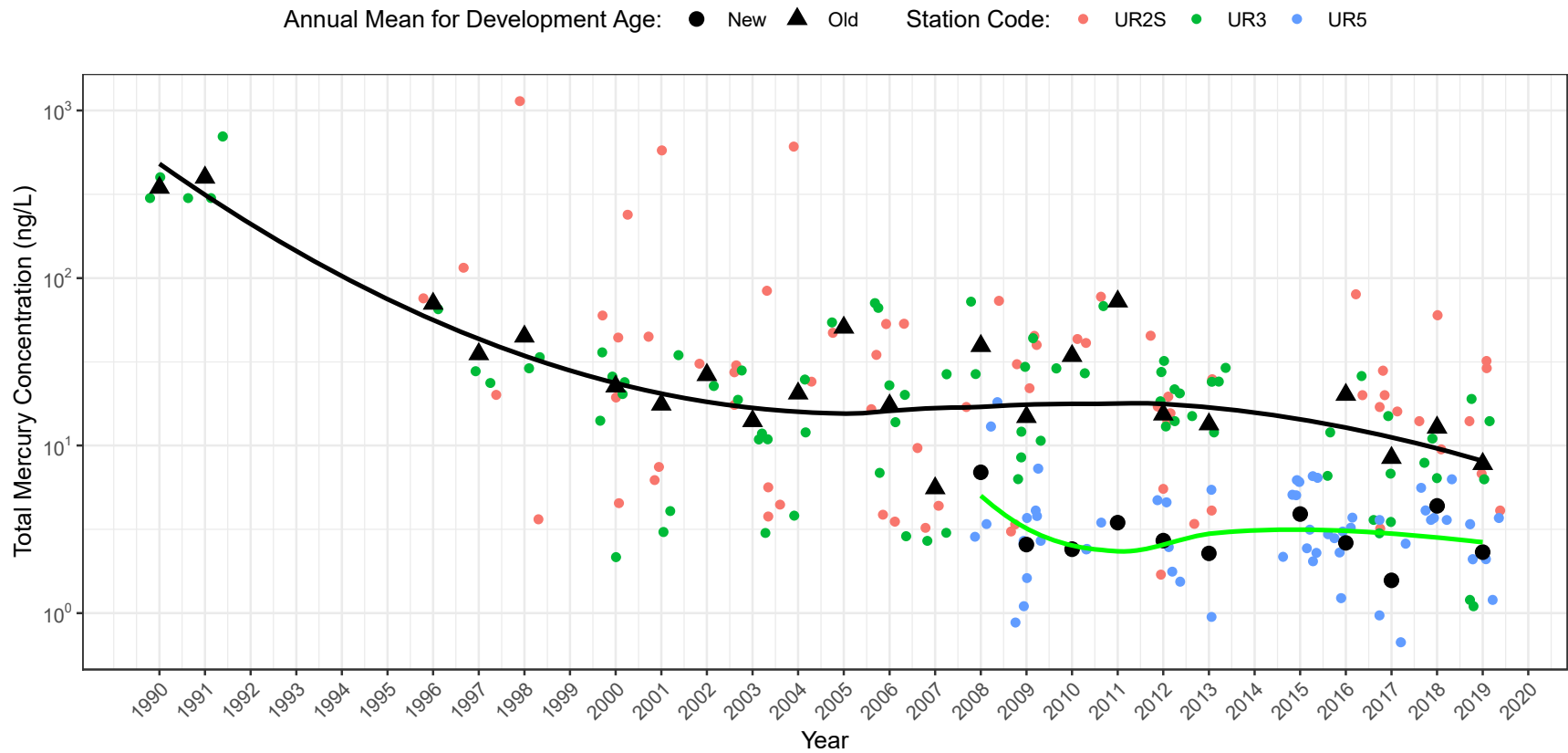
Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
UR2S	Dry	3	100.0%	0.26	0.19	0.75	0.04	0.48	0.22	1.30	0.35	0.11	0.48
	Wet	12	100.0%	0.37	0.39	1.07	0.15	0.59	0.27	0.82	0.26	0.15	1.50
	All	15	100.0%	0.34	0.36	1.03	0.16	0.52	0.26	0.81	0.25	0.11	1.50
UR3	Dry	5	100.0%	0.06	0.02	0.31	0.05	0.08	0.06	0.12	0.04	0.03	0.08
	Wet	11	100.0%	0.13	0.05	0.40	0.10	0.16	0.12	0.27	0.08	0.06	0.21
	All	16	100.0%	0.11	0.05	0.50	0.08	0.13	0.09	0.25	0.08	0.03	0.21
UR5	Dry	3	100.0%	0.30	0.35	1.18	-0.10	0.69	0.18	3.53	0.55	0.06	0.70
	Wet	15	93.3%	0.12	0.08	0.72	0.07	0.16	0.10	0.26	0.08	0.07	0.36
	All	18	94.4%	0.15	0.16	1.09	0.07	0.22	0.11	0.37	0.11	0.06	0.70

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 8. Urban Runoff Discharge Total Methylmercury (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

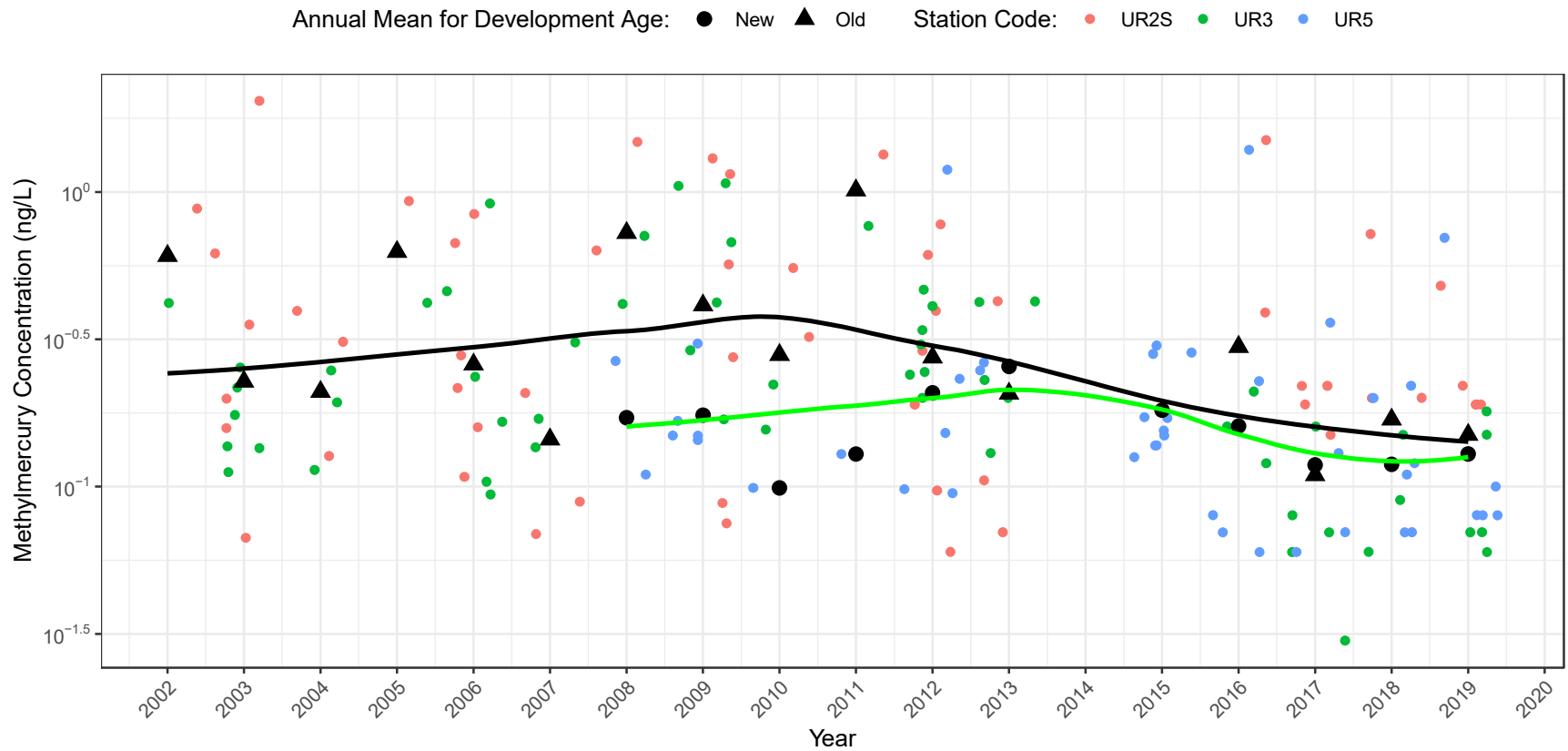
Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
UR2S	Dry	16	100.0%	0.25	0.49	1.93	0.01	0.49	0.14	0.54	0.16	0.07	2.04
	Wet	40	100.0%	0.52	0.39	0.76	0.39	0.64	0.40	1.44	0.44	0.06	1.50
	All	56	100.0%	0.44	0.43	0.98	0.33	0.55	0.29	1.42	0.40	0.06	2.04
UR3	Dry	18	100.0%	0.23	0.25	1.06	0.12	0.35	0.16	0.80	0.23	0.03	1.07
	Wet	41	100.0%	0.30	0.23	0.79	0.22	0.37	0.23	0.79	0.24	0.06	1.05
	All	59	100.0%	0.28	0.24	0.85	0.22	0.34	0.21	0.78	0.24	0.03	1.07
UR5	Dry	9	100.0%	0.37	0.43	1.16	0.09	0.65	0.24	1.42	0.38	0.06	1.39
	Wet	40	92.5%	0.17	0.18	1.09	0.11	0.23	0.13	0.42	0.13	0.06	1.19
	All	49	93.9%	0.21	0.25	1.23	0.14	0.28	0.14	0.54	0.16	0.06	1.39

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet



Notes: Old development averages and best-fit smoothed (black) line based on Strong Ranch Slough (UR2S) and Sump 111 (UR3) annual averages. New development and best-fit smoothed (green) line based on North Natomas Detention Basin No. 4 (UR5) data.

Figure 3. Total Mercury Concentrations in Urban Runoff Discharge Monitoring at Current Characterization Stations (1990-2019)



Notes: Old development averages and best-fit smoothed (black) line based on Strong Ranch Slough (UR2S) and Sump 111 (UR3) annual averages. New development and best-fit smoothed (green) line based on North Natomas Detention Basin No. 4 (UR5) data.

Figure 4. Total Methylmercury Concentrations in Urban Runoff Discharge Monitoring at Current Characterization Stations (2001-2019)

4.2 PYRETHROID PESTICIDES

Summary statistics for pyrethroid pesticides for the three urban runoff discharge sites, Strong Ranch Slough (UR2S), Sump 111 (UR3), and North Natomas Detention Basin No. 4 (UR5), are shown in **Table 9** through **Table 20**. Bifenthrin, cyfluthrin, cypermethrin, esfenvalerate, lambda-cyhalothrin, and permethrin, are the six individual pyrethroid pesticides of focus in the Central Valley Pyrethroid Total Maximum Daily Load (TMDL). Additionally, **Table 21** through **Table 24** includes statistics for dissolved and total organic carbon. Organic carbon is a component of the pyrethroid trigger limits in the Central Valley Pyrethroid TMDL and should be considered when reviewing pyrethroid concentration results to account for bioavailable forms of the pesticides. Each set of tables includes a summary for data that was collected during the current permit term (October 2016 through October 2019) and the historical data set (1990 through 2019).

Time series plots for the urban runoff discharge locations are provided in **Figure 5** through **Figure 10**. Best-fit smoothed lines are provided to visually examine trends at each of the sites, but are not robust statistical evaluations of trends. Future evaluations may examine grouping sites together, especially if site specific conditions (i.e., controls and other management factors present in the tributary drainage) are identified as effective control strategies.

The concentration goal unit (CGU) is defined in the Central Valley Pyrethroid TMDL as the summation of the ratio of each of the six individual pyrethroids to the effect level (see **Figure 2**). The CGU (>1) triggers management actions. The dissolved concentration was calculated using the Central Valley Pyrethroid TMDL ambient partition coefficient and organic carbon concentration based equation to estimate aquatic life exposure concentration (see **Equation 1**). Time series plots for the calculated dissolved acute and chronic CGU in urban runoff discharge are provided in **Figure 11** and **Figure 12**, respectively.

Table 9. Urban Runoff Discharge Bifenthrin (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Bifenthrin (ng/L)													
UR2S	Dry	3	100%	1.73	0.67	0.38	0.98	2.49	1.63	4.52	1.40	1	2.3
	Wet	9	100%	27.67	23.61	0.85	12.24	43.09	22.99	58.85	18.16	14	89
	All	12	100%	21.18	23.30	1.10	8.00	34.37	11.87	120.69	26.14	1	89
UR3	Dry	3	67%	Insufficient Detected Data								0.2	0.4
	Wet	9	100%	9.23	6.39	0.69	5.06	13.41	7.52	28.75	8.69	2.6	22
	All	12	92%	6.99	6.80	0.97	3.14	10.83	3.23	60.12	9.74	0.2	22
UR5	Dry	3	100%	1.03	0.93	0.90	-0.02	2.08	0.80	6.02	1.48	0.4	2.1
	Wet	9	100%	12.84	4.80	0.37	9.71	15.98	11.98	26.87	8.08	5.7	20
	All	12	100%	9.89	6.74	0.68	6.08	13.71	6.08	61.77	13.38	0.4	20

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 10. Urban Runoff Discharge Bifenthrin (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Bifenthrin (ng/L)													
UR2S	Dry	7	100%	20.11	31.72	1.58	-3.39	43.61	4.90	134.02	17.76	1	75.6
	Wet	16	100%	36.21	28.93	0.80	22.04	50.39	28.84	89.16	27.66	14	108
	All	23	100%	31.31	30.04	0.96	19.04	43.59	16.81	177.88	37.84	1	108
UR3	Dry	6	83%	3.15	4.76	1.51	-0.66	6.96	0.72	64.31	4.44	0.2	12.1
	Wet	17	100%	20.84	35.53	1.71	3.95	37.73	11.65	65.46	17.90	2.6	155
	All	23	96%	16.23	31.40	1.93	3.40	29.06	6.32	91.50	16.80	0.2	155
UR5	Dry	7	86%	1.59	1.15	0.72	0.74	2.43	1.18	6.32	1.75	0.4	3.3
	Wet	26	100%	10.81	6.31	0.58	8.38	13.23	9.03	28.21	8.75	1.5	27.5
	All	33	97%	8.86	6.77	0.76	6.55	11.17	6.02	35.33	9.52	0.4	27.5

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 11. Urban Runoff Discharge Cyfluthrin (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Cyfluthrin (ng/L)													
UR2S	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	100%	11.52	24.60	2.14	-4.55	27.60	2.86	57.90	8.99	0.5	76
	All	12	75%	8.66	21.61	2.50	-3.57	20.89	1.11	66.54	5.74	0.5	76
UR3	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	78%	13.16	36.32	2.76	-10.57	36.89	1.38	26.12	4.20	0.4	110
	All	12	58%	9.81	31.56	3.22	-8.05	27.67	0.43	29.40	2.36	0.4	110
UR5	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	100%	1.86	1.37	0.74	0.96	2.75	1.56	4.86	1.51	0.7	5.2
	All	12	75%	1.48	1.35	0.91	0.72	2.25	1.09	5.03	1.46	0.7	5.2

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 12. Urban Runoff Discharge Cyfluthrin (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Cyfluthrin (ng/L)													
UR2S	Dry	7	0%	Insufficient Detected Data								NA	NA
	Wet	16	94%	11.09	19.63	1.77	1.47	20.71	3.48	67.50	10.71	0.5	76
	All	23	65%	7.76	17.01	2.19	0.81	14.71	1.18	60.74	5.71	0.5	76
UR3	Dry	6	17%	Insufficient Detected Data								0.3	0.3
	Wet	17	76%	8.15	26.31	3.23	-4.35	20.66	1.43	18.88	3.63	0.4	110
	All	23	61%	6.02	22.73	3.78	-3.27	15.31	0.58	19.30	2.31	0.3	110
UR5	Dry	7	14%	Insufficient Detected Data								0.3	0.3
	Wet	26	85%	1.44	1.50	1.04	0.86	2.01	1.03	4.02	1.21	0.3	7
	All	33	70%	1.18	1.42	1.21	0.69	1.66	0.73	4.01	1.10	0.3	7

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 13. Urban Runoff Discharge Cypermethrin (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Cypermethrin (ng/L)													
UR2S	Dry	3	67%	Insufficient Detected Data								0.3	0.9
	Wet	9	67%	1.54	0.93	0.60	0.94	2.15	1.34	3.57	1.11	1.2	3.7
	All	12	67%	1.21	0.98	0.81	0.65	1.76	0.88	3.89	1.14	0.3	3.7
UR3	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	78%	1.69	0.91	0.54	1.10	2.29	1.47	4.18	1.30	0.6	3.5
	All	12	58%	1.35	0.98	0.72	0.80	1.90	1.04	4.07	1.23	0.6	3.5
UR5	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	89%	0.72	0.26	0.36	0.55	0.88	0.68	1.33	0.38	0.5	1.2
	All	12	67%	0.62	0.28	0.44	0.47	0.78	0.57	1.30	0.39	0.5	1.2

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 14. Urban Runoff Discharge Cypermethrin (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Cypermethrin (ng/L)													
UR2S	Dry	7	43%	0.52	0.76	1.46	-0.04	1.08	0.19	3.77	0.59	0.3	2.1
	Wet	16	75%	2.76	2.27	0.82	1.65	3.88	1.97	9.44	2.71	1.2	7.4
	All	23	65%	2.07	2.19	1.06	1.18	2.97	1.14	9.21	2.20	0.3	7.4
UR3	Dry	6	33%	Insufficient Detected Data								0.3	0.6
	Wet	17	76%	2.16	1.66	0.77	1.37	2.95	1.60	7.02	2.06	0.6	5.7
	All	23	65%	1.64	1.67	1.02	0.95	2.32	0.92	7.15	1.74	0.3	5.7
UR5	Dry	7	14%	Insufficient Detected Data								0.4	0.4
	Wet	26	85%	1.02	0.89	0.87	0.68	1.37	0.77	2.80	0.85	0.4	3.9
	All	33	70%	0.85	0.85	1.00	0.56	1.14	0.58	2.69	0.78	0.4	3.9

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 15. Urban Runoff Discharge Esfenvalerate (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Esfenvalerate (ng/L)													
UR2S	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	33%	0.61	0.31	0.50	0.41	0.81	0.55	1.43	0.44	0.5	1.3
	All	12	25%	0.44	0.33	0.74	0.26	0.63	0.36	1.30	0.40	0.5	1.3
UR3	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	56%	0.83	1.17	1.40	0.07	1.60	0.40	4.03	0.88	0.3	3.7
	All	12	42%	0.62	1.06	1.71	0.02	1.22	0.22	3.38	0.60	0.3	3.7
UR5	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	56%	0.43	0.38	0.88	0.18	0.68	0.31	1.60	0.45	0.4	1.3
	All	12	42%	0.35	0.36	1.03	0.14	0.55	0.22	1.42	0.37	0.4	1.3

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 16. Urban Runoff Discharge Esfenvalerate (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Esfenvalerate (ng/L)													
UR2S	Dry	7	0%	Insufficient Detected Data								NA	NA
	Wet	17	59%	0.82	0.58	0.71	0.54	1.09	0.64	2.30	0.70	0.3	2.1
	All	24	42%	0.60	0.58	0.96	0.37	0.83	0.39	2.04	0.57	0.3	2.1
UR3	Dry	6	17%	Insufficient Detected Data								0.2	0.2
	Wet	17	59%	0.79	1.02	1.28	0.31	1.28	0.42	3.35	0.80	0.2	3.7
	All	23	48%	0.59	0.93	1.58	0.21	0.97	0.23	2.86	0.56	0.2	3.7
UR5	Dry	7	0%	Insufficient Detected Data								NA	NA
	Wet	26	42%	0.40	0.27	0.68	0.30	0.51	0.33	1.01	0.31	0.3	1.3
	All	33	33%	0.35	0.26	0.76	0.26	0.44	0.27	0.93	0.29	0.3	1.3

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 17. Urban Runoff Discharge Lambda-Cyhalothrin (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
L-Cyhalothrin (ng/L)													
UR2S	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	44%	1.18	2.46	2.08	-0.42	2.79	0.32	7.49	1.08	0.2	7.7
	All	12	33%	0.82	2.18	2.66	-0.41	2.05	0.09	5.76	0.49	0.2	7.7
UR3	Dry	3	33%	Insufficient Detected Data								0.4	0.4
	Wet	9	33%	0.31	0.22	0.72	0.17	0.46	0.25	1.49	0.40	0.3	0.8
	All	12	33%	0.28	0.20	0.70	0.17	0.40	0.23	1.00	0.30	0.3	0.8
UR5	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	67%	0.43	0.39	0.90	0.18	0.68	0.31	1.48	0.42	0.2	1.3
	All	12	50%	0.34	0.37	1.09	0.13	0.55	0.21	1.31	0.34	0.2	1.3

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 18. Urban Runoff Discharge Lambda-Cyhalothrin (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
L-Cyhalothrin (ng/L)													
UR2S	Dry	7	0%	Insufficient Detected Data								NA	NA
	Wet	16	63%	1.38	1.95	1.41	0.43	2.34	0.64	6.91	1.46	0.2	7.7
	All	23	43%	0.96	1.74	1.82	0.25	1.67	0.25	5.95	0.86	0.2	7.7
UR3	Dry	6	17%	Insufficient Detected Data								0.4	0.4
	Wet	17	53%	1.03	1.20	1.16	0.46	1.60	0.58	4.37	1.07	0.3	4.7
	All	23	43%	0.78	1.11	1.43	0.32	1.23	0.34	3.65	0.78	0.3	4.7
UR5	Dry	7	14%	Insufficient Detected Data								0.2	0.2
	Wet	26	50%	0.33	0.34	1.03	0.20	0.47	0.21	1.20	0.33	0.2	1.3
	All	33	42%	0.28	0.32	1.17	0.17	0.39	0.16	1.05	0.27	0.2	1.3

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 19. Urban Runoff Discharge Permethrin (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Permethrin (ng/L)													
UR2S	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	44%	7.52	7.23	0.96	2.80	12.24	5.21	29.13	7.98	2.8	25
	All	12	33%	5.21	6.96	1.34	1.27	9.14	2.70	24.78	5.62	2.8	25
UR3	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	33%	3.58	1.42	0.40	2.65	4.51	3.34	8.16	2.50	3.6	5.8
	All	12	25%	2.93	1.50	0.51	2.08	3.78	2.61	7.35	2.28	3.6	5.8
UR5	Dry	3	0%	Insufficient Detected Data								NA	NA
	Wet	9	22%	Insufficient Detected Data								3.3	4.7
	All	12	17%	Insufficient Detected Data								3.3	4.7

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 20. Urban Runoff Discharge Permethrin (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Permethrin (ng/L)													
UR2S	Dry	5	20%	Insufficient Detected Data								2.3	2.3
	Wet	15	60%	13.62	11.48	0.84	7.81	19.43	9.25	50.23	13.89	2.8	38
	All	20	50%	9.88	11.61	1.17	4.80	14.97	4.56	49.62	10.42	2.3	38
UR3	Dry	5	0%	Insufficient Detected Data								NA	NA
	Wet	15	40%	4.70	4.07	0.87	2.64	6.76	3.47	15.61	4.56	3.6	14
	All	20	30%	3.58	3.89	1.09	1.88	5.29	2.29	13.61	3.65	3.6	14
UR5	Dry	7	14%	Insufficient Detected Data								7.4	7.4
	Wet	25	28%	2.11	1.17	0.56	1.65	2.57	1.82	5.13	1.59	2	4.9
	All	32	25%	2.05	1.51	0.74	1.53	2.57	1.63	5.51	1.70	2	7.4

Notes: [1] all concentration units are ng/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 21. Urban Runoff Discharge Dissolved Organic Carbon (mg/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Dissolved Organic Carbon (mg/L)													
UR2S	Dry	2	100%	11.90	4.38	0.37	5.82	17.98	Insufficient Detected Data			8.8	15
	Wet	6	100%	35.88	57.31	1.60	-9.97	81.74	14.71	224.17	40.13	4	150
	All	8	100%	29.89	49.72	1.66	-4.57	64.34	13.83	126.26	28.66	4	150
UR3	Dry	2	100%	3.05	1.63	0.53	0.80	5.30	Insufficient Detected Data			1.9	4.2
	Wet	6	100%	22.00	34.08	1.55	-5.27	49.27	9.42	159.76	27.13	2.2	90
	All	8	100%	17.26	30.12	1.74	-3.61	38.13	6.97	85.42	16.99	1.9	90
UR5	Dry	2	100%	5.30	1.84	0.35	2.75	7.85	Insufficient Detected Data			4	6.6
	Wet	6	100%	19.78	29.18	1.47	-3.56	43.13	10.85	84.78	20.54	3.8	79
	All	8	100%	16.16	25.56	1.58	-1.55	33.88	9.00	51.42	13.99	3.8	79

Notes: [1] all concentration units are mg/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 22. Urban Runoff Discharge Dissolved Organic Carbon (mg/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Dissolved Organic Carbon (mg/L)													
UR2S	Dry	22	100%	11.92	8.61	0.72	8.32	15.52	10.11	26.75	8.28	2	46
	Wet	45	100%	16.92	24.15	1.43	9.86	23.97	10.86	42.70	12.84	3.8	150
	All	67	100%	15.28	20.45	1.34	10.38	20.17	10.61	36.59	11.24	2	150
UR3	Dry	21	95%	11.48	8.18	0.71	7.98	14.98	8.37	42.16	11.93	1	30
	Wet	43	100%	14.10	18.33	1.30	8.62	19.58	9.05	39.59	11.64	2	90
	All	64	98%	13.24	15.71	1.19	9.39	17.09	8.79	39.77	11.59	1	90
UR5	Dry	7	100%	6.87	1.80	0.26	5.54	8.20	6.66	11.41	2.96	4	10
	Wet	31	100%	13.01	14.17	1.09	8.02	17.99	9.50	33.07	10.15	3.8	79
	All	38	100%	11.88	13.00	1.09	7.74	16.01	8.90	27.89	8.64	3.8	79

Notes: [1] all concentration units are mg/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 23. Urban Runoff Discharge Total Organic Carbon (mg/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

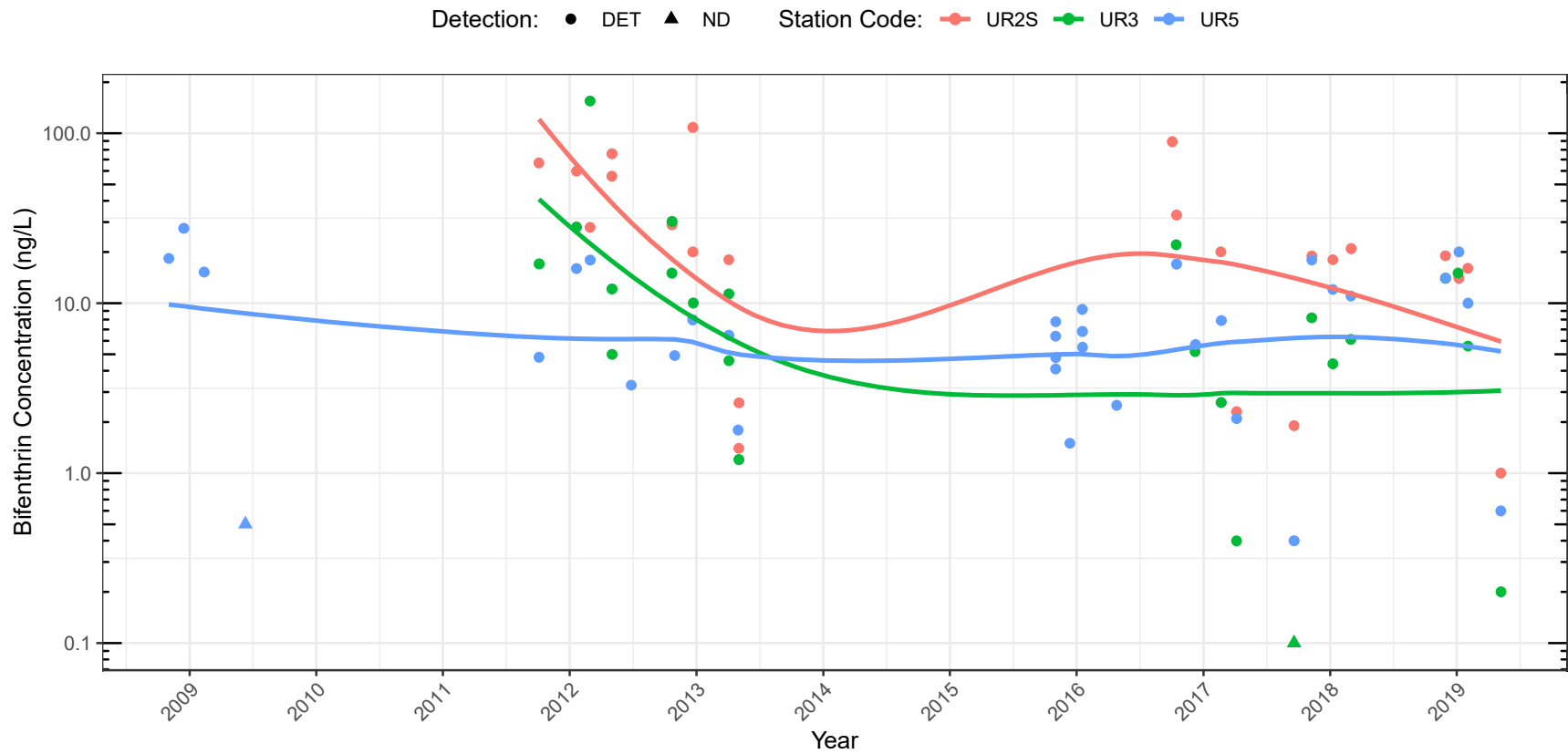
Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Total Organic Carbon (mg/L)													
UR2S	Dry	2	100%	12.80	4.53	0.35	6.53	19.07	Insufficient Detected Data			9.6	16
	Wet	6	100%	33.65	53.24	1.58	-8.95	76.25	14.50	198.78	37.47	4.4	140
	All	8	100%	28.44	46.05	1.62	-3.48	60.35	13.95	117.38	27.58	4.4	140
UR3	Dry	2	100%	3.00	1.41	0.47	1.04	4.96	Insufficient Detected Data			2	4
	Wet	6	100%	22.68	36.06	1.59	-6.17	51.54	9.58	158.84	27.28	2.2	95
	All	8	100%	17.76	31.82	1.79	-4.28	39.81	7.06	84.28	16.97	2	95
UR5	Dry	2	100%	6.35	2.62	0.41	2.72	9.98	Insufficient Detected Data			4.5	8.2
	Wet	6	100%	20.10	27.16	1.35	-1.63	41.83	11.92	89.88	22.09	3.7	75
	All	8	100%	16.66	23.84	1.43	0.14	33.18	10.07	56.46	15.46	3.7	75

Notes: [1] all concentration units are mg/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 24. Urban Runoff Discharge Total Organic Carbon (mg/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Total Organic Carbon (mg/L)													
UR2S	Dry	22	95%	12.90	9.87	0.76	8.78	17.03	11.06	26.93	8.25	4.9	53
	Wet	47	100%	19.19	22.97	1.20	12.63	25.76	13.20	49.14	14.93	4.4	140
	All	69	99%	17.16	19.91	1.16	12.47	21.86	12.38	41.33	12.74	4.4	140
UR3	Dry	21	95%	14.73	12.08	0.82	9.56	19.89	11.04	46.61	13.81	2	51
	Wet	45	100%	15.73	18.07	1.15	10.45	21.01	10.57	46.50	13.65	2.2	95
	All	66	98%	15.40	16.32	1.06	11.46	19.34	10.64	45.62	13.47	2	95
UR5	Dry	7	100%	7.50	2.02	0.27	6.00	9.00	7.26	12.72	3.37	4.5	11
	Wet	31	100%	13.68	14.02	1.03	8.74	18.61	10.01	36.37	11.09	3.7	75
	All	38	100%	12.54	12.88	1.03	8.44	16.64	9.43	30.52	9.44	3.7	75

Notes: [1] all concentration units are mg/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet



Notes: [1] DET = detected value; [2] ND = not detected indicated detection limit; [3] UR2S = Strong Ranch Slough; [4] UR3 = Sump 111; [5] UR5 = North Natomas Detention Basin No. 4 Outlet

Figure 5. Bifenthrin Concentrations in Urban Runoff Discharge Monitoring at Current Characterization Stations (2008-2019)

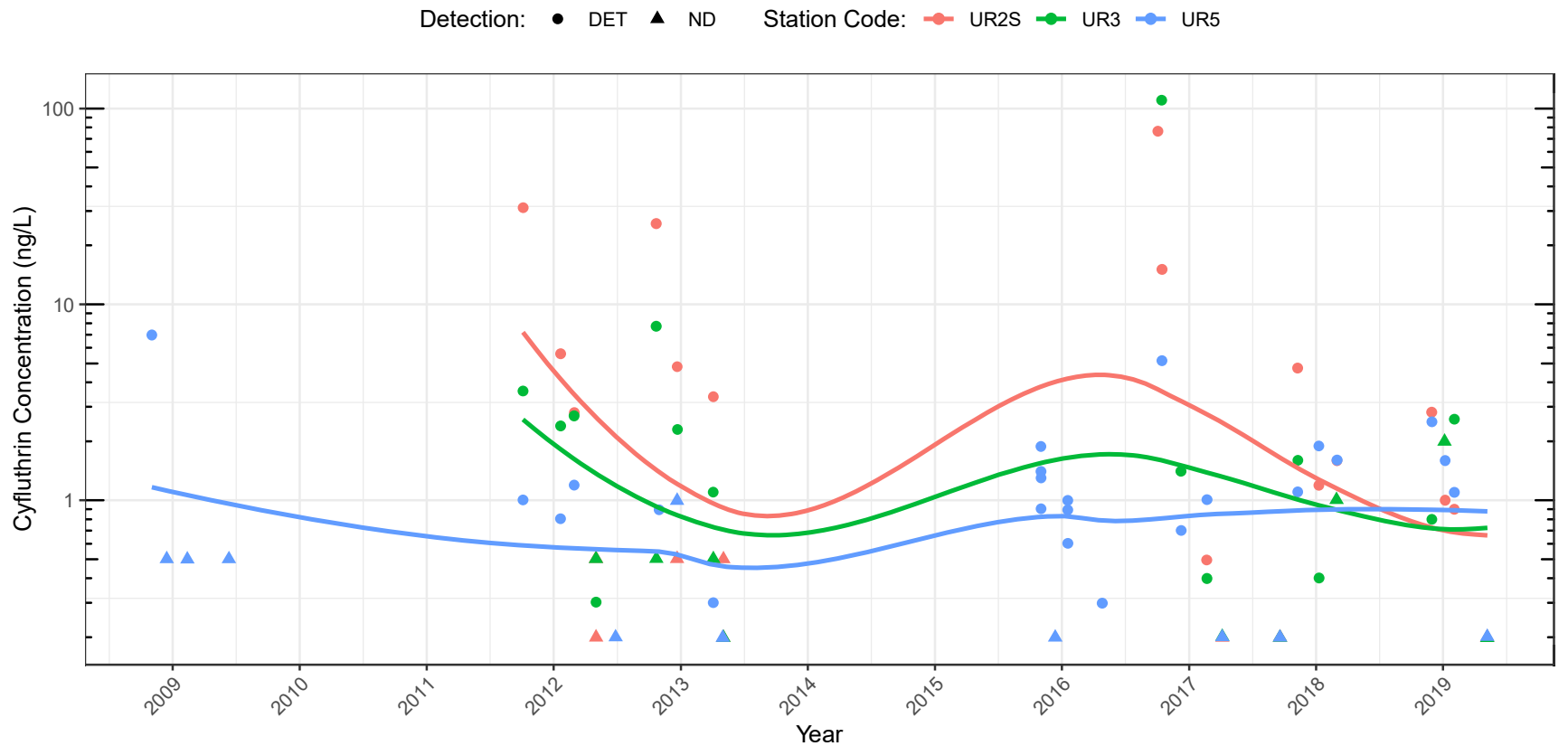


Figure 6. Cyfluthrin Concentrations in Urban Runoff Discharge Monitoring at Current Characterization Stations (2008-2019)

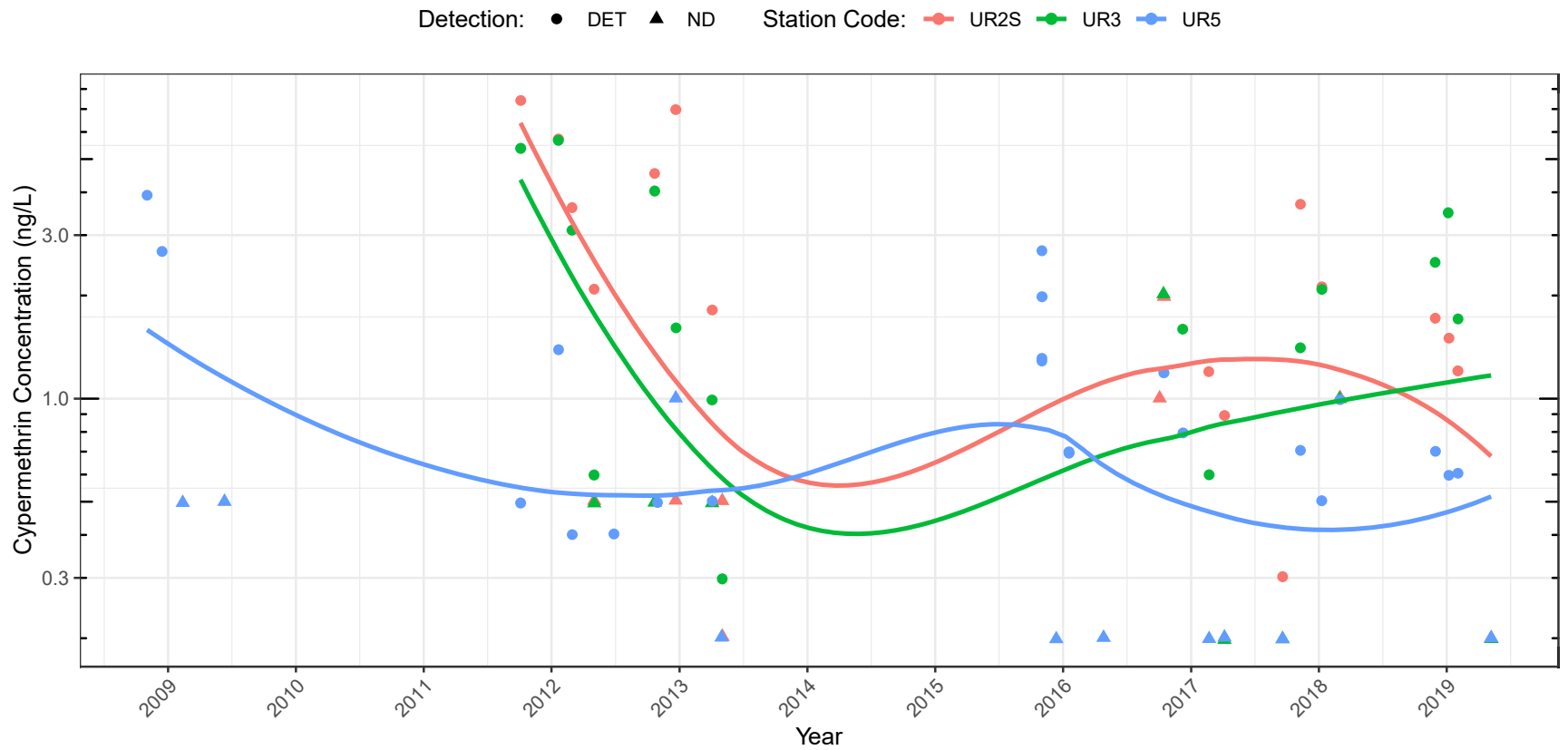


Figure 7. Cypermethrin Concentrations in Urban Runoff Discharge Monitoring at Current Characterization Stations (2008-2019)

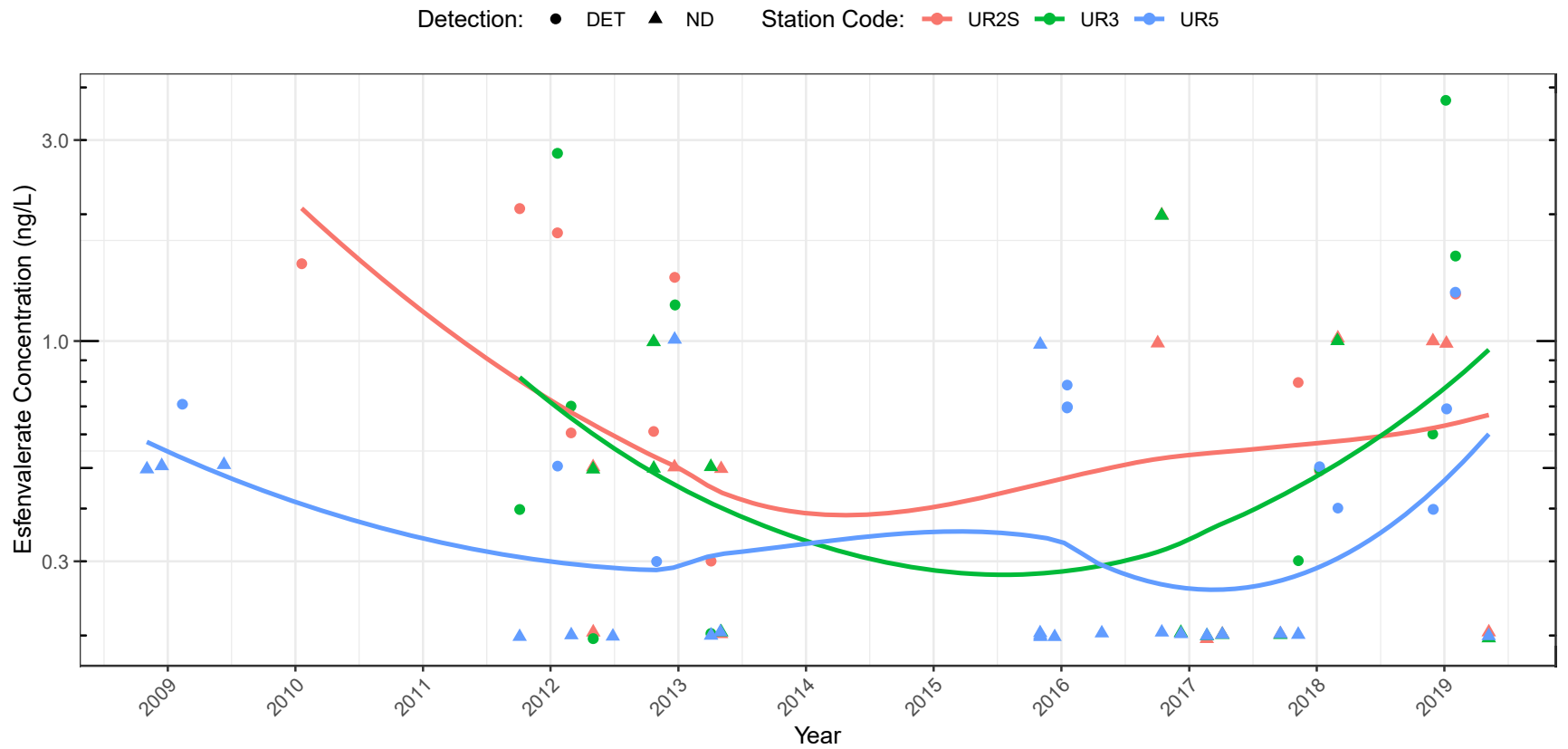


Figure 8. Esfenvalerate Concentrations in Urban Runoff Discharge Monitoring at Current Characterization Stations (2008-2019)

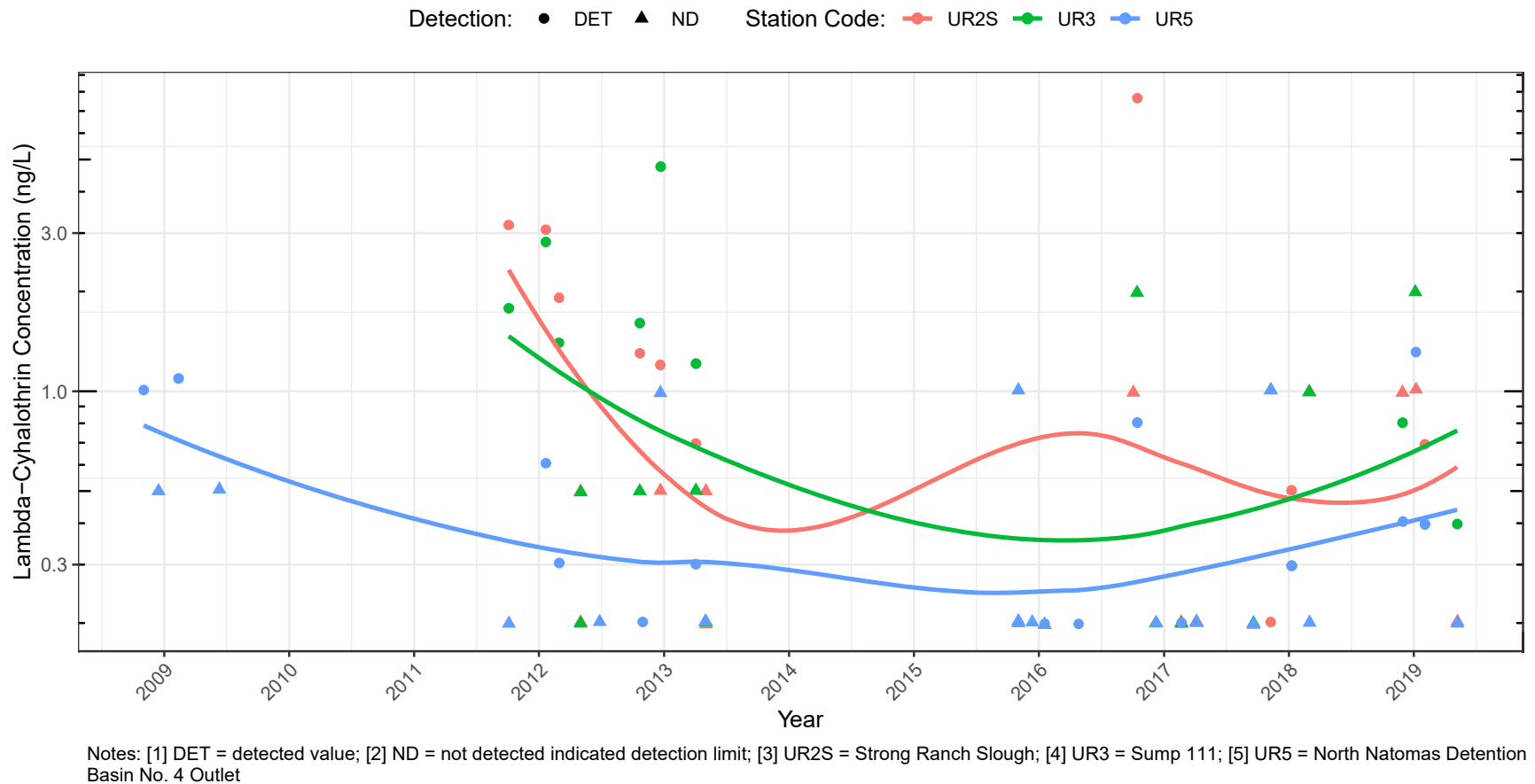


Figure 9. Lambda-Cyhalothrin Concentrations in Urban Runoff Discharge Monitoring at Current Characterization Stations (2008-2019)

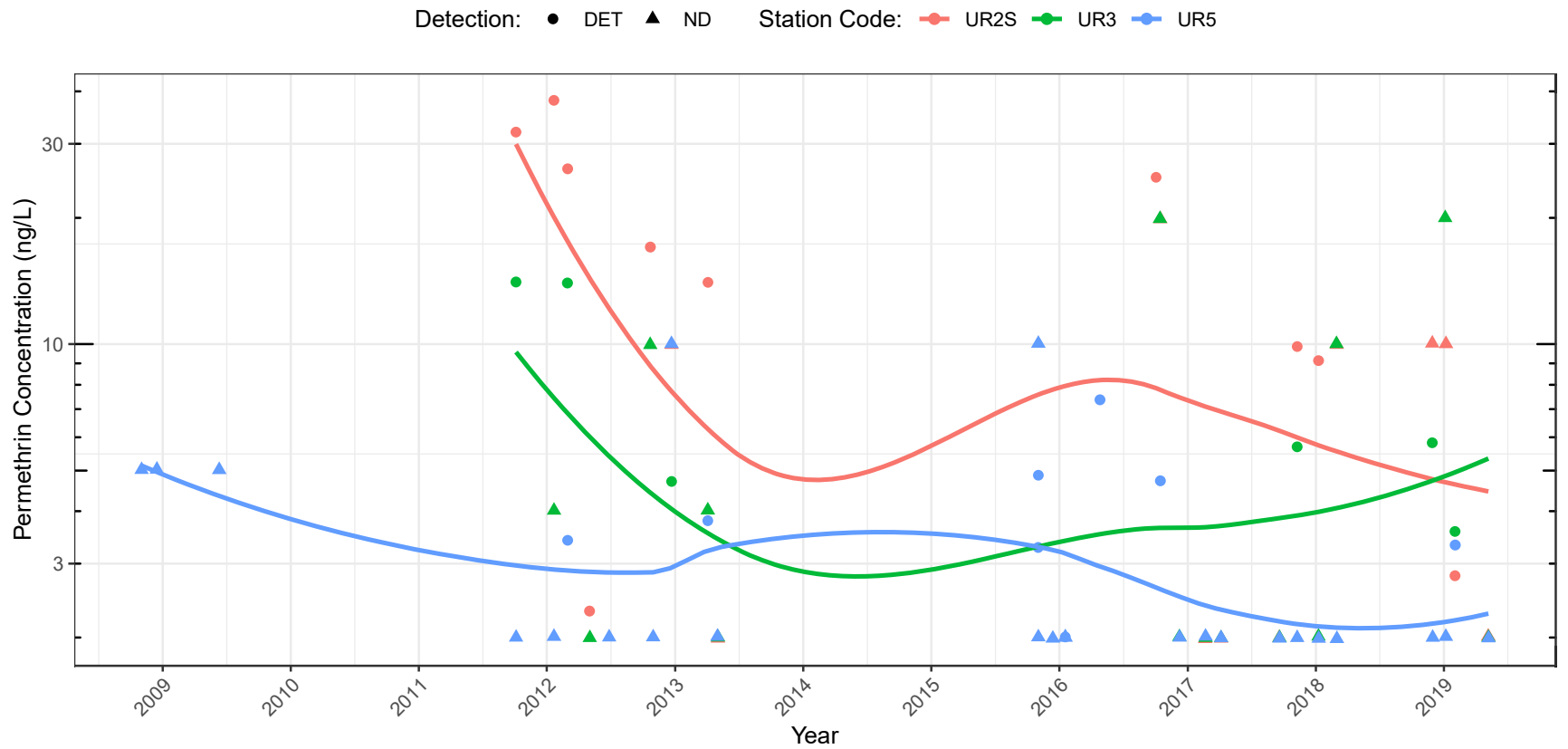
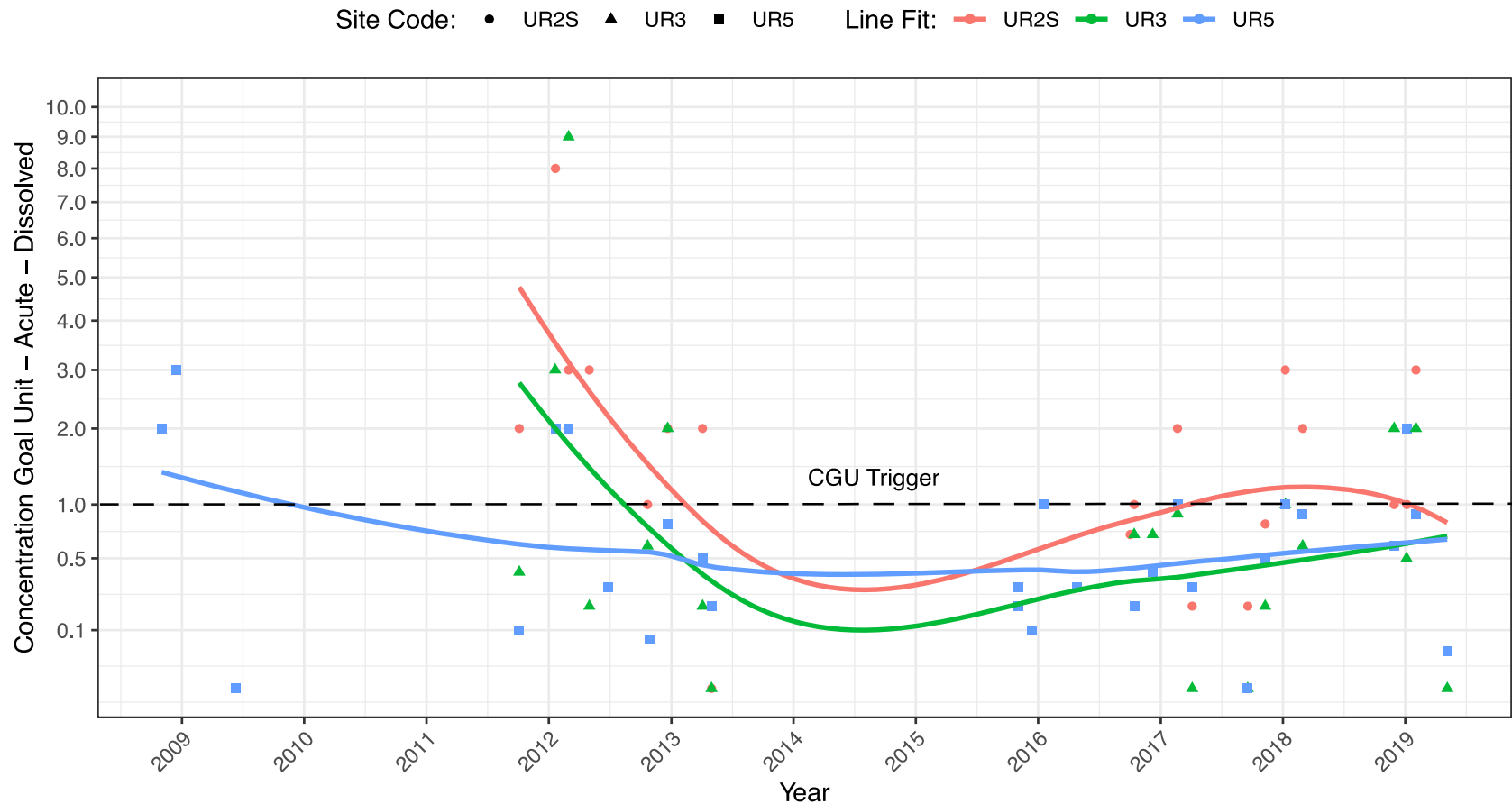


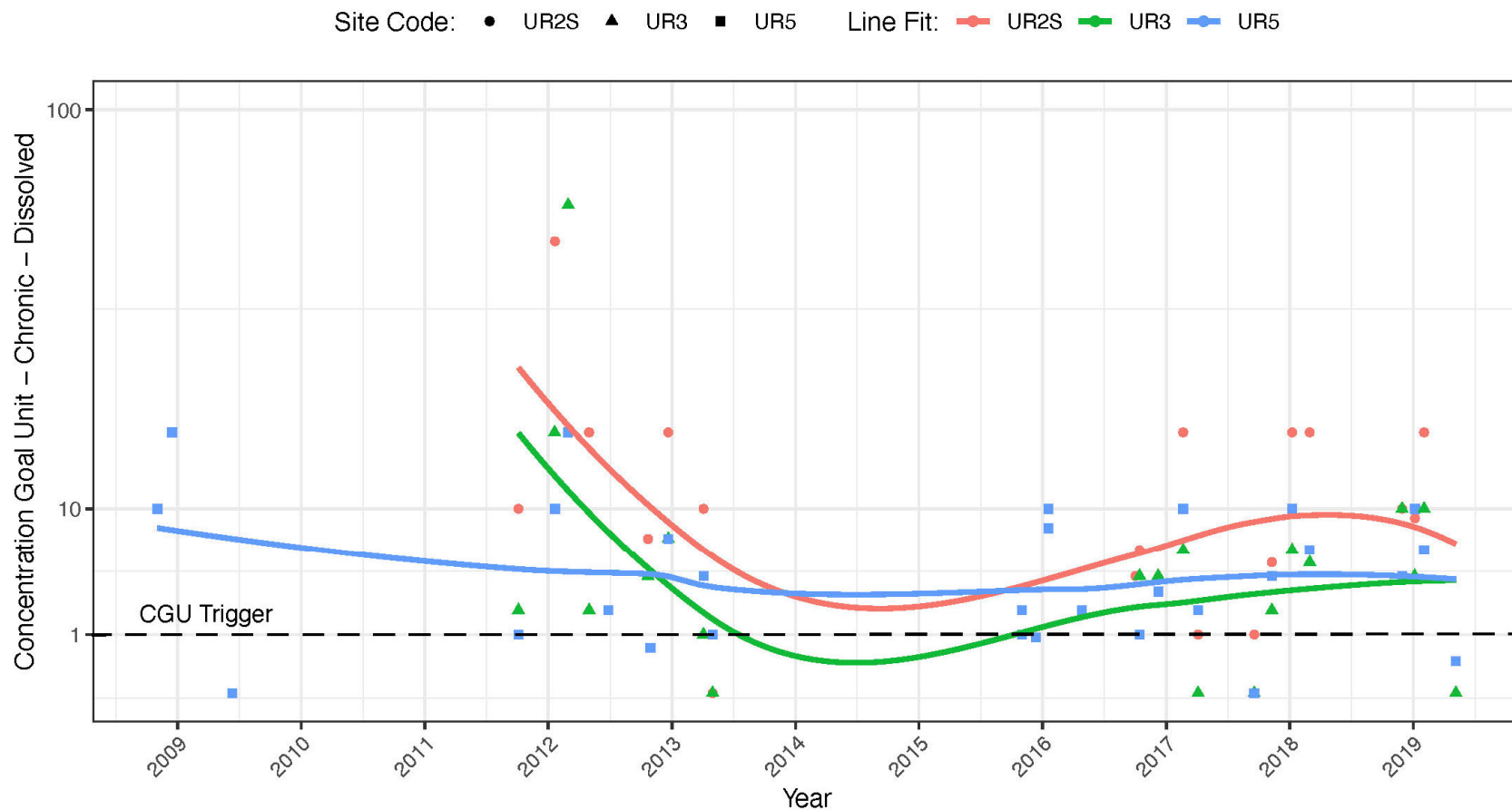
Figure 10. Permethrin Concentrations in Urban Runoff Discharge Monitoring at Current Characterization Stations (2008-2019)



Notes: UR2S = Strong Ranch Slough; UR3 = Sump 111; UR5 = North Natomas Detention Basin No. 4 Outlet; Response variable (CGU) scale is square root transformed.

Figure 11. Dissolved Acute Concentration Goal Unit at Current Urban Runoff Discharge Monitoring Characterization Stations (2008-2019)

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Notes: UR2S = Strong Ranch Slough; UR3 = Sump 111; UR5 = North Natomas Detention Basin No. 4 Outlet; Response variable (CGU) scale is square root transformed.

Figure 12. Dissolved Chronic Concentration Goal Unit at Current Urban Runoff Discharge Monitoring Characterization Stations (2008-2019)

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4.3 LEGACY ORGANOPHOSPHATE PESTICIDES

Summary statistics for the OP pesticides, chlorpyrifos and diazinon, at the three urban runoff discharge sites, Strong Ranch Slough (UR2S), Sump 111 (UR3), and North Natomas Detention Basin No. 4 (UR5), are shown in **Table 25** through **Table 28**. Each set of tables includes a summary for data that was collected during the current permit term (October 2016 through October 2019) and the historical data set (1990 through 2019). The Partnership previously demonstrated compliance with multiple TMDL wasteload allocation target concentrations. Time series plots are provided as **Figure 13** and **Figure 14**. The time series plots include best-fit smooth lines that are fit to both detected concentrations and detection limits when samples were reported as not detected. This would bias the smoothed line fit high. Summary statistics in **Table 25** through **Table 28** consider values reported as not detected by using a regression on order statistics.

Table 25. Urban Runoff Discharge Chlorpyrifos (µg/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value								
Chlorpyrifos (µg/L)																					
UR2S	Dry	3	0.0%	Insufficient Detected Data								NA	NA								
	Wet	8	25.0%									0.0007	0.0049								
	All	11	18.2%									0.0007	0.0049								
UR3	Dry	2	50.0%	0.0035	0.0029	0.81	0.0012	0.0058	0.0026	0.015	0.0041	0.0005	0.0005								
	Wet	6	83.3%									0.0009	0.0078								
	All	8	75.0%									0.0027	0.0028	1.03	0.0008	0.0047	0.0016	0.014	0.0032	0.0005	0.0078
UR5	Dry	2	0.0%	Insufficient Detected Data								NA	NA								
	Wet	6	66.7%									0.0015	0.0021	1.38	-0.00015	0.00314	0.00055	0.016	0.0021	0.0005	0.0054
	All	8	50.0%									0.0011	0.0019	1.64	-0.00016	0.00242	0.00026	0.013	0.0012	0.0005	0.0054

Notes: [1] all concentration units are µg/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 26. Urban Runoff Discharge Chlorpyrifos (µg/L) Summary Statistics for Historical Sample Collection (1995-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Chlorpyrifos (µg/L)													
UR2S	Dry	122	32.8%	0.022	0.058	2.68	0.011	0.032	0.0019	0.13	0.011	0.0006	0.53
	Wet	50	20.0%	0.013	0.031	2.45	0.0040	0.021	0.0020	0.071	0.0083	0.0006	0.2
	All	72	41.7%	0.029	0.071	2.49	0.012	0.045	0.0024	0.22	0.015	0.0007	0.53
UR3	Dry	53	35.8%	0.002	0.0055	2.48	0.0007	0.0037	0.0006	0.010	0.0017	0.0004	0.0318
	Wet	15	26.7%	0.00055	0.00021	0.39	0.00044	0.00066	0.0005	0.0011	0.00031	0.0004	0.0011
	All	38	39.5%	0.0030	0.006	2.15	0.00094	0.0050	0.0009	0.013	0.0024	0.0009	0.0318
UR5	Dry	41	24.4%	0.0008	0.002	2.49	0.00019	0.0014	0.0002	0.004	0.0006	0.0005	0.0116
	Wet	10	0.0%	Insufficient Detected Data								NA	NA
	All	31	32.3%									0.0005	0.0116

Notes: [1] all concentration units are µg/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 27. Urban Runoff Discharge Diazinon (µg/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

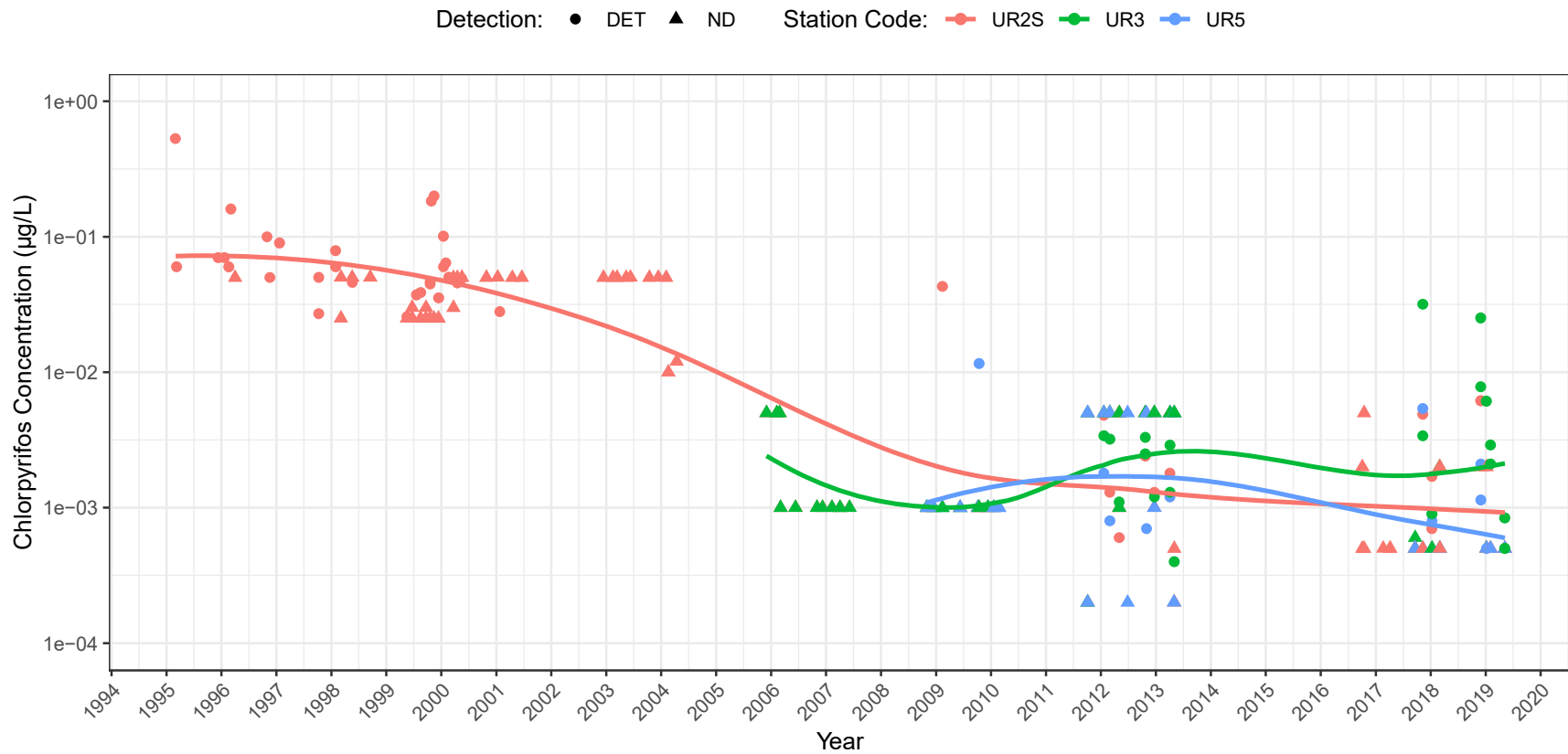
Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Diazinon (µg/L)													
UR2S	Dry	3	33.3%	Insufficient Detected Data								0.0038	0.0038
	Wet	8	0.0%									NA	NA
	All	11	9.1%									0.0038	0.0038
UR3	Dry	2	0.0%	Insufficient Detected Data								NA	NA
	Wet	6	0.0%									NA	NA
	All	8	0.0%									NA	NA
UR5	Dry	2	0.0%	Insufficient Detected Data								NA	NA
	Wet	6	16.7%									0.0027	0.0027
	All	8	12.5%									0.0027	0.0027

Notes: [1] all concentration units are µg/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet

Table 28. Urban Runoff Discharge Diazinon (µg/L) Summary Statistics for Historical Sample Collection (1995-2019)

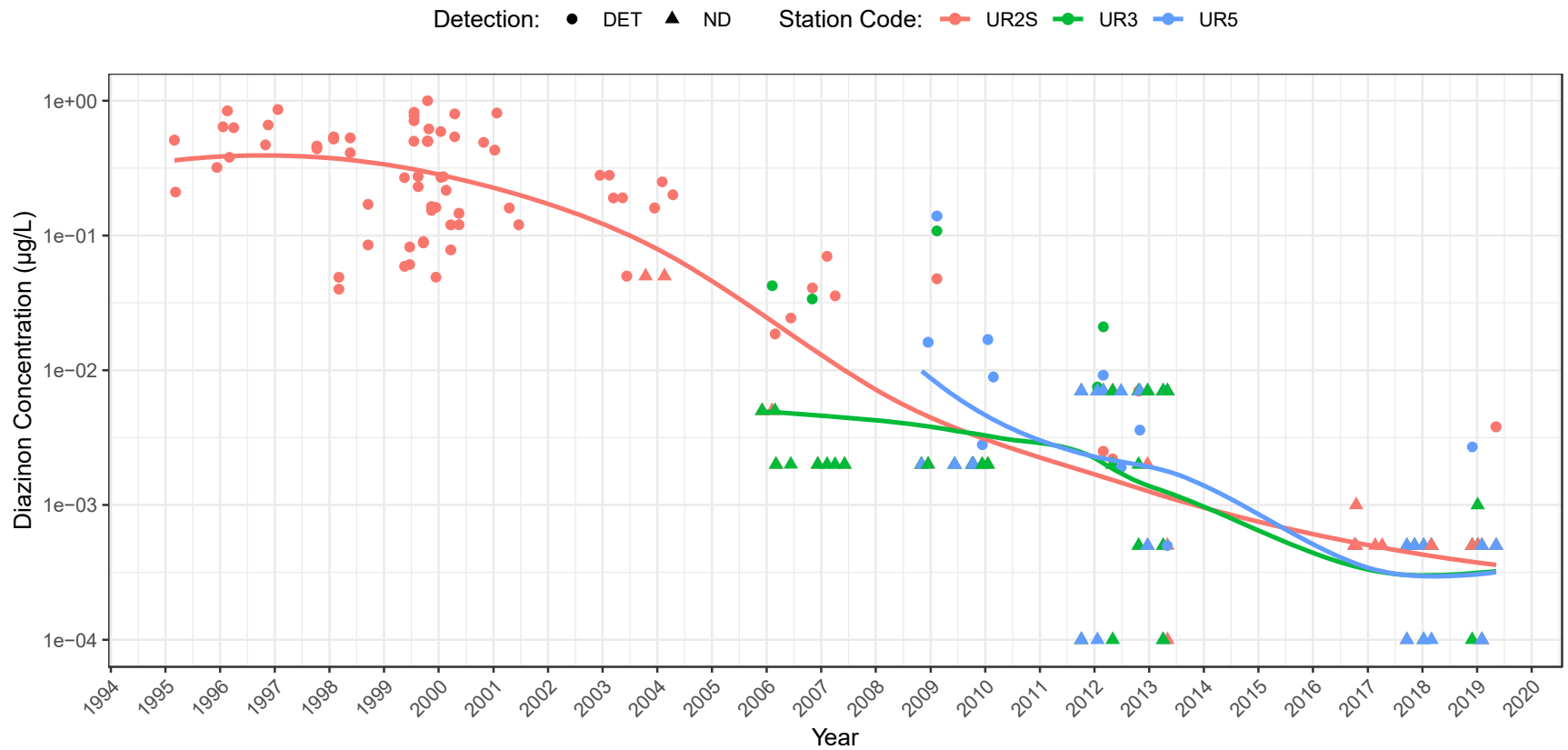
Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Diazinon (µg/L)													
UR2S	Dry	133	60.2%	0.24	0.34	1.44	0.18	0.29	0.063	1.37	0.21	0.0022	2.18
	Wet	61	73.8%	0.28	0.41	1.50	0.17	0.38	0.078	1.79	0.26	0.0022	2.18
	All	72	48.6%	0.20	0.26	1.25	0.15	0.26	0.062	1.12	0.18	0.0025	0.86
UR3	Dry	53	9.4%	Insufficient Detected Data								0.0075	0.11
	Wet	15	6.7%									0.0424	0.042
	All	38	10.5%	0.0047	0.018	3.96	-0.0012	0.011	0.000044	0.025	0.0006	0.0075	0.11
UR5	Dry	41	24.4%	0.0050	0.022	4.33	-0.0016	0.012	0.00012	0.024	0.0011	0.0005	0.14
	Wet	10	20.0%	Insufficient Detected Data								0.0005	0.0019
	All	31	25.8%	0.007	0.025	3.76	-0.0022	0.015	0.00032	0.035	0.0022	0.0027	0.14

Notes: [1] all concentration units are µg/L; [2] UR2S = Strong Ranch Slough; [3] UR3 = Sump 111; [4] UR5 = North Natomas Detention Basin No. 4 Outlet



Notes: [1] DET = detected value; [2] ND = not detected indicated detection limit; [3] UR2S = Strong Ranch Slough; [4] UR3 = Sump 111; [5] UR5 = North Natomas Detention Basin No. 4 Outlet

Figure 13. Chlorpyrifos Concentrations in Urban Runoff Discharge Monitoring at Current Characterization Stations (1995-2019)



Notes: [1] DET = detected value; [2] ND = not detected indicated detection limit; [3] UR2S = Strong Ranch Slough; [4] UR3 = Sump 111; [5] UR5 = North Natomas Detention Basin No. 4 Outlet

Figure 14. Diazinon Concentrations in Urban Runoff Discharge Monitoring at Current Characterization Stations (1995-2019)

5 Urban Tributary Monitoring

The Partnership's urban tributary monitoring characterizes urban waterways that receive MS4 discharges and include urban and non-urban mixed land use areas for larger drainages than the urban runoff discharge characterization monitoring as shown in **Table 29**. These drainages, with the exception of Arcade Creek at Watt Avenue, which was almost entirely developed before 1996, have larger non-urban areas and a mix of urban development before and after the implementation of water quality development standards in 1996. The Laguna Creek at Stockton Boulevard, and to a lesser degree the Willow Creek at Blue Ravine Road monitoring locations are also representative of developing areas. Characterization at these sites includes contributions from other sources and undeveloped non-urban areas.

Table 29. 2016-2019 Urban Tributary Monitoring Location Drainage Area Characteristics

Drainage	Site ID Code	Drainage Area	Percent of Total Area		
			Pre-1996	Post-1996	non-urban
Urban Tributary Characterization					
Arcade Creek at Watt Avenue	AC03	20,657	97%	2%	1%
Laguna Creek at Stockton Blvd.	LC02	27,074	14%	18%	68%
Willow Creek at Blue Ravine Road	WC01	10,767	41%	30%	28%

Monitoring at Arcade, Willow, and Laguna Creeks is required once every five years based on the August 3, 2015 approval letter from the Regional Water Board. Arcade Creek monitoring was last conducted during fiscal year 2015/2016, before the Notice of Applicability for the MS4 General Permit. The Partnership conducted urban tributary monitoring at both Willow and Laguna Creeks during fiscal year 2017/2018. The Partnership collected urban tributary water column grab samples for the constituents listed in Table B of the Partnership's 2015 Limited Term NPDES permit MRP requirements at the two creeks (see **Table 2** constituent list). Samples were collected for one dry weather event and three wet weather events in fiscal year 2017/2018 as shown in **Table 30**. The Urban Tributary Annual Monitoring Report includes time series plots for key representative constituents to visually identify apparent trends or significant year-to-year changes that may require additional investigation.

Table 30. 2017/2018 Urban Tributary Monitoring Events

Event Period	Event Type	Laguna Creek	Willow Creek
9/19/2017	Dry	■	■
11/8/2017	Wet	■	■
1/8/2018	Wet	■	■
3/1/2018	Wet	■	■

Notes: ■ = sampling event completed

5.1 MERCURY AND METHYLMERCURY

Summary statistics for mercury and methylmercury for the three urban tributary sites, Arcade Creek at Watt Avenue (AC03), Laguna Creek at West Stockton Boulevard (LC02), and Willow Creek at Blue Ravine Road (WC01), are shown in tables **Table 31** through **Table 34**. Each set of

tables includes a summary for data that was collected during the current permit term (October 2016 through October 2019) and the historical data set (1990 through 2019, though these current monitoring locations started later in the early 2000s). Arcade Creek was not sampled during the current permit term, therefore, there are no summary statistics for that site in the current permit term tables.

Time series plots for mercury and methylmercury in urban tributaries are provided in **Figure 15** and **Figure 16**. The best-fit smoothed trendline is shown to visually compare older and newer development age. Annual means for older and newer development are also provided for this comparison.

Table 31. Urban Tributary Total Mercury (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
LC02	Dry	1	100.0%	Insufficient Detected Data								4.00	4.00
	Wet	4	100.0%	4.00	1.07	0.27	2.95	5.05	3.88	7.35	2.06	2.50	5.00
	All	5	100.0%	4.00	0.92	0.23	3.19	4.81	3.90	6.57	1.68	2.50	5.00
WC01	Dry	1	100.0%	Insufficient Detected Data								1.60	1.60
	Wet	3	100.0%	13.67	6.03	0.44	6.85	20.49	12.77	39.04	12.12	8.00	20.0
	All	4	100.0%	10.65	7.79	0.73	3.02	18.28	7.60	83.30	17.43	1.60	20.0

Notes: [1] all concentration units are ng/L; [2] LC02 = Laguna Creek at West Stockton Boulevard ; [3] WC01 = Willow Creek at Blue Ravine Road

Table 32. Urban Tributary Total Mercury (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
AC03	Dry	7	100.0%	3.43	0.79	0.23	2.84	4.01	3.34	5.43	1.34	2.36	4.35
	Wet	44	100.0%	27.50	19.43	0.71	21.76	33.24	22.53	66.92	20.79	6.51	101
	All	51	100.0%	24.20	19.87	0.82	18.74	29.65	17.34	79.20	23.03	2.36	101
LC02	Dry	8	100.0%	3.20	2.23	0.70	1.66	4.75	2.67	9.32	2.86	1.25	8.04
	Wet	26	100.0%	5.39	2.42	0.45	4.46	6.32	4.89	11.14	3.37	1.59	12.0
	All	34	100.0%	4.88	2.52	0.52	4.03	5.73	4.24	11.33	3.51	1.25	12.0
WC01	Dry	9	100.0%	2.95	1.07	0.36	2.25	3.65	2.75	6.01	1.79	1.27	4.90
	Wet	32	100.0%	29.81	26.38	0.89	20.67	38.95	20.52	103.75	29.32	3.23	110
	All	41	100.0%	23.91	25.81	1.08	16.01	31.82	13.20	102.98	24.97	1.27	110

Notes: [1] all concentration units are ng/L; [2] AC03 = Arcade Creek at Watt; [3] LC02 = Laguna Creek at West Stockton Boulevard; [4] WC01 = Willow Creek at Blue Ravine Road

Table 33. Urban Tributary Total Methylmercury (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

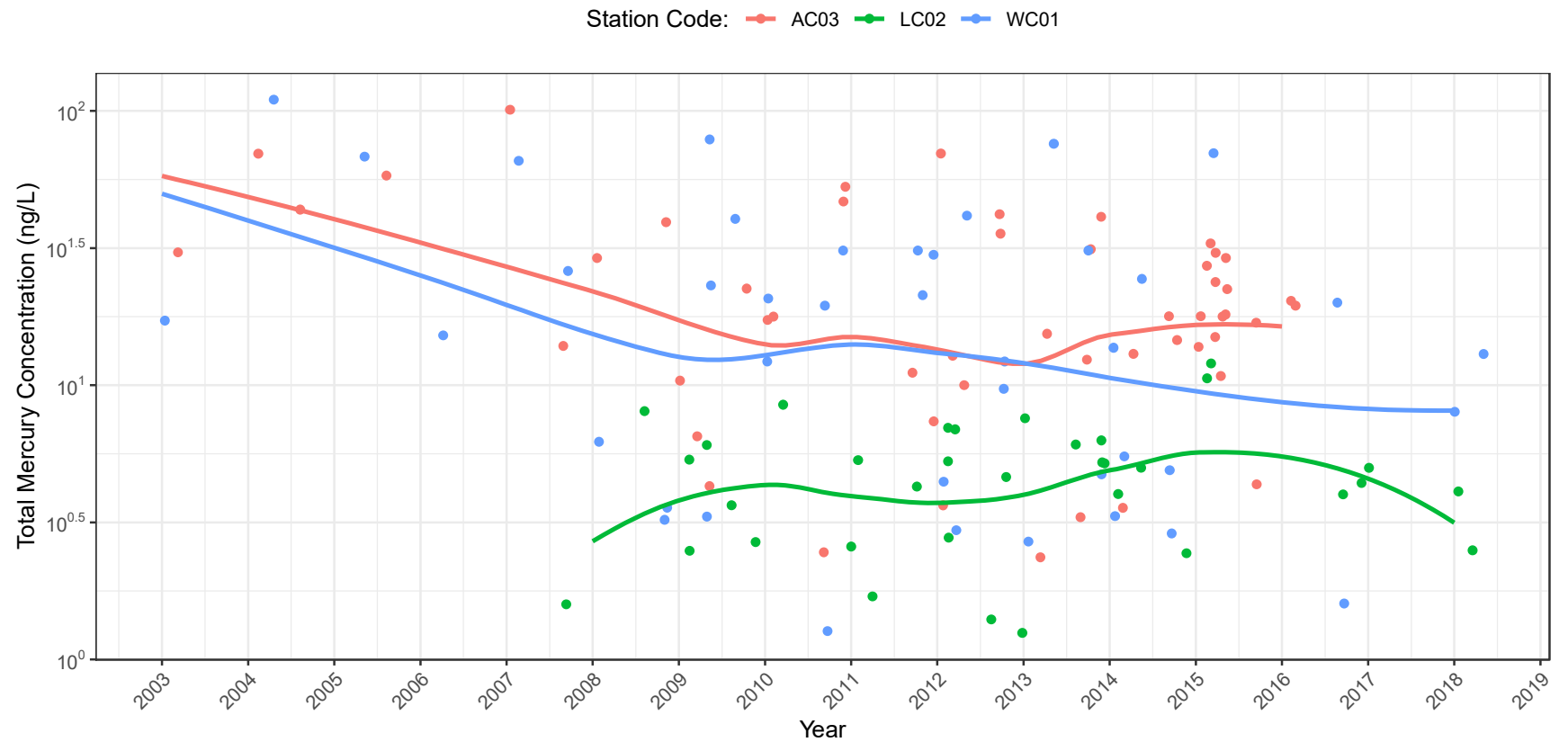
Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
LC02	Dry	1	100.0%	Insufficient Detected Data								0.08	0.08
	Wet	4	100.0%	0.11	0.05	0.43	0.06	0.15	0.10	0.30	0.09	0.05	0.15
	All	5	100.0%	0.10	0.04	0.41	0.07	0.14	0.09	0.25	0.08	0.05	0.15
WC01	Dry	1	100.0%	Insufficient Detected Data								0.27	0.27
	Wet	3	100.0%	0.15	0.09	0.61	0.05	0.25	0.13	0.46	0.14	0.09	0.25
	All	4	100.0%	0.18	0.10	0.54	0.08	0.27	0.16	0.54	0.17	0.09	0.27

Notes: [1] all concentration units are ng/L; [2] LC02 = Laguna Creek at West Stockton Boulevard ; [3] WC01 = Willow Creek at Blue Ravine Road

Table 34. Urban Tributary Total Methylmercury (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
AC03	Dry	6	100.0%	0.31	0.06	0.18	0.27	0.36	0.31	0.45	0.10	0.24	0.38
	Wet	40	100.0%	0.53	0.37	0.71	0.41	0.64	0.42	1.38	0.43	0.11	1.57
	All	46	100.0%	0.50	0.36	0.71	0.40	0.60	0.40	1.23	0.38	0.11	1.57
LC02	Dry	8	100.0%	0.24	0.15	0.63	0.13	0.34	0.20	0.71	0.22	0.08	0.49
	Wet	25	100.0%	0.16	0.07	0.44	0.14	0.19	0.15	0.33	0.10	0.05	0.35
	All	33	100.0%	0.18	0.10	0.54	0.15	0.22	0.16	0.39	0.12	0.05	0.49
WC01	Dry	8	100.0%	0.18	0.07	0.41	0.13	0.23	0.16	0.39	0.12	0.09	0.27
	Wet	30	96.7%	0.37	0.29	0.78	0.27	0.48	0.28	1.17	0.35	0.07	1.11
	All	38	97.4%	0.33	0.27	0.82	0.24	0.42	0.25	0.97	0.29	0.07	1.11

Notes: [1] all concentration units are ng/L; [2] AC03 = Arcade Creek at Watt; [3] LC02 = Laguna Creek at West Stockton Boulevard; [4] WC01 = Willow Creek at Blue Ravine Road



Notes: Old development averages and best-fit smoothed (black) line based on Arcade Creek at Watt (AC03) annual averages. New development and best-fit smoothed (green) line based on Willow Creek at Blue Ravine Road (WC03) and Laguna Creek at West Stockton Boulevard data.

Figure 15. Total Mercury Concentrations in Urban Tributary Monitoring at Current Characterization Stations (2003-2019)

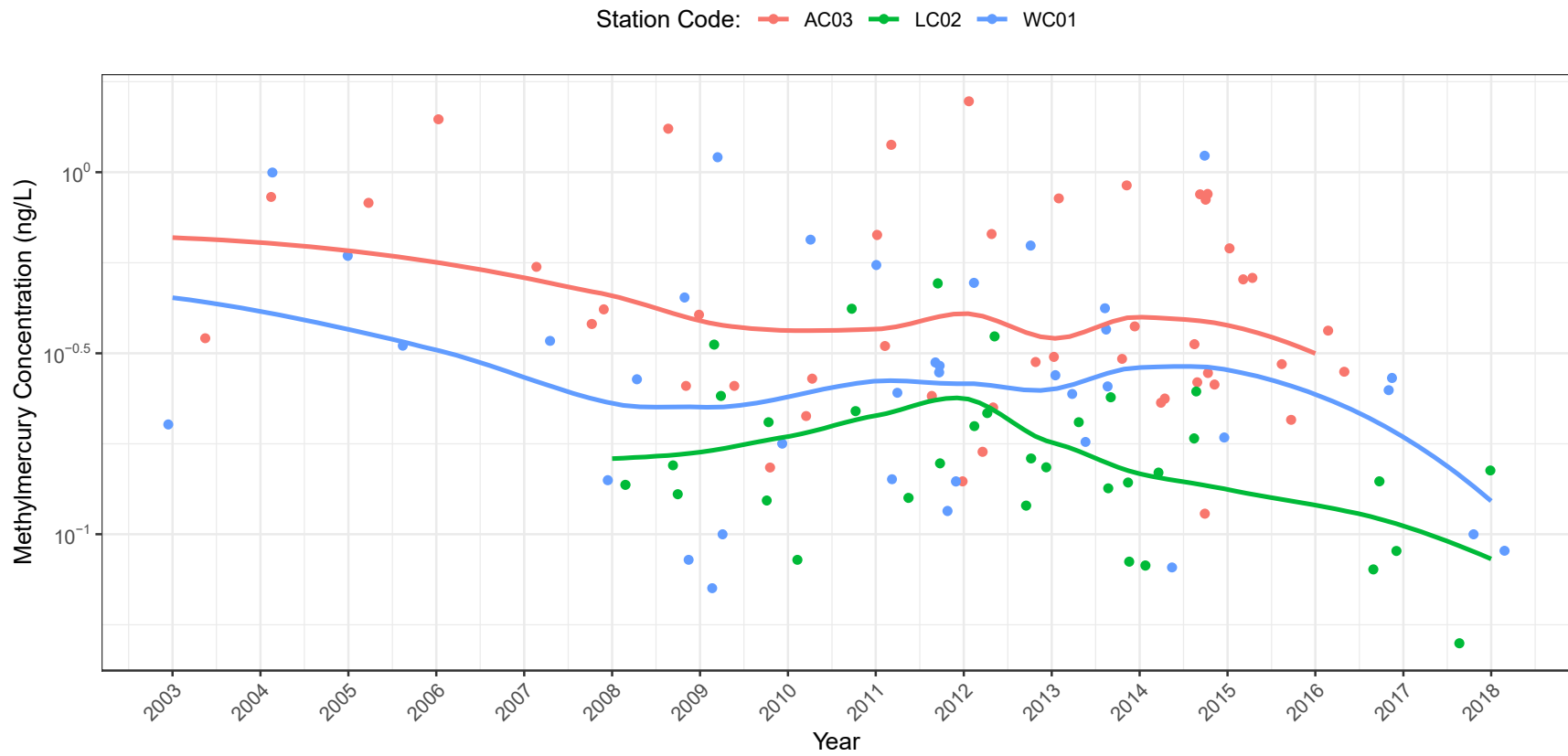


Figure 16. Total Methylmercury Concentrations in Urban Tributary Monitoring at Current Characterization Stations (1990-2019)

5.2 PYRETHROID PESTICIDES

Summary statistics for pyrethroid pesticides for the three urban tributary sites, Arcade Creek at Watt Avenue (AC03), Laguna Creek at West Stockton Boulevard (LC02), and Willow Creek at Blue Ravine Road (WC01), are shown in tables **Table 35** through **Table 46**. Bifenthrin, cyfluthrin, cypermethrin, esfenvalerate, lambda-cyhalothrin, and permethrin, are the six individual pyrethroids that are included in this analysis. Additionally, **Table 47** through **Table 50** include statistics for dissolved and total organic carbon. Organic carbon is a component of the pyrethroid trigger limits in the Central Valley Pyrethroid TMDL and should be factored in when reviewing pyrethroid results. Each set of tables includes a summary for data that was collected during the current permit term (October 2016 through October 2019) and the historical data set (1990 through 2019). Arcade Creek was not sampled during the current permit term, therefore, there are no summary statistics for that site in the current permit term tables.

Time series plots for the urban tributary monitoring locations are provided in **Figure 17** through **Figure 22**. Best-fit smoothed lines are provided to visually examine trends at each of the sites, but are not robust statistical evaluations of trends. Future evaluations may examine grouping sites together, especially if site specific conditions (i.e., controls and other management factors present in the tributary drainage) are identified as effective control strategies.

The concentration goal unit (CGU) is defined in the Central Valley Pyrethroid TMDL as the summation of the ratio of each of the six individual pyrethroids to the effect level (see **Figure 2**). The CGU (>1) triggers management actions. Time series plots for the dissolved acute and chronic CGU in urban tributaries is provided in **Figure 23** and **Figure 24**, respectively. The dissolved concentration was calculated using the Central Valley Pyrethroid TMDL ambient partition coefficient and organic carbon concentration based equation to estimate aquatic life exposure concentration (see **Equation 1**).

Table 35. Urban Tributary Bifenthrin (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Bifenthrin (ng/L)													
LC02	Dry	1	100%	Insufficient Detected Data								NA	NA
	Wet	3	100%	5.57	3.62	0.65	1.47	9.66	4.82	23.74	6.76	2.6	9.6
	All	4	100%	4.50	3.65	0.81	0.93	8.07	3.48	24.19	6.13	1.3	9.6
WC01	Dry	1	0%	Insufficient Detected Data								NA	NA
	Wet	3	100%	0.60	0.10	0.17	0.49	0.71	0.59	0.90	0.20	0.5	0.7
	All	4	75%	0.54	0.14	0.26	0.40	0.68	0.53	0.90	0.23	0.5	0.7

Notes: [1] all concentration units are ng/L; [2] LC02 = Laguna Creek at West Stockton Boulevard ; [3] WC01 = Willow Creek at Blue Ravine Road

Table 36. Urban Tributary Bifenthrin (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Bifenthrin (ng/L)													
AC03	Dry	6	67%	0.94	1.19	1.26	-0.01	1.89	0.42	8.06	1.29	0.3	3.2
	Wet	20	100%	25.50	26.89	1.05	13.71	37.28	16.89	88.85	24.82	3.6	107
	All	26	92%	19.86	25.69	1.29	9.98	29.73	8.34	130.57	23.06	0.3	107
LC02	Dry	8	63%	1.04	0.44	0.42	0.74	1.35	0.96	2.20	0.66	0.9	1.8
	Wet	18	100%	8.63	6.82	0.79	5.48	11.78	6.84	23.47	7.22	2.6	28
	All	26	88%	6.29	6.67	1.06	3.72	8.85	3.72	27.06	6.75	0.9	28
WC01	Dry	7	29%	Insufficient Detected Data								0.1	0.2
	Wet	20	80%	1.29	1.59	1.23	0.60	1.99	0.84	4.33	1.22	0.5	7.4
	All	27	67%	0.97	1.47	1.51	0.42	1.52	0.44	4.72	0.99	0.1	7.4

Notes: [1] all concentration units are ng/L; [2] AC03 = Arcade Creek at Watt; [3] LC02 = Laguna Creek at West Stockton Boulevard; [4] WC01 = Willow Creek at Blue Ravine Road

Table 37. Urban Tributary Cyfluthrin (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Cyfluthrin (ng/L)													
LC02	Dry	1	0%	Insufficient Detected Data								NA	NA
	Wet	3	67%									0.4	3.2
	All	4	50%									0.4	3.2
WC01	Dry	1	0%	Insufficient Detected Data								NA	NA
	Wet	3	0%									NA	NA
	All	4	0%									NA	NA

Notes: [1] all concentration units are ng/L; [2] LC02 = Laguna Creek at West Stockton Boulevard ; [3] WC01 = Willow Creek at Blue Ravine Road

Table 38. Urban Tributary Cyfluthrin (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Cyfluthrin (ng/L)													
AC03	Dry	6	17%	Insufficient Detected Data								0.3	0.3
	Wet	20	85%	3.14	3.85	1.22	1.46	4.83	1.62	14.35	3.30	0.3	15
	All	26	69%	2.44	3.60	1.47	1.06	3.83	0.87	14.48	2.48	0.3	15
LC02	Dry	8	0%	Insufficient Detected Data								NA	NA
	Wet	18	78%	1.47	1.35	0.92	0.84	2.09	0.86	6.50	1.60	0.3	3.7
	All	26	54%	1.06	1.28	1.21	0.56	1.55	0.45	5.38	1.09	0.3	3.7
WC01	Dry	7	0%	Insufficient Detected Data								NA	NA
	Wet	20	25%	0.35	1.02	2.94	-0.10	0.79	0.04	2.06	0.18	0.3	4.6
	All	27	19%	0.26	0.89	3.41	-0.07	0.59	0.02	1.42	0.11	0.3	4.6

Notes: [1] all concentration units are ng/L; [2] AC03 = Arcade Creek at Watt; [3] LC02 = Laguna Creek at West Stockton Boulevard; [4] WC01 = Willow Creek at Blue Ravine Road

Table 39. Urban Tributary Cypermethrin (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Cypermethrin (ng/L)													
LC02	Dry	1	0%	Insufficient Detected Data								NA	NA
	Wet	3	67%									0.7	1
	All	4	50%									0.7	1
WC01	Dry	1	0%	Insufficient Detected Data								NA	NA
	Wet	3	0%									NA	NA
	All	4	0%									NA	NA

Notes: [1] all concentration units are ng/L; [2] LC02 = Laguna Creek at West Stockton Boulevard ; [3] WC01 = Willow Creek at Blue Ravine Road

Table 40. Urban Tributary Cypermethrin (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Cypermethrin (ng/L)													
AC03	Dry	6	17%	Insufficient Detected Data								0.4	0.4
	Wet	20	90%	16.63	62.98	3.79	-10.97	44.23	2.27	24.15	5.13	0.7	284
	All	26	73%	12.83	55.35	4.31	-8.45	34.11	1.19	24.72	3.78	0.4	284
LC02	Dry	8	0%	Insufficient Detected Data								NA	NA
	Wet	18	78%	1.17	1.05	0.90	0.69	1.66	0.86	3.61	1.07	0.5	3.9
	All	26	54%	0.87	0.98	1.12	0.50	1.25	0.53	3.26	0.86	0.5	3.9
WC01	Dry	7	0%	Insufficient Detected Data								NA	NA
	Wet	20	15%	0.15	0.19	1.26	0.07	0.23	0.08	0.61	0.15	0.3	0.7
	All	27	11%	0.12	0.17	1.40	0.06	0.18	0.06	0.51	0.12	0.3	0.7

Notes: [1] all concentration units are ng/L; [2] AC03 = Arcade Creek at Watt; [3] LC02 = Laguna Creek at West Stockton Boulevard; [4] WC01 = Willow Creek at Blue Ravine Road

Table 41. Urban Tributary Esfenvalerate (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Esfenvalerate (ng/L)													
LC02	Dry	1	0%	Insufficient Detected Data								NA	NA
	Wet	3	0%										
	All	4	0%										
WC01	Dry	1	0%	Insufficient Detected Data								NA	NA
	Wet	3	0%										
	All	4	0%										

Notes: [1] all concentration units are ng/L; [2] LC02 = Laguna Creek at West Stockton Boulevard ; [3] WC01 = Willow Creek at Blue Ravine Road

Table 42. Urban Tributary Esfenvalerate (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Esfenvalerate (ng/L)													
AC03	Dry	6	0%	Insufficient Detected Data								NA	NA
	Wet	21	52%	0.63	1.19	1.88	0.12	1.14	0.25	2.80	0.58	0.2	5.5
	All	27	41%	0.50	1.08	2.17	0.09	0.90	0.15	2.39	0.42	0.2	5.5
LC02	Dry	8	0%	Insufficient Detected Data								NA	NA
	Wet	18	22%	0.43	1.24	2.86	-0.14	1.01	0.01	3.31	0.12	0.2	5.1
	All	26	15%	0.30	1.04	3.47	-0.10	0.70	0.00	1.75	0.05	0.2	5.1
WC01	Dry	7	0%	Insufficient Detected Data								NA	NA
	Wet	21	10%										
	All	28	7%										

Notes: [1] all concentration units are ng/L; [2] AC03 = Arcade Creek at Watt; [3] LC02 = Laguna Creek at West Stockton Boulevard; [4] WC01 = Willow Creek at Blue Ravine Road

Table 43. Urban Tributary Lambda-Cyhalothrin (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
L-Cyhalothrin (ng/L)													
LC02	Dry	1	0%	Insufficient Detected Data								NA	NA
	Wet	3	67%									0.4	0.9
	All	4	50%									0.4	0.9
WC01	Dry	1	0%	Insufficient Detected Data								NA	NA
	Wet	3	0%									NA	NA
	All	4	0%									NA	NA

Notes: [1] all concentration units are ng/L; [2] LC02 = Laguna Creek at West Stockton Boulevard ; [3] WC01 = Willow Creek at Blue Ravine Road

Table 44. Urban Tributary Lambda-Cyhalothrin (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
L-Cyhalothrin (ng/L)													
AC03	Dry	6	0%	Insufficient Detected Data								NA	NA
	Wet	20	70%	0.74	1.06	1.42	0.28	1.21	0.48	2.11	0.62	0.3	5
	All	26	54%	0.59	0.96	1.64	0.22	0.96	0.32	1.96	0.52	0.3	5
LC02	Dry	8	0%	Insufficient Detected Data								NA	NA
	Wet	18	78%	0.79	1.04	1.32	0.31	1.27	0.48	2.62	0.72	0.2	4.6
	All	26	54%	0.57	0.92	1.62	0.21	0.92	0.27	2.34	0.54	0.2	4.6
WC01	Dry	7	0%	Insufficient Detected Data								NA	NA
	Wet	20	20%	0.14	0.16	1.11	0.07	0.21	0.09	0.53	0.14	0.2	0.6
	All	27	15%	0.12	0.14	1.24	0.06	0.17	0.07	0.45	0.12	0.2	0.6

Notes: [1] all concentration units are ng/L; [2] AC03 = Arcade Creek at Watt; [3] LC02 = Laguna Creek at West Stockton Boulevard; [4] WC01 = Willow Creek at Blue Ravine Road

Table 45. Urban Tributary Permethrin (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Permethrin (ng/L)													
LC02	Dry	1	0%	Insufficient Detected Data								NA	NA
	Wet	3	0%										
	All	4	0%										
WC01	Dry	1	0%	Insufficient Detected Data								NA	NA
	Wet	3	0%										
	All	4	0%										

Notes: [1] all concentration units are ng/L; [2] LC02 = Laguna Creek at West Stockton Boulevard ; [3] WC01 = Willow Creek at Blue Ravine Road

Table 46. Urban Tributary Permethrin (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Permethrin (ng/L)													
AC03	Dry	5	0%	Insufficient Detected Data								NA	NA
	Wet	20	65%	8.74	8.40	0.96	5.05	12.42	5.64	32.89	8.89	2.3	33
	All	25	52%	7.09	8.15	1.15	3.90	10.29	3.80	30.81	7.35	2.3	33
LC02	Dry	6	0%	Insufficient Detected Data								NA	NA
	Wet	18	33%	4.39	7.09	1.62	1.11	7.66	1.67	22.61	4.29	3.4	29
	All	24	25%	3.39	6.35	1.87	0.85	5.93	1.03	18.00	3.01	3.4	29
WC01	Dry	6	0%	Insufficient Detected Data								NA	NA
	Wet	18	0%										
	All	24	0%										

Notes: [1] all concentration units are ng/L; [2] AC03 = Arcade Creek at Watt; [3] LC02 = Laguna Creek at West Stockton Boulevard; [4] WC01 = Willow Creek at Blue Ravine Road

Table 47. Urban Tributary Dissolved Organic Carbon (mg/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Dissolved Organic Carbon (mg/L)													
LC02	Dry	1	100%	Insufficient Detected Data								NA	NA
	Wet	3	100%	11.83	7.09	0.60	3.81	19.86	10.61	36.90	11.33	7.2	20
	All	4	100%	12.38	5.89	0.48	6.60	18.15	11.37	32.72	10.17	7.2	20
WC01	Dry	1	100%	Insufficient Detected Data								NA	NA
	Wet	3	100%	4.13	2.06	0.50	1.81	6.46	3.84	10.71	3.33	2.8	6.5
	All	4	100%	3.68	1.91	0.52	1.80	5.55	3.38	8.80	2.72	2.3	6.5

Notes: [1] all concentration units are mg/L; [2] LC02 = Laguna Creek at West Stockton Boulevard ; [3] WC01 = Willow Creek at Blue Ravine Road

Table 48. Urban Tributary Dissolved Organic Carbon (mg/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Dissolved Organic Carbon (mg/L)													
AC03	Dry	8	100%	10.00	3.07	0.31	7.87	12.13	9.67	15.92	3.98	7.1	17
	Wet	44	100%	18.81	19.92	1.06	12.93	24.70	13.23	50.94	15.38	4.6	110
	All	52	100%	17.46	18.60	1.07	12.40	22.51	12.61	43.81	13.45	4.6	110
LC02	Dry	7	100%	10.91	1.73	0.16	9.63	12.19	10.80	14.81	2.80	8.7	14
	Wet	23	100%	10.97	6.30	0.57	8.40	13.55	9.72	22.54	6.84	4.8	30
	All	30	100%	10.96	5.54	0.51	8.98	12.94	9.96	20.93	6.16	4.8	30
WC01	Dry	10	90%	2.39	0.24	0.10	2.24	2.54	2.38	2.86	0.35	2.2	2.9
	Wet	37	100%	6.48	4.69	0.72	4.96	7.99	5.25	15.46	4.80	2.3	23
	All	47	98%	5.58	4.50	0.81	4.30	6.87	4.38	13.54	4.20	2.2	23

Notes: [1] all concentration units are mg/L; [2] AC03 = Arcade Creek; [3] LC02 = Laguna Creek at West Stockton Boulevard; [4] WC01 = Willow Creek at Blue Ravine Road

Table 49. Urban Tributary Total Organic Carbon (mg/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

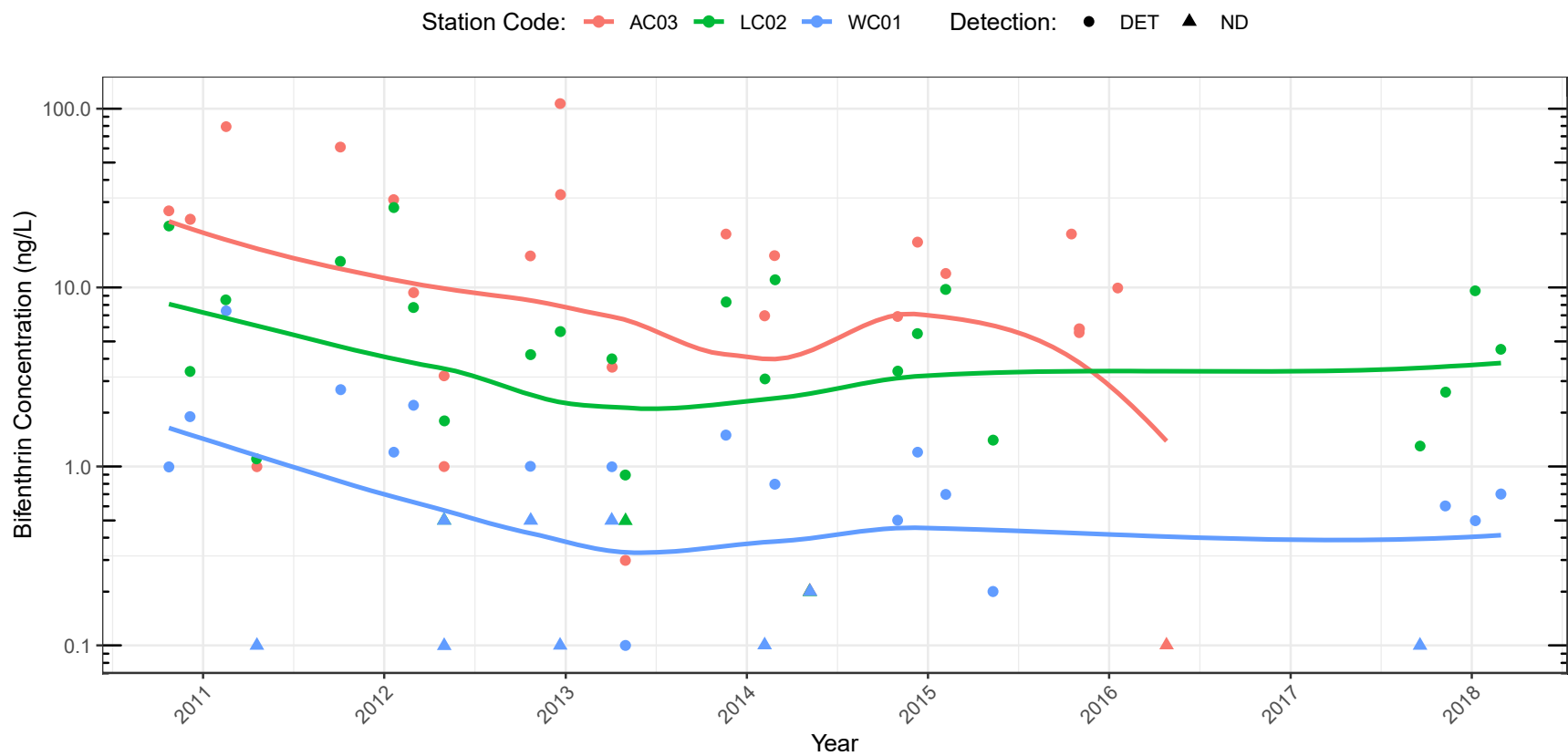
Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Total Organic Carbon (mg/L)													
LC02	Dry	1	100%	Insufficient Detected Data								NA	NA
	Wet	3	100%	11.60	7.31	0.63	3.33	19.87	10.28	39.02	11.81	6.7	20
	All	4	100%	11.70	5.97	0.51	5.85	17.55	10.68	31.65	9.83	6.7	20
WC01	Dry	1	100%	Insufficient Detected Data								NA	NA
	Wet	3	100%	4.33	2.14	0.49	1.91	6.75	4.03	10.93	3.39	3.0	6.8
	All	4	100%	3.85	2.00	0.52	1.89	5.81	3.54	9.16	2.83	2.4	6.8

Notes: [1] all concentration units are mg/L; [2] LC02 = Laguna Creek at West Stockton Boulevard ; [3] WC01 = Willow Creek at Blue Ravine Road

Table 50. Urban Tributary Total Organic Carbon (mg/L) Summary Statistics for Historical Sample Collection (1990-2019)

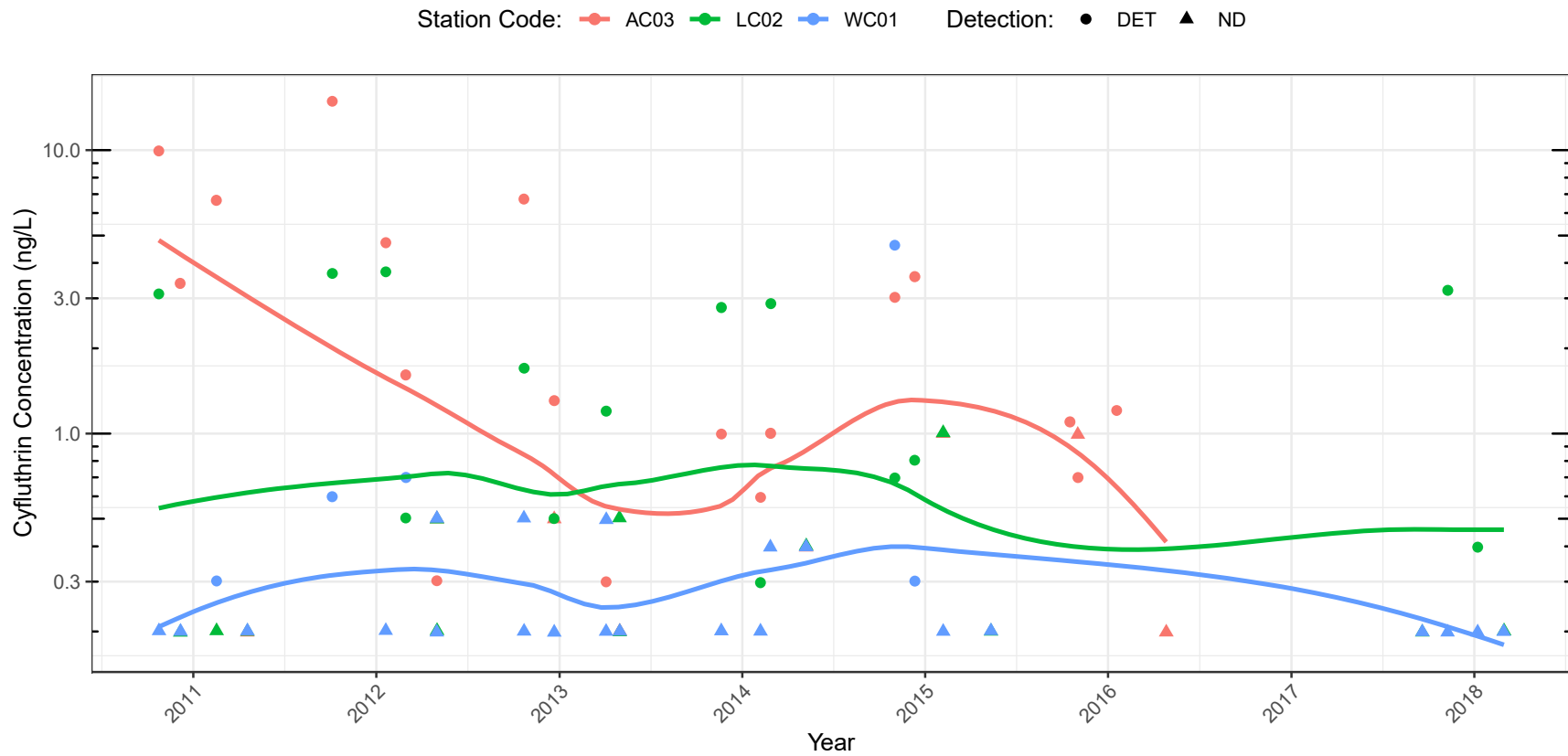
Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Total Organic Carbon (mg/L)													
AC03	Dry	8	100%	10.65	3.02	0.28	8.56	12.74	10.33	16.78	4.13	7.9	17
	Wet	44	100%	19.13	19.91	1.04	13.25	25.02	13.36	55.18	16.43	3.9	110
	All	52	100%	17.83	18.58	1.04	12.78	22.88	12.85	47.53	14.45	3.9	110
LC02	Dry	7	100%	12.10	2.78	0.23	10.04	14.16	11.87	17.31	3.69	9.7	18
	Wet	24	100%	11.65	6.42	0.55	9.08	14.22	10.30	24.90	7.62	4.7	30
	All	31	100%	11.75	5.76	0.49	9.72	13.78	10.63	23.43	7.01	4.7	30
WC01	Dry	11	100%	3.24	1.96	0.60	2.08	4.39	2.94	5.58	1.56	2	9
	Wet	39	100%	6.60	4.77	0.72	5.10	8.10	5.10	18.65	5.68	0.21	23
	All	50	100%	5.86	4.52	0.77	4.61	7.11	4.52	15.58	4.79	0.21	23

Notes: [1] all concentration units are mg/L; [2] AC03 = Arcade Creek; [3] LC02 = Laguna Creek at West Stockton Boulevard; [4] WC01 = Willow Creek at Blue Ravine Road



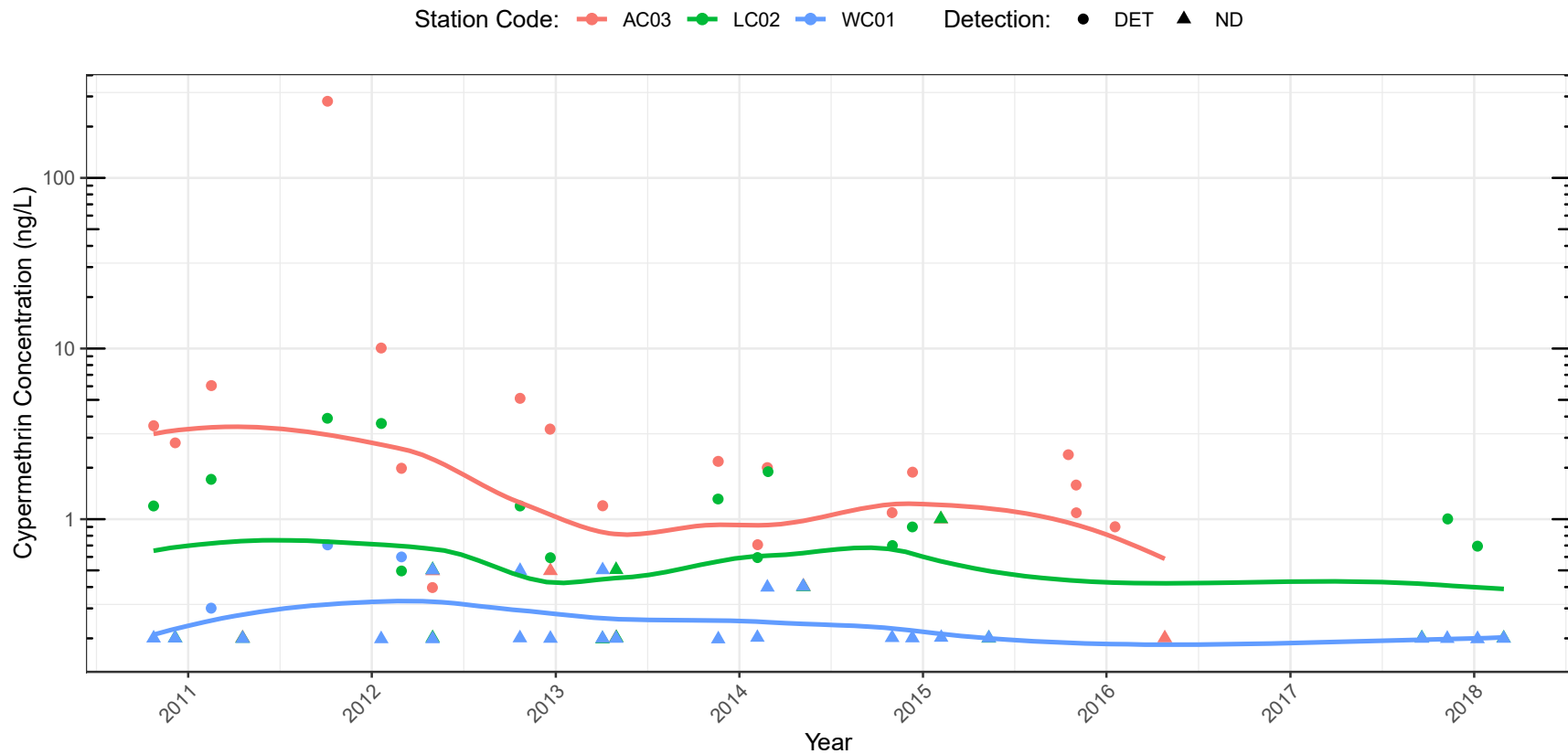
Notes: [1] DET = detected value; [2] ND = not detected indicated detection limit; [3] AC03 = Arcade Creek at Watt; [4] LC02 = Laguna Creek at West Stockton Boulevard; [5] WC01 = Willow Creek at Blue Ravine Road

Figure 17. Bifenthrin Concentrations in Urban Tributary Monitoring at Current Characterization Stations (2010-2019)



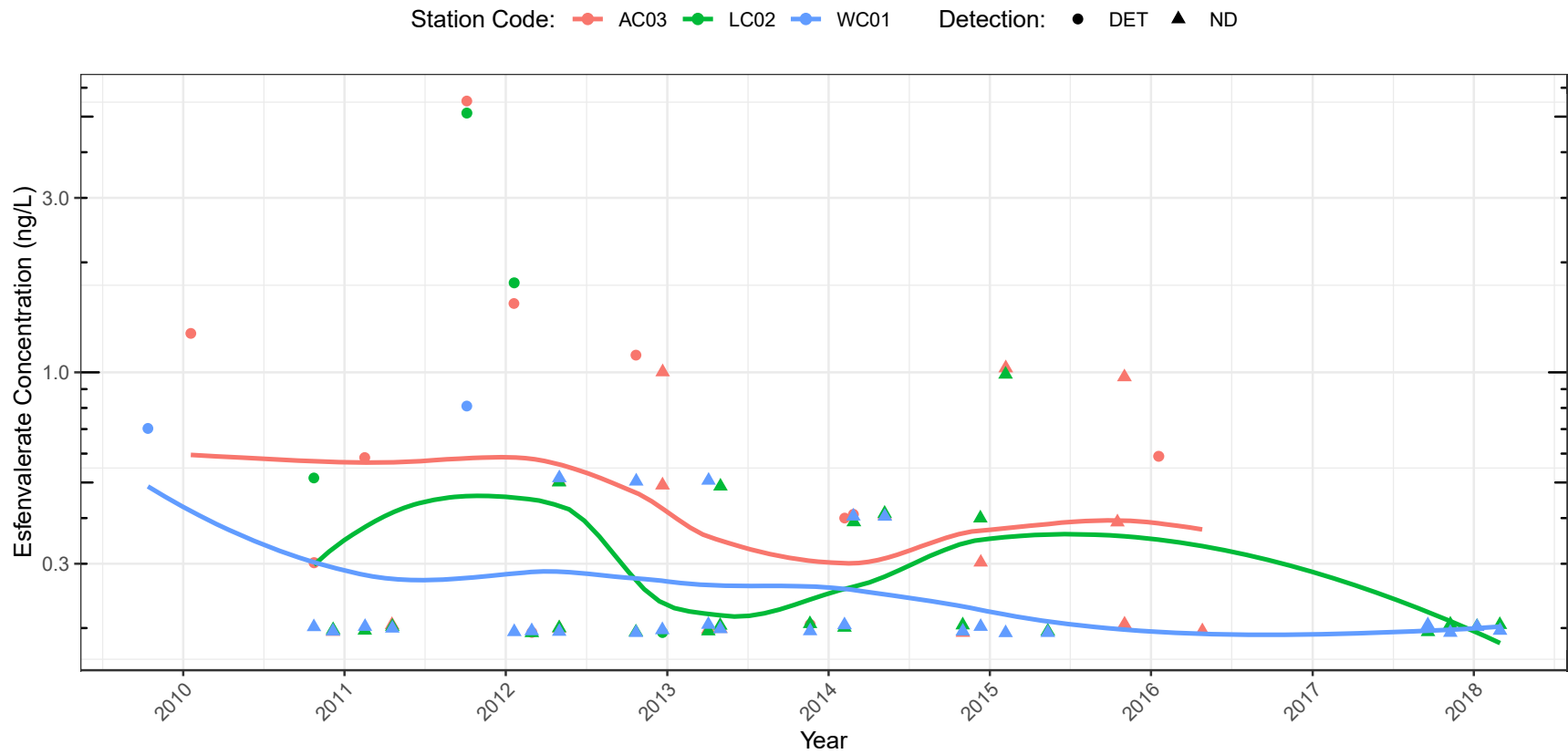
Notes: [1] DET = detected value; [2] ND = not detected indicated detection limit; [3] AC03 = Arcade Creek at Watt; [4] LC02 = Laguna Creek at West Stockton Boulevard; [5] WC01 = Willow Creek at Blue Ravine Road

Figure 18. Cyfluthrin Concentrations in Urban Tributary Monitoring at Current Characterization Stations (2010-2019)



Notes: [1] DET = detected value; [2] ND = not detected indicated detection limit; [3] AC03 = Arcade Creek at Watt; [4] LC02 = Laguna Creek at West Stockton Boulevard; [5] WC01 = Willow Creek at Blue Ravine Road

Figure 19. Cypermethrin Concentrations in Urban Tributary Monitoring at Current Characterization Stations (2010-2019)



Notes: [1] DET = detected value; [2] ND = not detected indicated detection limit; [3] AC03 = Arcade Creek at Watt; [4] LC02 = Laguna Creek at West Stockton Boulevard; [5] WC01 = Willow Creek at Blue Ravine Road

Figure 20. Esfenvalerate Concentrations in Urban Tributary Monitoring at Current Characterization Stations (2010-2019)

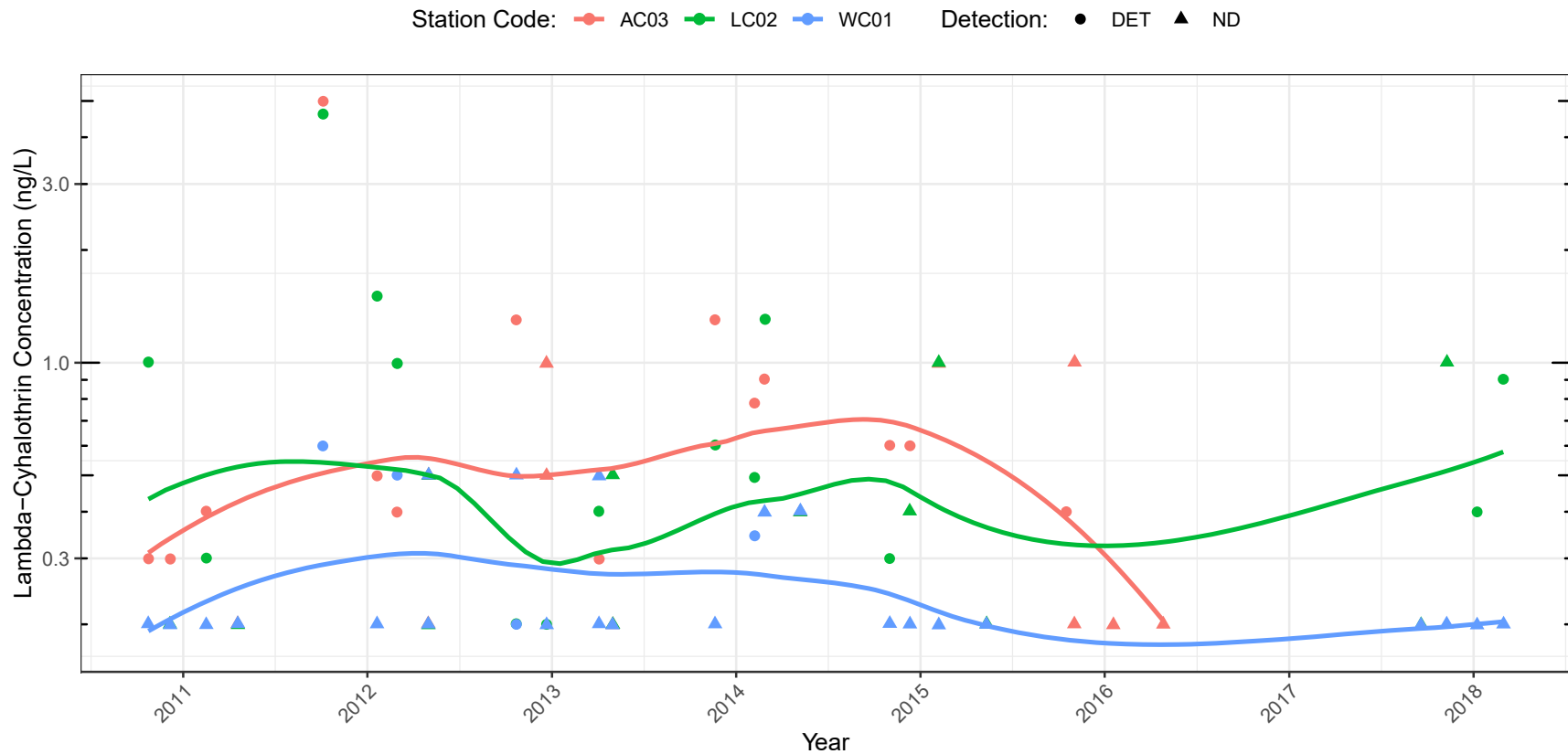
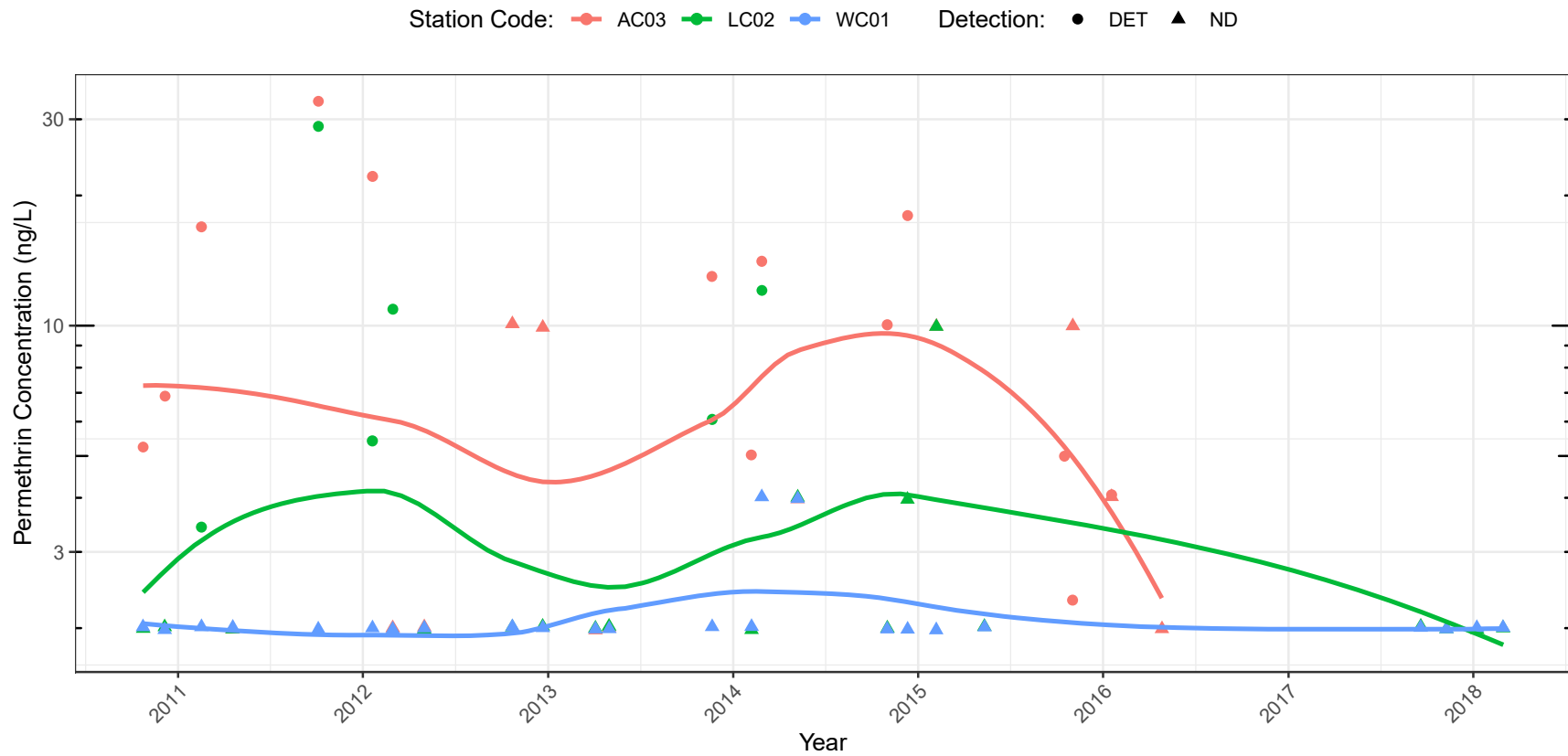
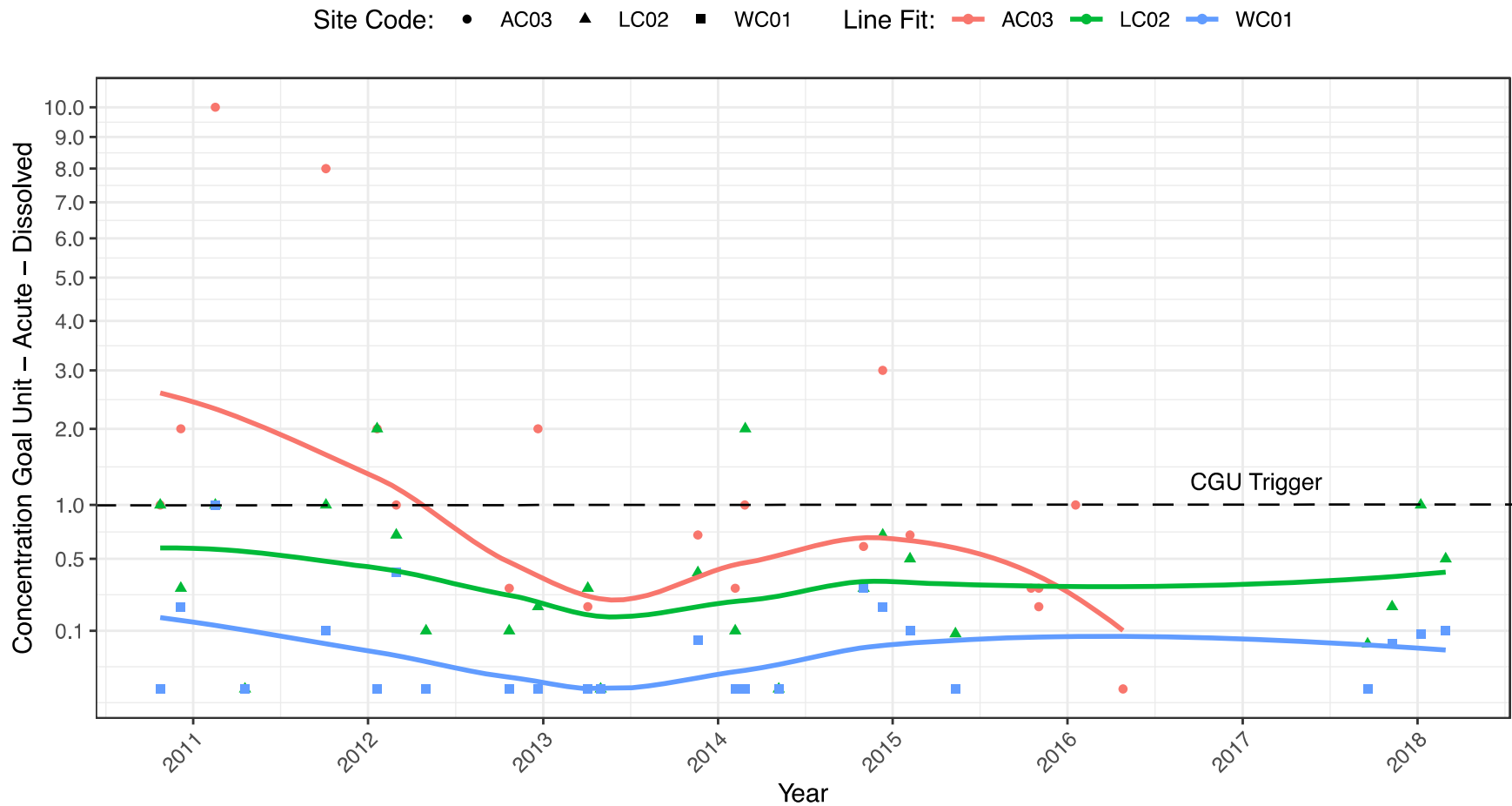


Figure 21. Lambda-Cyhalothrin Concentrations in Urban Tributary Monitoring at Current Characterization Stations (2010-2019)



Notes: [1] DET = detected value; [2] ND = not detected indicated detection limit; [3] AC03 = Arcade Creek at Watt; [4] LC02 = Laguna Creek at West Stockton Boulevard; [5] WC01 = Willow Creek at Blue Ravine Road

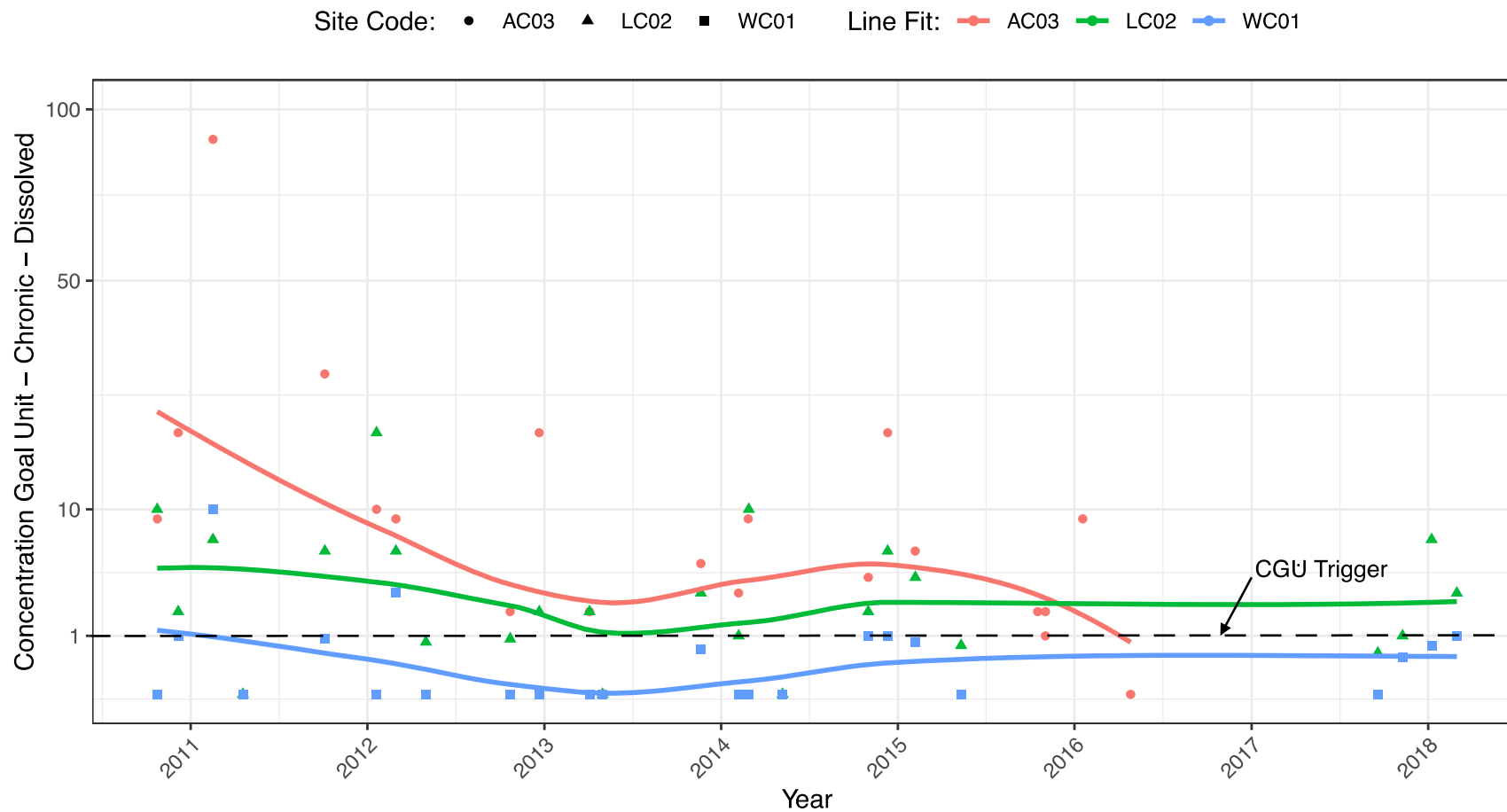
Figure 22. Permethrin Concentrations in Urban Tributary Monitoring at Current Characterization Stations (2010-2019)



Notes: AC03 = Arcade Creek at Watt; LC02 = Laguna Creek at West Stockton Boulevard; WC01 = Willow Creek at Blue Ravine Road; Response variable (CGU) scale is square root transformed.

Figure 23. Dissolved Acute Concentration Goal Unit at Current Urban Tributary Monitoring Characterization Stations (2010-2019)

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Notes: AC03 = Arcade Creek at Watt; LC02 = Laguna Creek at West Stockton Boulevard; WC01 = Willow Creek at Blue Ravine Road; Response variable (CGU) scale is square root transformed.

Figure 24. Dissolved Chronic Concentration Goal Unit at Current Urban Tributary Monitoring Characterization Stations (2010-2019)

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5.3 LEGACY ORGANOPHOSPHATE PESTICIDES

Summary statistics for the OP pesticides, chlorpyrifos and diazinon, at the three urban tributary sites, Arcade Creek at Watt Avenue (AC03), Laguna Creek at West Stockton Boulevard (LC02), and Willow Creek at Blue Ravine Road (WC01), are shown in **Table 51** through **Table 54**. Each set of tables includes a summary for data that was collected during the current permit term (October 2016 through October 2019) and the historical data set (1990 through 2019). Arcade Creek was not sampled during the current permit term, therefore, there are no summary statistics for that site in the current permit term tables.

Time series plots are provided as **Figure 25** and **Figure 26**. The time series plots include best-fit smoothed lines that are fit to both detected concentrations and detection limits when samples were reported as not detected. Use of detection limits to represent concentrations bias the smoothed line fit high. Summary statistics in **Table 51** through **Table 54** consider values reported as not detected by using a regression on order statistics.

Table 51. Urban Tributary Chlorpyrifos (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Chlorpyrifos (µg/L)													
LC02	Dry	1	0	Insufficient Detected Data								NA	NA
	Wet	3	100.0%	0.00	0.00	1.21	0.00	0.01	0.00	0.05	0.01	0.0006	0.0082
	All	4	75.0%	0.00	0.00	1.47	0.00	0.01	0.00	0.05	0.00	0.0006	0.0082
WC01	Dry	1	0	Insufficient Detected Data								NA	NA
	Wet	3	33.3%									0.0009	0.0009
	All	4	25.0%									0.0009	0.0009

Notes: [1] all concentration units are µg/L; [2] LC02 = Laguna Creek at West Stockton Boulevard ; [3] WC01 = Willow Creek at Blue Ravine Road

Table 52. Urban Tributary Chlorpyrifos (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Chlorpyrifos (µg/L)													
AC03	Dry	184	59.2%	0.03	0.03	0.99	0.02	0.03	0.01	0.13	0.02	0.0003	0.089
	Wet	76	72.4%	0.03	0.02	0.60	0.02	0.03	0.02	0.09	0.03	0.0003	0.065
	All	108	50.0%	0.02	0.03	1.29	0.02	0.03	0.00	0.15	0.02	0.0005	0.089
LC02	Dry	56	42.9%	0.00	0.01	3.03	0.00	0.01	0.00	0.01	0.00	0.0002	0.0631
	Wet	15	20.0%	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.0002	0.0006
	All	41	51.2%	0.00	0.01	2.60	0.00	0.01	0.00	0.02	0.00	0.0006	0.0631
WC01	Dry	91	14.3%	0.00	0.00	1.03	0.00	0.00	0.00	0.00	0.00	0.0002	0.0035
	Wet	20	10.0%	Insufficient Detected Data								0.0003	0.0012
	All	71	15.5%	0.00	0.00	1.01	0.00	0.00	0.00	0.00	0.00	0.0002	0.0035

Notes: [1] all concentration units are µg/L; [2] AC03 = Arcade Creek at Watt; [3] LC02 = Laguna Creek at West Stockton Boulevard; [4] WC01 = Willow Creek at Blue Ravine Road

Table 53. Urban Tributary Diazinon (ng/L) Summary Statistics for Current Permit Term (October 2016 – October 2019)

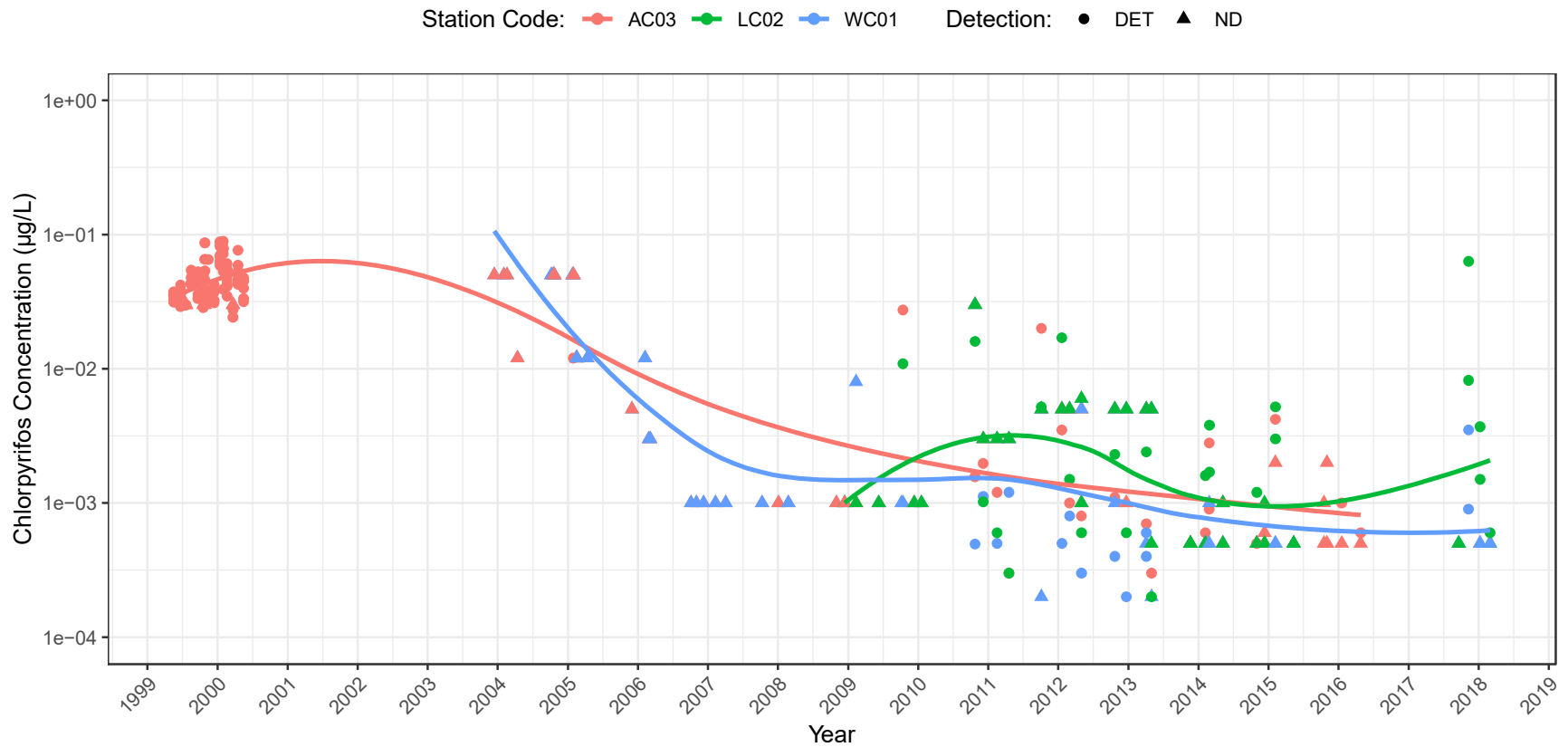
Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Diazinon (µg/L)													
LC02	Dry	1	0	Insufficient Detected Data								NA	NA
	Wet	3	0.0%										
	All	4	0.0%										
WC01	Dry	1	0	Insufficient Detected Data								NA	NA
	Wet	3	0.0%										
	All	4	0.0%										

Notes: [1] all concentration units are µg/L; [2] LC02 = Laguna Creek at West Stockton Boulevard ; [3] WC01 = Willow Creek at Blue Ravine Road

Table 54. Urban Tributary Diazinon (ng/L) Summary Statistics for Historical Sample Collection (1990-2019)

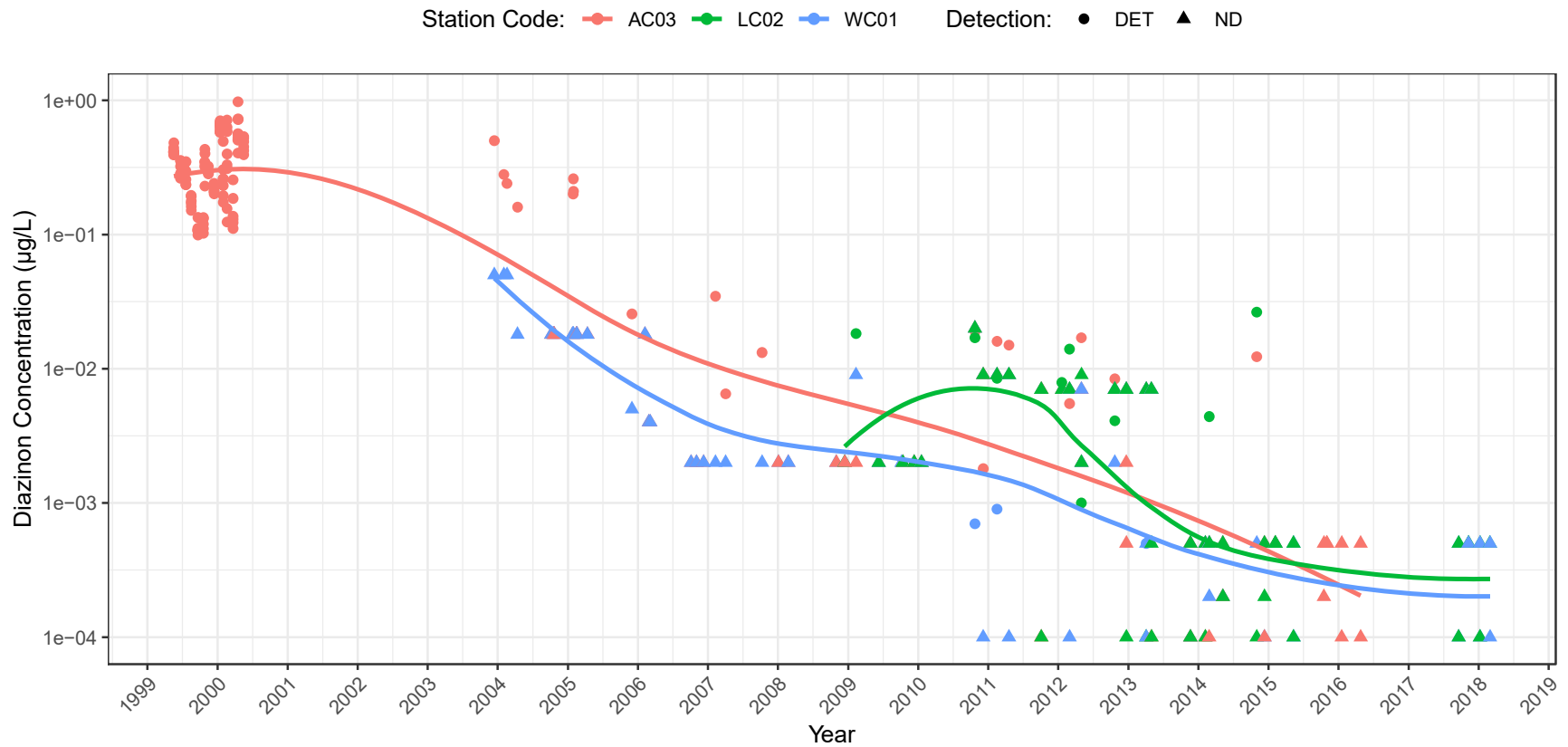
Site	Event Type	n	Percent Detected	Mean	Standard Deviation	Coefficient of Variation	Lower 95% Confidence Limit about Mean	Upper 95% Confidence Limit about Mean	50th percentile	95th percentile	Inter Quartile Range	Minimum Detected Value	Maximum Detected Value
Diazinon (µg/L)													
AC03	Dry	184	63.6%	0.21	0.21	1.03	0.18	0.24	0.09	0.94	0.20	0.0018	0.974
	Wet	74	82.4%	0.21	0.14	0.68	0.18	0.24	0.15	0.66	0.19	0.0065	0.536
	All	110	50.9%	0.20	0.25	1.23	0.16	0.25	0.06	1.15	0.18	0.0018	0.974
LC02	Dry	56	17.9%	0.02	0.13	6.75	-0.02	0.05	0.00	0.03	0.00	0.001	1
	Wet	15	6.7%	Insufficient Detected Data								0.001	0.001
	All	41	22.0%	0.03	0.16	5.76	-0.02	0.07	0.00	0.05	0.00	0.0041	1
WC01	Dry	91	3.3%	Insufficient Detected Data								0.0005	0.0009
	Wet	20	0.0%									NA	NA
	All	71	4.2%									0.0005	0.0009

Notes: [1] all concentration units are µg/L; [2] AC03 = Arcade Creek at Watt; [3] LC02 = Laguna Creek at West Stockton Boulevard; [4] WC01 = Willow Creek at Blue Ravine Road



Notes: [1] DET = detected value; [2] ND = not detected indicated detection limit; [3] AC03 = Arcade Creek at Watt; [4] LC02 = Laguna Creek at West Stockton Boulevard; [5] WC01 = Willow Creek at Blue Ravine Road

Figure 25. Chlorpyrifos Concentrations in Urban Tributary Monitoring at Current Characterization Stations (1999-2019)



Notes: [1] DET = detected value; [2] ND = not detected indicated detection limit; [3] AC03 = Arcade Creek at Watt; [4] LC02 = Laguna Creek at West Stockton Boulevard; [5] WC01 = Willow Creek at Blue Ravine Road

Figure 26. Diazinon Concentrations in Urban Tributary Monitoring at Current Characterization Stations (1999-2019)

6 Special Studies

The Partnership performs additional monitoring and special studies as needed to support future monitoring programs (i.e., pilot studies), program effectiveness, and as-needed to support regulatory or investigative programs. In 2018-2019 the Partnership performed a bacteria source tracking pilot study to evaluate tools and methods available for future work.

6.1 MICROBIAL SOURCE TRACKING

The American River is listed as impaired due to elevated *E. coli*, though the sources of the impairment during dry weather are not well quantified or attributed. The Partnership is participating in the Regional Water Board's Lower American River Elevated *E. coli* Investigation (LAMR *E. coli* Investigation) with a number of stakeholders. Bacteria is a Category 2 Priority Water Quality Constituent (PWQC). While specific monitoring has not been required, it is expected that the SQIP Monitoring Study Design will include indicator bacteria (*E. coli*).

In order to inform the Regional Water Board's *E. coli* Investigation, and the development of the Monitoring Study Design, an initial Microbial Source Tracking (MST) Pilot Study was conducted during fiscal year 2018/2019 to collect and analyze additional *E. coli* and MST data as part of the Discharge Characterization Monitoring.

The objectives of this MST Pilot Study were to generally characterize urban runoff *E. coli* concentrations, estimate the contribution of human and other sources to fecal contamination in urban runoff, and to identify obvious control opportunities for further assessment. The study approach, monitoring events, and results are described in this section.

6.1.1 Monitoring Parameters and Events

The following four urban runoff discharge sites were monitored:

- North Natomas at Detention Basin No. 4 (UR5);
- Strong Ranch Slough (UR2S);
- Sump 111 (UR3); and
- Sump 152 – Monitored during dry events due to the possibility of horse contribution from Cal Expo.

The monitored parameters are shown in **Table 55**. Monitoring was conducted over six events – three wet weather and three dry events, shown in **Table 56**.

Table 55. Monitored Parameters for Microbial Source Tracking Special Study

Parameter
Indicator bacteria
<i>E. coli</i>
MST Marker
Human source marker (HF183)
Dog source marker (BacCan)
Bird source marker (AvianGFD)
Horse source marker (HorseBact)

Table 56. Microbial Source Tracking Special Study Monitoring Events and Antecedent Conditions

Event	Event Date	Total Rain	Days Since Storm Greater Than	
			0.10"	0.25"
WW63	11/29/2018	1.39	6 days	8 days
WW64	1/5-6/2019	1.44	12 days	12 days
WW65	2/2/2019	0.87	12 days	12 days
DW29	5/7/2019	0.00	22 days	41 days
DW-MST1	6/4/2019	0.00	16 days	16 days
DW-MST2	6/18/2019	0.00	26 days	26 days

Note: Precipitation data were obtained from the National Weather Service (NWS) rain gauge located at the California State University at Sacramento (CSU) station. [Source: California Department of Water Resources. California Data Exchange Center (CDEC) Historical Data Selector. <https://cdec.water.ca.gov/>]

6.1.2 Quality Control

Split samples for MST markers were sent to two analytical laboratories for one monitoring site during each event, in order to evaluate laboratory performance and inter-laboratory variability. The comparison between results from the primary laboratory (Weston) and secondary laboratory (Source Molecular) is shown in **Table 57**.

Table 57. Inter-laboratory Split MST Result Comparison

Event	Site	Analyte/Marker	Primary Lab (Weston) (copies/100 mL) [1]	Secondary Lab (Source Molecular) (copies/100 mL) [2]
Wet Weather Event 1	Strong Ranch Slough (UR2S)	Human	5,380	6,040
		Dog	114,305	135,000
		Avian	3,118	DNQ
		Horse	ND	ND
Wet Weather Event 2	Sump 111 (UR3)	Human	1,178	DNQ
		Dog	8,871	1,620
		Avian	3,716	DNQ
		Horse	ND	ND
Wet Weather Event 3	North Natomas Detention Basin No. 4 (UR5)	Human	ND	DNQ
		Dog	554	DNQ
		Avian	ND	ND
		Horse	ND	ND
Dry Weather Event 1	Strong Ranch Slough (UR2S)	Human	<18 BDL	ND
		Dog	ND	DNQ
		Avian	<114 BDL	DNQ
		Horse	ND	DNQ
Dry Weather Event 2	Sump 111 (UR3)	Human	780	504
		Dog	263	ND
		Avian	ND	DNQ
		Horse	<356 BDL	DNQ
Dry Weather Event 3	North Natomas Detention Basin No. 4 (UR5)	Human	ND	DNQ
		Dog	554	DNQ
		Avian	ND	ND
		Horse	ND	ND

Notes:

[1] Weston reports sample specific detection and quantification limits; ND = not detected at the detection limit value and absence is confirmed (i.e., result is 0); BDL = below detection level, however, a signal below the detection level was observed and absence is not confirmed; [3] DNQ detected but not quantified and the presence is confirmed.

[2] Source Molecular does not provide detection or quantification limits, but does include qualitative findings (e.g., "low concentration"); ND = not detected and absence is confirmed; DNQ = detected but not quantified and the presence is confirmed

6.1.3 Results

Results from wet weather events are shown in **Table 58** and results from dry weather events are shown in **Table 59**.

Table 58. 2018-2019 Wet Weather *E. coli* and MST Results

Wet Weather Event NO.	Event Date	<i>E. coli</i> (MPN/100 mL)	Human (copies/100 mL)	Dog (copies/100 mL)	Avian (copies/100 mL)	Horse (copies/100 mL)
North Natomas Detention Basin No. 4 (UR5)						
1	11/29/19	92,000	ND	18,967	9,608	ND
2	1/5/19	3,300	301	6,500	10,020	ND
3	2/2/19	13,000	ND	554	ND	ND
Strong Ranch Slough (UR2S)						
1	11/29/19	54,000	5,380	114,305	3,118	ND
2	1/5/19	11,000	60,280	27,688	25,535	ND
3	2/2/19	2,700	661	9,255	2,163	ND
Sump 111 (UR3)						
1	11/29/19	54,000	22,491	37,860	5,731	ND
2	1/5/19	92,000	1,178	8,871	3,716	ND
3	2/2/19	2,200	ND	665	ND	ND

Notes: [1] Weston reports sample specific detection and quantification limits; ND = not detected at the detection limit value and absence is confirmed (i.e., result is 0); BDL = below detection level, however, a signal below the detection level was observed and absence is not confirmed; [3] DNQ detected but not quantified and the presence is confirmed.

Table 59. 2018-2019 Dry Weather *E. coli* and MST Results

Dry Weather Event NO.	Event Date	<i>E. coli</i> (MPN/100 mL)	Human (copies/100 mL)	Dog (copies/100 mL)	Avian (copies/100 mL)	Horse (copies/100 mL)
North Natomas Detention Basin No. 4 (UR5)						
1	5/7/19	210	ND	ND	15,256	<5 BDL
2	6/4/19	45	ND	ND	7,914	ND
3	6/18/19	45	ND	ND	4,415	ND
Strong Ranch Slough (UR2S)						
1	5/7/19	450	<18 BDL	ND	<114 BDL	ND
2	6/4/19	<18 BDL	<134 BDL	ND	<197 BDL	ND
3	6/18/19	22,000	1,002	ND	1,661	<155 BDL
Sump 111 (UR3)						
1	5/7/19	4,900	2,302	ND	<146 BDL	ND
2	6/4/19	780	263	ND	<356 BDL	ND
3	6/18/19	28,000	12,203	17,709	2,730	ND
Sump 152 (S152)						
1	5/7/19	2,200	ND	1,778	1,022	ND
2	6/4/19	130	<49 BDL	ND	451	ND
3	6/18/19	18	ND	ND	1,207	ND

Notes: [1] Weston reports sample specific detection and quantification limits; ND = not detected at the detection limit value and absence is confirmed (i.e., result is 0); BDL = below detection level, however, a signal below the detection level was observed and absence is not confirmed; [3] DNQ detected but not quantified and the presence is confirmed.