OCTOBER 2018

DELTA REGIONAL MONITORING PROGRAM

Pathogen Study Final Report

Prepared by

LARRY WALKER ASSOCIATES

This Page Intentionally Left Blank

Acknowledgements

The contributions of the following work groups and individuals, who contributed to the development of the Pathogen Study and preparation of this document, are gratefully acknowledged:

Central Valley Clean Water Association

Central Valley Drinking Water Policy Workgroup

California Department of Water Resources, Municipal Water Quality Investigations Program

City of Sacramento Department of Utilities

Sacramento Regional County Sanitation District

City of Sacramento Department of Utilities:

Elissa Callman

City of Davis:

Josie Tellers

Delta Regional Monitoring Program Pathogen Subcommittee:

Brian Laurenson, Larry Walker Associates
Cindy Garcia, Department of Water Resources
Elaine Archibald, Archibald Consulting
Hope Taylor, Larry Walker Associates
Jay Simi, Regional Water Quality Control Board
Lynda Smith, Metropolitan Water District of Southern Califorina
Lysa Voight, Sacramento Regional County Sanitation District
Tim Mussen, Sacramento Regional County Sanitation District
Patrick Morris, Regional Water Quality Control Board
Selina Cole, Regional Water Quality Control Board
Steven San Julian, Department of Water Resources
Tom Grovhoug, Larry Walker Associates
Vyomini Upadhyay, Sacramento Regional County Sanitation District

Larry Walker Associates:

Steve Maricle
Airy Krich-Brinton
Katrina Arredondo

Stantec:

Mark Graham

Table of Contents

List of Tables

List of Figures

Delta RMP Pathogen Study Final Report

1. INTRODUCTION

The Delta Regional Monitoring Program (RMP) Pathogen Study (Pathogen Study) was designed to fulfill the dual purposes of characterizing ambient conditions for pathogens (*Cryptosporidium* and *Giardia*) throughout the Sacramento-San Joaquin Delta (Delta) and satisfying regulatory requirements. The Central Valley Regional Water Quality Control Board (Water Board) adopted a Basin Plan Amendment to establish a Drinking Water Policy (Basin Plan Amendment) to protect source water quality on July 26, 2013.[1] The Basin Plan Amendment added a narrative water quality objective for *Cryptosporidium* and *Giardia* to the Basin Plan, with associated implementation and monitoring provisions, as well as language addressing other constituents of potential concern to drinking water. The Basin Plan Amendment recommends that a study be performed to "characterize ambient background conditions and potential sources to be used when and if exceedance of a trigger occurs."

The Monitoring Design Summary[2] describes the two year pathogen monitoring study developed by the Central Valley Drinking Water Policy Workgroup (Workgroup) in coordination with the Delta RMP. The study coordinated water agency intake sample collection for the United States Environmental Protection Agency (USEPA) Long Term 2 Enhanced Surface Water Treatment Rule (LT2) between April 2015 and April 2017 with ambient sample collection. The Delta RMP collected ambient samples at twelve locations through in-kind field support by the Municipal Water Quality Investigations (MWQI) section of the Department of Water Resources (DWR), with funding from the Delta RMP for analytical services, and in-kind contributions from Workgroup members to oversee sample collection and data assessment.

The study was phased to perform an initial assessment in the first year of characterization data and then a more targeted Delta subarea evaluation of infectibility, source tracking, hydrodynamics, and decay/ growth in the second year. However, monitoring results were all below threshold values in the first year and targeted studies were not necessary during the second year.

This final report addresses the Basin Plan requirements and presents the results of ambient and drinking water intake monitoring in the context of the Delta RMP assessment questions that were developed prior to this study.

1.1 Basin Plan Requirements

The Basin Plan specifies a narrative objective for *Cryptosporidium* and *Giardia* to protect the public water system component of the MUN beneficial use, with the goal of maintaining existing levels of pathogens at public water system intakes below levels of concern. In accordance with the USEPA LT2, public water systems are required to monitor for *Cryptosporidium* at their

---

[1] https://www.waterboards.ca.gov/rwqcb5/water_issues/drinking_water_policy/

[2] Delta Regional Monitoring Program. *Monitoring Design Summary***.** Prepared for Delta RMP Steering Committee. November 3, 2014. *Revised June 16, 2015*

intakes (USEPA, 2006).[3] The monitoring results are used to implement the bin classification for the water system, which prescribes the level of treatment that the system must provide depending on the bin level for the raw water supply. To assure that *Cryptosporidium* levels at public water systems stay at their current bin classifications, the Basin Plan specifies "triggers" based on 80% of the LT2 bin classification thresholds.

Since all drinking water intake locations within or immediately upstream of the Delta[4] are currently classified as bin 1 (maximum running annual average <0.075 oocysts/L), the trigger value (80% of the bin 2 level) is 0.06 oocysts/L (maximum running annual average). A maximum running annual average above the trigger value at a drinking water intake prompts proactive actions to investigate potential contributors to the change in bin level.

If a maximum running annual average at an ambient location exceeds the trigger value, a follow-up study would only occur if a trigger value exceedance also occurred at the nearest drinking water intake or if other compelling evidence was obtained (e.g., increasing trend, extreme value). The Basin Plan Amendment specifies that a one-time special study would be undertaken by the RMP, or through other coordinated efforts by stakeholders, that would characterize ambient background concentrations and potential sources to be used when and if a trigger is exceeded. The Pathogen Study was designed to fulfill the Policy actions that would be undertaken by a trigger. **Table 1** outlines the components specified by the Basin Plan Amendment and indicates how they were addressed by the Pathogen Study.

The Monitoring Design Summary implements the Basin Plan Figure IV-1 trigger response and identifies several possible tools that can be used for a triggered study. During the RMP Pathogen Study, the Pathogen Workgroup compiled the data and compared drinking water intake rolling twelve-month averages to the trigger value. Because the water intake data are compiled by other agencies, the Pathogen Workgroup also evaluated ambient data against the trigger values. The trigger response would have involved data and source assessments and associated decision steps: 1) data review, 2) assessment, and 3) investigation. The results are discussed in subsequent sections of this final report; however, no follow-up studies were triggered during the Pathogen Study.

Table 1. Drinking Water Policy Basin Plan Amendment Study Components

Component	Addressed by RMP Pathogen Study
Literature review to identify available source information	Literature Review (Section 1.1.1)
Continued monitoring at existing public water system intakes	Drinking Water Intake Monitoring (Sections 2.1, 3.1)
Monitoring at several ambient locations that will be identified as sites that integrate the pathogen sources where historic pathogen data are unavailable	Ambient Monitoring (Sections 2.2, 3.2)

[3] LT2 guidance allows for analysis of intake samples using either USEPA Method 1622 or 1623. Method 1622 is for just *Cryptosporidium*, while Method 1623 includes *Giardia* also. The LT2 rule does not require monitoring for *Giardia,* and only *Cryptosporidium* data need to be submitted.

[4] With the exception of Davis/Woodland, which does not have a current bin level classification.

Component	Addressed by RMP Pathogen Study
Monitoring at several representative discharge locations, if representative pathogen concentrations are not available or if coordinated data are necessary	Not required – No trigger
Hydrodynamic and particle tracking models to simulate the transport of pathogens from potential sources to public water system intakes	Not required – No trigger
If needed, focused studies to identify the viability and fate and transport of *Cryptosporidium*.	Not required – No trigger

1.2 Literature Review

Pathogenic protozoa such as *Cryptosporidium* and *Giardia* are unicellular parasitic microorganisms that exist in two life stages, either living within a host or as spores that can survive outside of a host. Protozoa can only replicate inside of a host, but can survive and be transmitted from host to host in the form of oocysts or cysts. Spore formation protects protozoa from some environmental stresses, such as extreme temperatures; prolonged periods without food, water, or oxygen; and some harmful chemicals.

1.2.1 Sources

Cryptosporidium and *Giardia* can infect and be transmitted between humans, domestic animals and wildlife. Protozoan pathogens are shed in fecal matter and can enter the water supply either through direct deposition or by transport from land to nearby water bodies. Sources of protozoan pathogens may include treated wastewater effluent, urban stormwater discharge, agricultural runoff, wildlife sources, and human water-contact recreation.

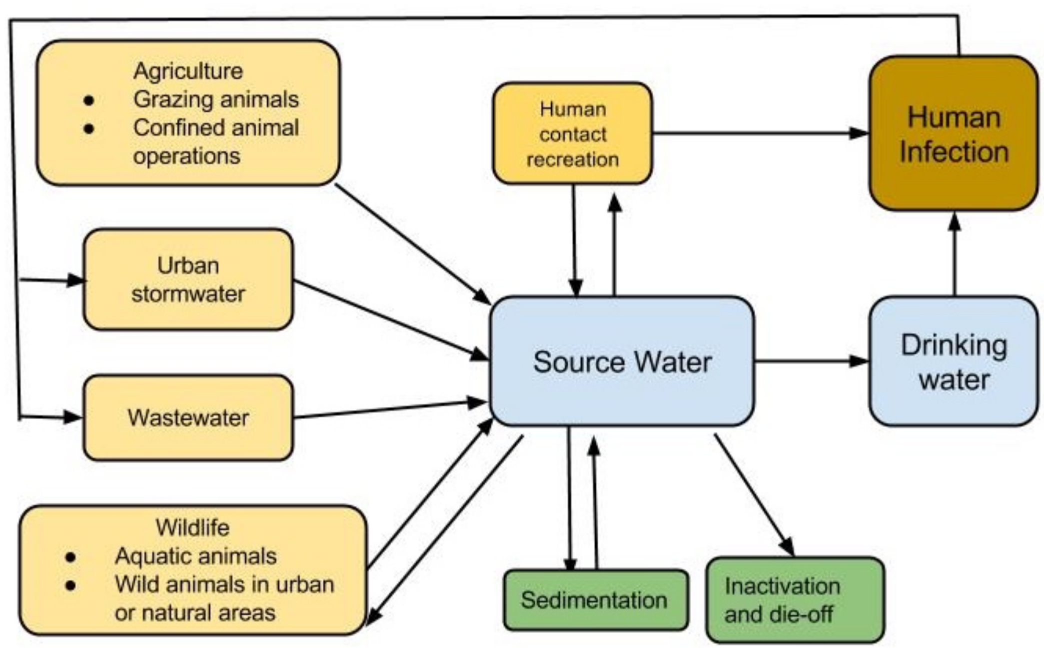

Figure 1. Sources and Fate of *Cryptosporidium* and *Giardia*

1.2.2 Environmental Fate

Cryptosporidium oocysts and *Giardia* cysts are robust, capable of surviving in the environment under unfavorable conditions for long time periods (Carey et al., 2004). Their persistence in surface waters is influenced by temperature, UV exposure, and removal from the water column by sedimentation processes.

In general, microorganisms survive longer in the environment at lower temperatures. There is some indication that temperature within narrow environmental ranges may not be a major factor in the survival of protozoan pathogens. One study used a factorial design to investigate the combined effect of environmental conditions on oocyst survival, and concluded that *Cryptosporidium* oocyst survival was stable within a range of cold temperatures (from 4°C to 18°C) (Freire-Santos et al., 2000). Another study determined that inactivation of *Cryptosporidium* oocysts increased in direct proportion to temperatures between 4°C and 30°C (Walker et al., 2001).

Exposure to UV light from sunlight is detrimental to all types of pathogens. Protozoan pathogens have been found to be more resistant to UV than bacteria or viruses, but are still significantly impacted by exposure to sunlight (Ferguson et al., 2003). Brookes et al. modeled oocyst inactivation by UV, finding that inactivation followed an exponential decay function (Brookes et al., 2004). The extinction coefficient for UV light in a waterbody is important for determining the timescale for UV inactivation – Brooks et al. state that UV inactivation of *Cryptosporidium* can vary widely depending on the location of the oocysts in the water column and the extinction coefficient for UV light.

Sedimentation is an important removal mechanism in low-flowing aquatic environments (Dai and Boll, 2006).

1.2.3 Viability and Infectivity

USEPA Method 1623 reports cysts or oocysts by examination of size, shape and fluorescence observed under a microscope; however, the presence of cysts or oocysts does not indicate whether they are viable. Not all of the cysts or oocysts in water are viable, and subsequently capable of causing an infection. One study using a method for assessing the viability of oocysts in wastewater found that only 40% of the oocysts in the raw untreated sewage entering a treatment plant were infectious, and this number decreased after treatment (Harwood et al., 2005).

The current body of scientific literature points to considerable uncertainty about the infectivity of protozoan pathogens. Issues influencing infectivity include variability in host susceptibility, response at low oocyst doses, and relative infectivity and occurrence of different *Cryptosporidium* or *Giardia* isolates. Infectivity studies in humans have been conducted using healthy adult volunteers. Chappell and colleagues at the University of Texas assessed infection following dosing using varying amounts of three different *C. parvum* isolates in three separate studies (Okhuysen et al. 1999). Data indicated differences in infectivity among the isolates:

- *C. parvum* TAMU (from an infected horse) was the most infectious, with 67% of volunteers infected when dosed with 10 oocysts, and 100% infected when dosed with 100 oocysts.

- *C. parvum* Iowa (derived from calf) was less infectious, with 40% of volunteers infected when dosed with 30 oocysts, and 100% infected with does with 1,000 oocysts.
- *C. parvum* UCP (derived from calf) was the least infections, with 60% of volunteers infected when dosed with 500 oocysts, and 100% infected with dosed with 10,000 oocysts.

Other human volunteer studies have confirmed the ranges of infectivity found in the 1999 study. A 2006 study by Chappell and colleagues used a *C. hominis* isolate (TU502) and found that 40% of subjects were infected by a dose of 10 oocysts, 71% were infected by a dose of 100 oocysts, and 75% were infected by a dose of 500 oocysts (Chappell et al. 2006). An additional study using a different isolate found that a dose of 100 oocysts infected 75% of volunteers, with higher doses (300, 1000, and 3000) resulting in similar or lower percentages of infection (60%, 67%, and 75%) (Okhuysen et al. 2002).

1.3 Delta RMP Pathogen Study Purpose

The Pathogen Study was designed to fulfill the Basin Plan Amendment actions that would be undertaken if a trigger value was exceeded. The RMP assessment questions for the Pathogen Study were designed to fulfill the Policy requirements, as outlined in **Table 2**.

Table 2. Delta RMP Assessment Questions for the Pathogen Study

Assessment Question Type	Number	Assessment Question
Status and Trends (ST)	**ST 1**	Are current pathogen levels supportive of the municipal drinking water quality beneficial use as described in the Basin Plan?
	A.	Are the current pathogen levels for each Delta water intake and those immediately upstream (i.e., Sacramento Area) different than the previous LT2 sampling? Are any drinking water intakes reclassified into a higher bin level?
	B.	Are Basin Plan trigger values exceeded?
Sources, Pathways and Loading (SPLP)	**SPLP 1**	Can any changes in bin level be attributed to an identifiable event, condition, or changes in a source?
	A.	What are the concentrations in ambient waters upstream or downstream from intakes with observed changes to bin levels?
	B.	What is the influence of sources (agriculture, wastewater treatment plants, urban runoff, upstream tributary, natural, recreation, and other) on pathogen levels at drinking water intakes?
	C.	Are there new discharges or changes in sources or conditions that could explain the change in bin level compared to previous LT2 monitoring?
	SPLP 2	What is the viability and infectivity of pathogens at drinking water intakes?
	A.	What percentage of *Cryptosporidium* found in ambient waters and source waters can cause infection?
	SPLP 3	What are the factors affecting decay and growth rates and can they be quantified and characterized for the purpose of modeling?

Assessment Question Type	Number	Assessment Question
	A.	Is there recent research or literature on the environmental fate of *Cryptosporidium* and *Giardia* that can be used to develop decay/growth rates in models?
	B.	What are the observed changes in *Cryptosporidium* and *Giardia* concentrations as a pulse of ambient water or source water moves through the watershed and Delta?

2. MONITORING DESIGN

The Monitoring Design Summary describes the approach for the Pathogen Study. Drinking Water intake and Ambient locations are shown in **Figure 2**. As described in the following sections, sampling for *Cryptosporidium* and *Giardia* occurred monthly for two years at each monitoring location.

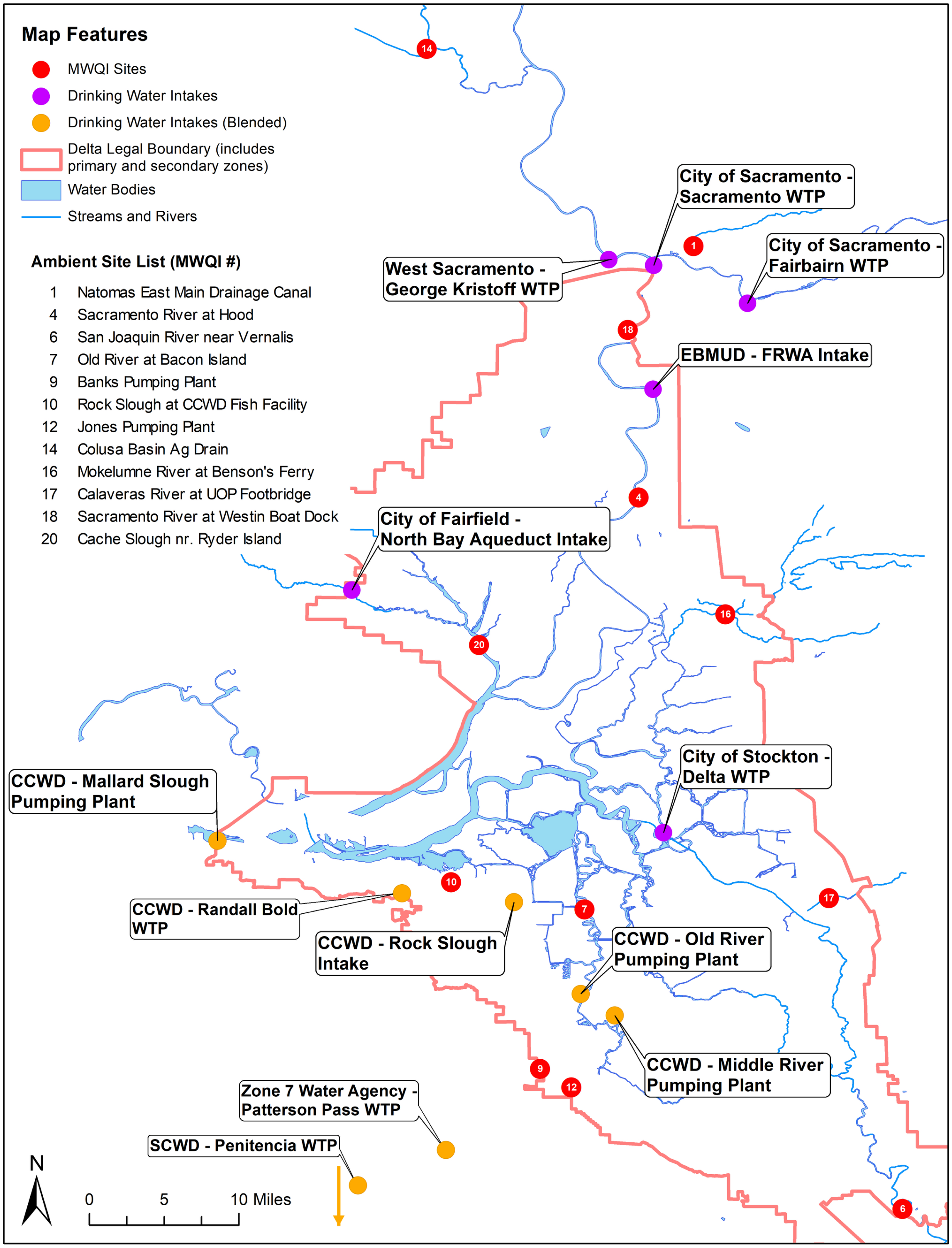

Figure 2. Locations of Ambient and Drinking Water Intake Locations

2.1 Water Intake Sample Collection

As part of the second round of the LT2, water supply agencies collected *Cryptosporidium* and *Giardia* samples monthly for two years in the source waters at treatment plant intakes[5] starting in April 2015. The water supply agencies that contributed data for the RMP Pathogen Study are shown in **Table 3**. The drinking water intake locations are shown in **Figure 2**. The City of Davis/Woodland/UC Davis – Woodland Davis Clean Water Agency (WDCWA) Regional Water Treatment Facility (WTF), located upstream of the Sacramento urban area, did not contribute data for this study. The WDCWA became fully operational in June 2016, and is in the process of preparing a 2-Year sampling and monitoring plan as required for Bin classification on a 6-year cycle. Sampling is anticipated to begin by September 2018.

In some cases, the treatment plant intakes include a blend of multiple "raw" water sources. These data will be used to determine if the bin levels[6] assigned after the first round of monitoring are still valid or need to be revised. In addition, data from the second round of monitoring was also used to evaluate conditions relative to the Basin Plan trigger levels (80% of bin level). The bin levels and Basin Plan triggers are shown in **Table 4**.

Table 3. Water Supply Agencies Contributing Drinking Water Intake Data

Agency and Intake Facility	Source Water Description	Location Description
West Sacramento – George Kristoff Water Treatment Plant (WTP)	Sacramento River	Upstream of Sacramento urban area
City of Sacramento – Fairbairn WTP	American River	Within Sacramento urban area
City of Sacramento – Sacramento WTP	Sacramento River	Within Sacramento urban area
East Bay Municipal Utilities District (EBMUD) – Freeport Regional Water Authority (FRWA) Intake	Sacramento River	Downstream of Sacramento urban area, within Delta
City of Fairfield – North Bay Aqueduct Intake	Barker Slough	North Delta water with some local watershed runoff in wet season
City of Stockton – Delta WTP	San Joaquin River	Within eastern Delta
Contra Costa Water District (CCWD) – Randall Bold WTP	Western Delta/Los Vaqueros Reservoir	Within western Delta, blended intakes
Zone 7 Water Agency – Patterson Pass WTP	South Bay Aqueduct	100% Delta water in South Bay Aqueduct

[5] LT2 Source Water Monitoring Guidance specifies that "LT2 Rule monitoring is intended to assess the mean Cryptosporidium level in the influent to drinking water plants that treat surface water or ground water under the direct influence (GWUDI) of surface water. PWSs are required to collect source water samples for the LT2 Rule from each plant intake prior to chemical treatment"

http://www.epa.gov/ogwdw/disinfection/lt2/pdfs/guide_lt2_swmonitoringguidance.pdf

[6] http://www.epa.gov/ogwdw/disinfection/lt2/pdfs/fs_sw_monitoring_fs_sch_1-3_final.pdf

Agency and Intake Facility	Source Water Description	Location Description
Santa Clara Valley Water District (SCVWD) – Penitencia WTP	South Bay Aqueduct	Blend of South Bay Aqueduct and Lake Del Valle water

Table 4. LT2 Bin Levels and Basin Plan 80% Triggers

LT2 Program		Basin Plan
Bin Classification	Maximum Running Annual Average[a] (oocysts/L)	Maximum Running Annual Average 80% Trigger (oocysts/L)
1	<0.075	0.06
2	0.075 to <1.0	0.80
3	1.0 to <3.0	2.40

Note: [a] The term used in the regulation is "mean *Cryptosporidium* bin concentration." If an agency collects at least 48 monthly samples, they can average all samples collected. The guidance specifies that agencies can use the maximum average of 12 consecutive samples if fewer than 48 samples are collected (USEPA, 2006).

2.2 Ambient Sample Collection

Ambient sampling was performed by the DWR MWQI Program, as described in the Monitoring Design Summary. The samples were analyzed by analytical laboratories certified for USEPA Method 1623 for *Cryptosporidium* and *Giardia*. The primary laboratory, BioVir, performed most all analyses and the secondary laboratory, Eurofins, analyzed inter-laboratory quality control samples.

Ambient locations are co-located with existing MWQI sites as shown in **Table 5**. Some sites are upstream of the Delta but could influence water quality at the drinking water intakes or are representative of larger areas with the same land uses. **Figure 2** shows the ambient sampling locations, alongside the drinking water intakes.

Samples were collected monthly by MWQI, during their established sample runs occurring the first full work-week of each month. The sampling frequency matched the LT2 intake monthly sampling frequency.

Table 5. Ambient Monitoring Locations

Location ID	Description	Source(s) Represented	Rationale for Inclusion
MWQI #14	Colusa Basin Ag Drain	Agriculture	Source representation
MWQI #1	Natomas East Main Drainage Canal	Stormwater, Agriculture	Source representation
MWQI #18	Sacramento River at Westin Boat Dock	Stormwater, Combined Sewer System	Proximity to intakes
MWQI #4	Sacramento River at Hood	Stormwater, Wastewater	General characterization
MWQI #20	Cache Slough near Ryder Island	Wetlands, Stormwater, Wastewater	Source Representation

Location ID	Description	Source(s) Represented	Rationale for Inclusion
MWQI #16	Mokelumne River at Benson's Ferry		Input to Delta
MWQI #17	Calaveras River at UOP Footbridge	Stormwater	Source representation
MWQI #10	Rock Slough at CCWD Fish Facility		General characterization
MWQI #7	Old River at Bacon Island		General characterization
MWQI #9	Banks Pumping Plant		Export from Delta
MWQI #12	Jones Pumping Plant		Export from Delta
MWQI #6	San Joaquin River near Vernalis		Input to Delta

3. RESULTS

The results for the Pathogen Study intake and ambient monitoring are presented in the following sections, as outlined in the Monitoring Design Summary. Complete results for Ambient and Intake monitoring are included in **Appendix A**. The general conclusions, and assessment of how the study addressed the RMP assessment questions, are included in Section 4.

In general, data confirmed that the Basin Plan trigger values (0.06 oocysts/L) for *Cryptosporidium* were not exceeded at the drinking water intakes during the Pathogen Study period, which included several widespread storm events. The ambient data collected by the RMP supports this finding, though the trigger values are only applicable at the water intake locations. The data are summarized in **Table 6**. **Figure 3** graphically presents both the intake and ambient data combined, showing the ranges of the maximum running annual average concentrations of *Cryptosporidium* and *Giardia*. All calculated running twelve-month averages were well below trigger values. In general, the mainstream Delta locations had fewer detected values of both pathogens relative to the more upstream locations.

The sample collection period included a critically dry year and an above normal wet year, including sample collection immediately after and during widespread rainfall events. While the sample collection frequency is not sufficient to identify statistically significant trends over time, if can help identify critical conditions.

Table 6. Summary of Drinking Water Intake and Ambient Monitoring Results

Agency/Site	*Cryptosporidium* (oocysts/L)						*Giardia* (cysts/L)					
	n	**n Det.**	**Min.**	**Max.**	**Median[a]**	**Mean[b]**	**n**	**n Det.**	**Min.**	**Max.**	**Median[a]**	**Mean[b]**
Drinking Water Intake												
West Sacramento	21	0	<0.1	<0.1	<0.1	0	21	1	<0.1	**0.1**	<0.1	**0.005**
Sacramento Fairbairn	24	0	<0.1	<0.1	<0.1	0	24	9	<0.1	**0.3**	<0.1	**0.06**
Sacramento River WTP	24	1	<0.1	**0.2**	<0.1	**0.008**	24	4	<0.1	**0.2**	<0.1	**0.02**
EBMUD	18	1	<0.1	**0.2**	<0.1	**0.01**	15	1	<0.1	**0.4**	<0.1	**0.03**
Fairfield	24	1	<0.1	**0.2**	<0.1	**0.008**	0	[c]	[c]	[c]	[c]	[c]
Stockton	21	0	<0.1	<0.1	<0.1	0	0	[c]	[c]	[c]	[c]	[c]
CCWD	25	0	<0.1	<0.1	<0.1	0	14	2	<0.1	**0.2**	<0.1	**0.02**
Zone 7	18	1	<0.06	**0.07**	<0.1	**0.004**	0	[c]	[c]	[c]	[c]	[c]
SCVWD	19	2	<0.1	**0.1**	<0.1	**0.01**	19	0	<0.1	<0.1	<0.1	0
Ambient												
MWQI #14	22	0	<0.1	<0.1	<0.1	0	22	7	<0.1	2.4	<0.1	**0.22**
MWQI #1	22	2	<0.1	0.1	<0.1	**0.009**	22	14	<0.1	22	0.3	**1.94**
MWQI #18	24	0	<0.1	<0.1	<0.1	0	24	5	<0.1	0.1	<0.1	**0.02**
MWQI #4	24	2	<0.1	0.4	<0.1	**0.02**	24	11	<0.1	0.8	<0.1	**0.15**
MWQI #20	23	0	<0.1	<0.1	<0.1	0	23	0	<0.1	<0.1	<0.1	0
MWQI #16	22	1	<0.1	0.1	<0.1	**0.005**	22	13	<0.1	0.6	0.1	**0.17**

Agency/Site	*Cryptosporidium* (oocysts/L)						*Giardia* (cysts/L)					
	n	n Det.	Min.	Max.	Median[a]	Mean[b]	n	n Det.	Min.	Max.	Median[a]	Mean[b]
MWQI #17	22	1	<0.1	0.1	<0.1	**0.005**	22	6	<0.1	0.4	<0.1	**0.05**
MWQI #10	24	0	<0.1	<0.1	<0.1	0	24	1	<0.1	0.1	<0.1	**0.004**
MWQI #7	22	0	<0.1	<0.1	<0.1	0	22	6	<0.1	2.3	<0.1	**0.13**
MWQI #9	22	0	<0.1	<0.1	<0.1	0	22	0	<0.1	<0.1	<0.1	0
MWQI #12	22	0	<0.1	<0.1	<0.1	0	22	3	<0.1	0.2	<0.1	**0.02**
MWQI #6	24	2	<0.1	**0.1**	<0.1	**0.008**	24	14	<0.1	**0.9**	**0.1**	**0.13**

Note:
Detected values are indicated in **bold**
[a] Where the median value is non-detect, the median concentration reported as less than the detection limit.
[b] Mean concentration calculated based on arithmetic mean of all sample concentrations, counting non-detects as zero, in accordance with 40 CFR § 141.710(b)(1).
[c] Giardia sample collection and analysis not required for LT2 sample collect

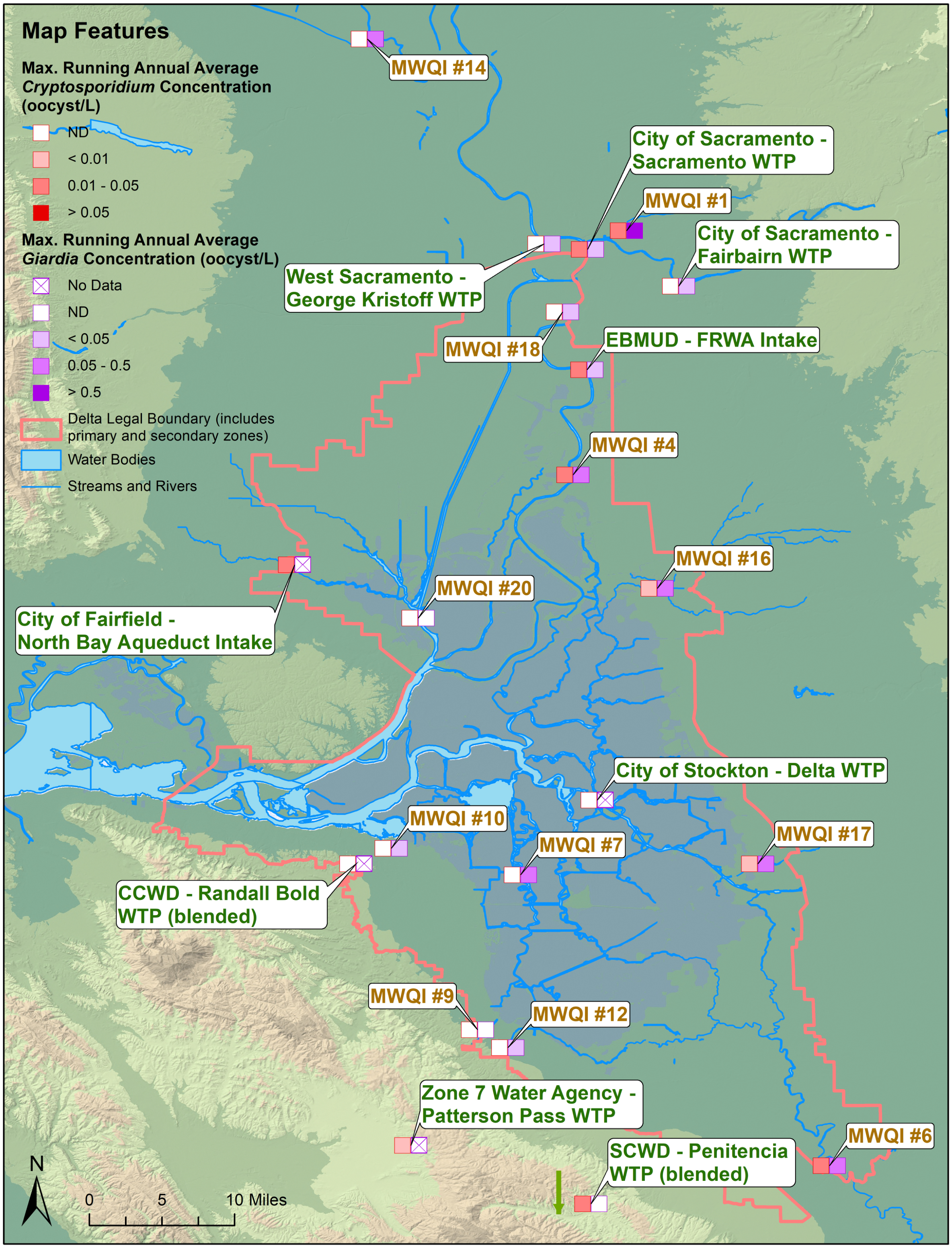

Figure 3. Ambient and Drinking Water Intake *Cryptosporidium* and *Giardia* Maximum Annual Running Annual Average Concentrations

3.1 Drinking Water Intake Results

The historic and current estimated bin levels for the drinking water intakes addressed in this study are presented in **Table 7**. *Cryptosporidium* was infrequently detected at intake locations, and all maximum annual running mean concentrations were well below the trigger value for a trigger exceedance assessment.

To further elucidate any trends due to temporal or spatial conditions, the intake data were assessed using incremental rainfall data (**Figure 4**) and by site (**Figure 5** and **Figure 6**). In general, detections of *Cryptosporidium* and *Giardia* did not correspond with larger rain events but were more prevalent in the fall/early winter periods of both monitoring years. *Cryptosporidium* were only detected in six samples and *Giardia* were detected in seventeen samples over all intake locations, with no one intake location showing a particularly high number of detections or concentration detected.

Table 7. Historic and Current Estimated Bin Levels and Trigger Assessments for Drinking Water Agencies

Water Agency Facility	2007 Bin Level	2015-17 Maximum Running Annual Average	Percent Detected *Cryptosporidium*	Estimated 2015-17 Bin Level	Trigger Exceedance Assessment (if > 0.06)
West Sacramento – George Kristoff WTP	1	0	0%	1	None
City of Sacramento – Fairbairn WTP	1	0	0%	1	None
City of Sacramento – Sacramento WTP	1	0.017	4%	1	None
EBMUD –FRWA Intake	1	0.017	6%	1	None
City of Fairfield – North Bay Aqueduct Intake	1	0.017	4%	1	None
City of Stockton – Delta WTP	1	0	0%	1	None
CCWD – Randall Bold WTP	1	0	0%	1	None
Zone 7 Water Agency – Patterson Pass WTP	1	0.006	6%	1	None
SCVWD – Penitencia WTP	1	0.017	10%	1	None

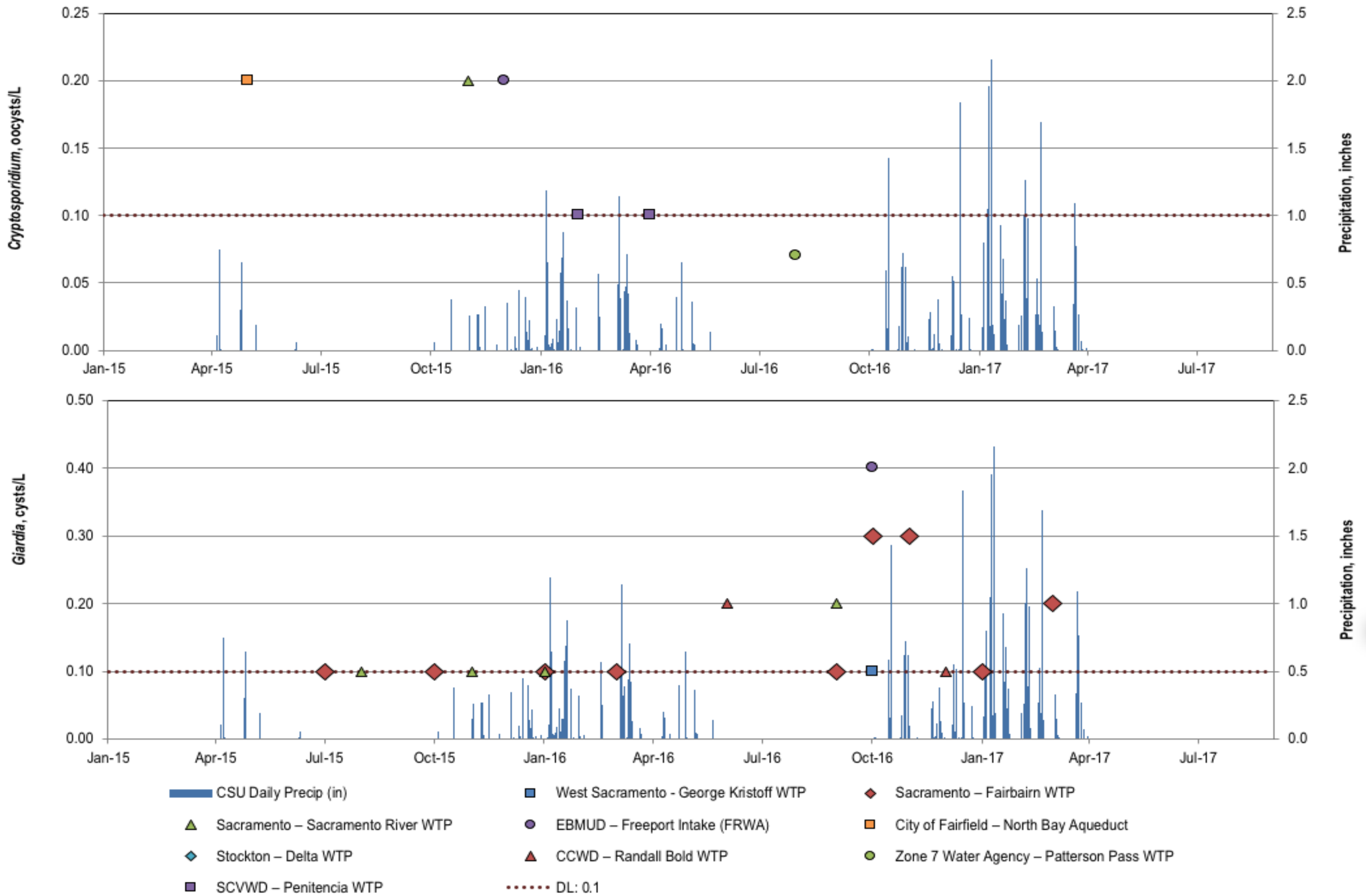

Figure 4. Drinking Water Intake Detected *Cryptosporidium* and *Giardia* Concentrations by Event/Rainfall

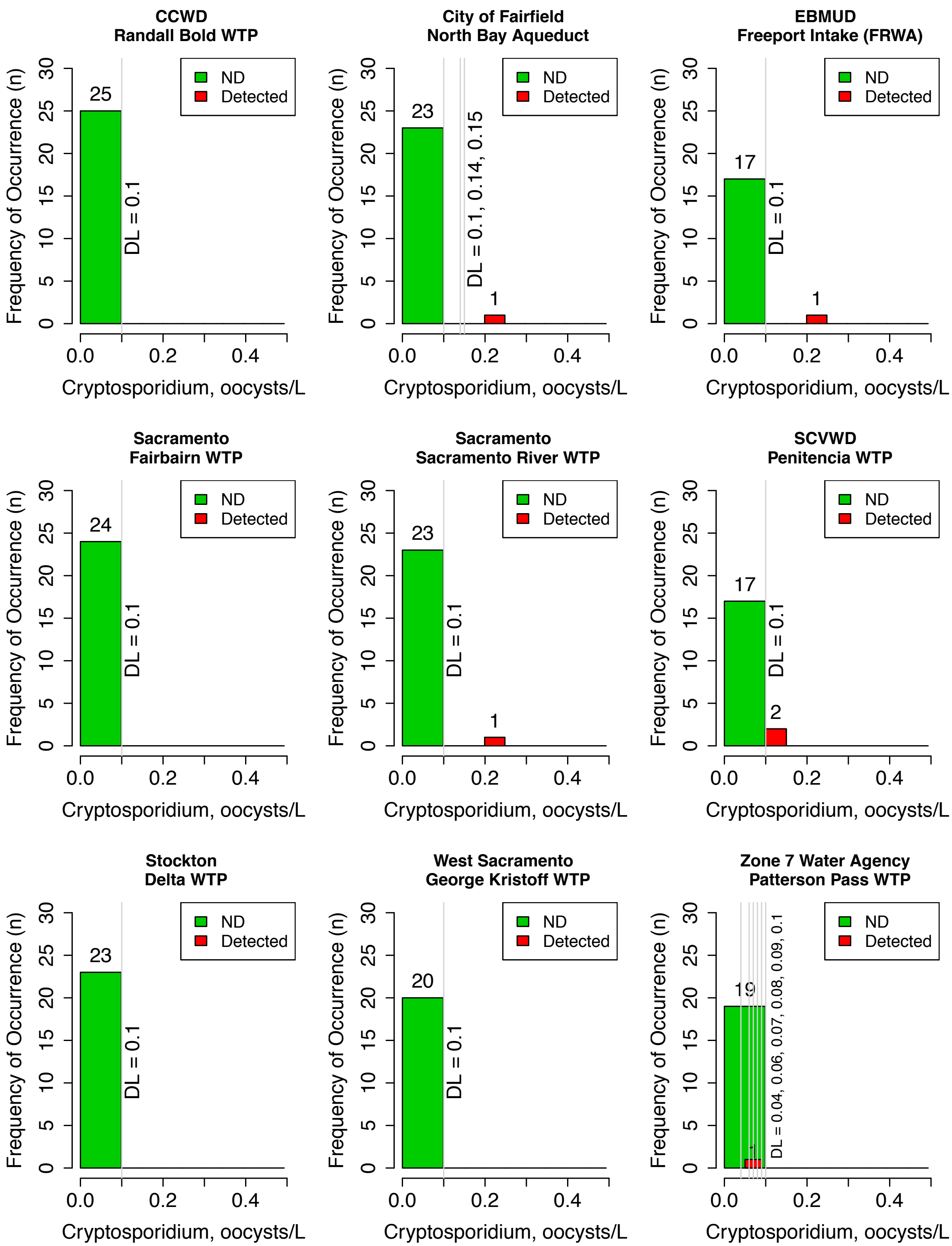

Figure 5. Drinking Water Intake *Cryptosporidium* Results by Site

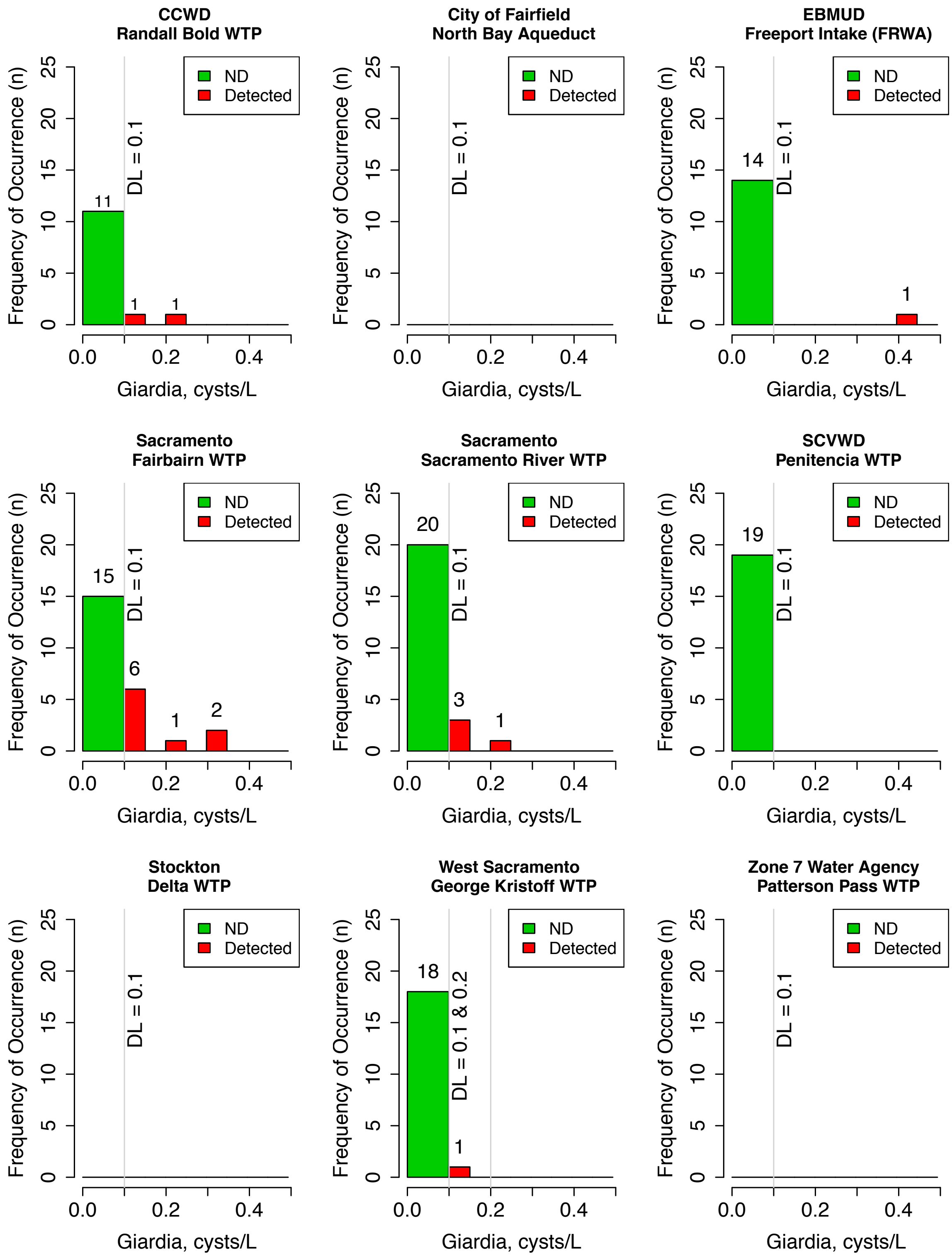

Figure 6. Drinking Water Intake *Giardia* Results by Site

3.2 Ambient Results

The ambient sampling data are presented along with incremental rainfall data (**Figure 7)** and by site (**Figure 8** and **Figure 9).** Similar to the intake results, the ambient data indicate that the most frequent detections occurred during the late summer to fall time period during both study years. Several intense rain events occurred during the study period; however, those events did not correlate with detected pathogens.

Cryptosporidium was detected at nearly half of the ambient locations, with more frequent detections generally at the outer edges of the Delta. However, the highest concentration was detected in the Sacramento River at Hood (with both detections occurring in September or October, before the first annual wet season event, but during the rice drainage season). *Giardia* detections were more widespread, and data suggest that *Giardia* is more frequently detected, and detected at higher concentration, in the tributaries to the Delta relative to the mainstream Delta locations, though no robust statistical comparison was performed.

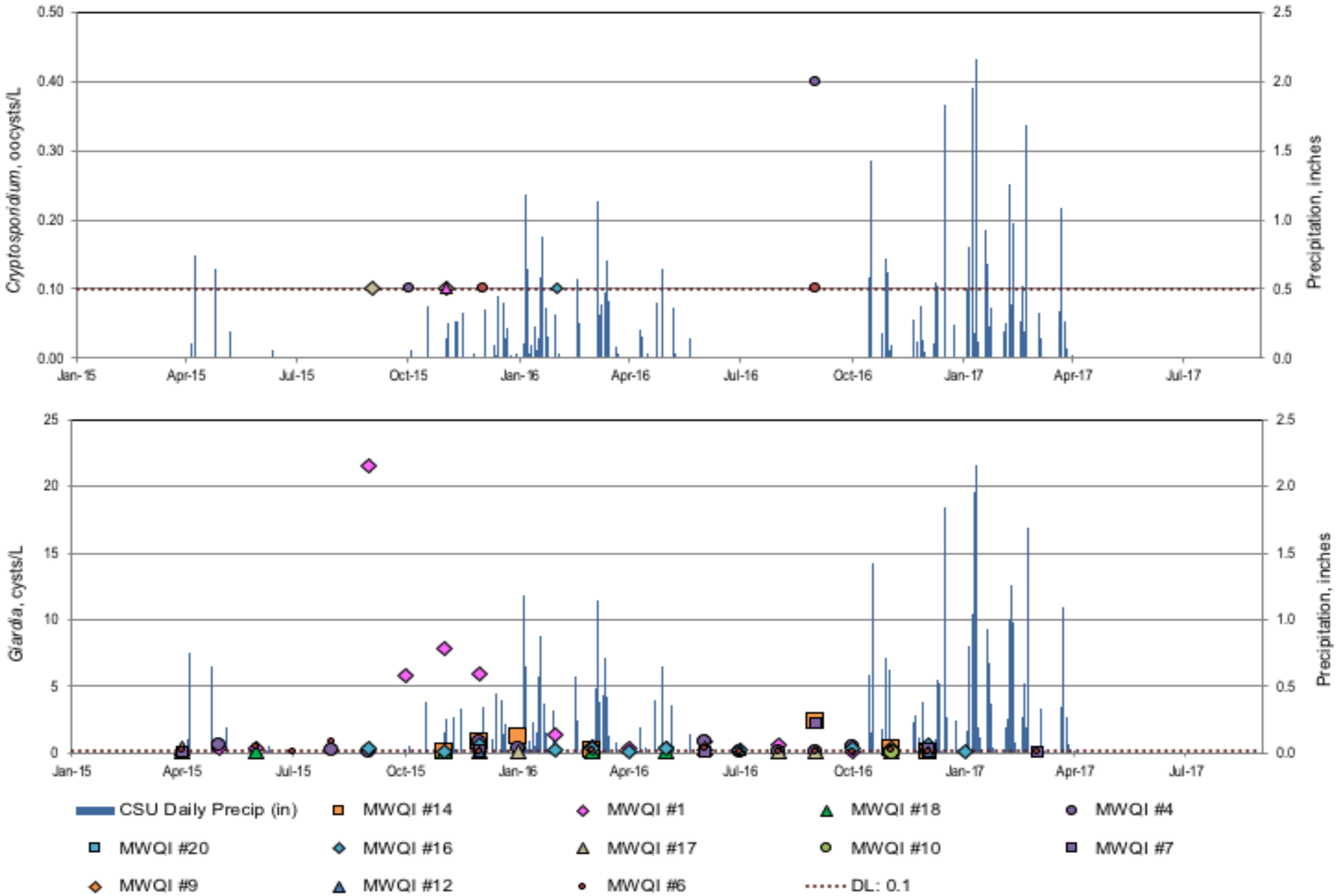

Figure 7. Detected Ambient *Cryptosporidium* and *Giardia* Concentrations by Event/Rainfall

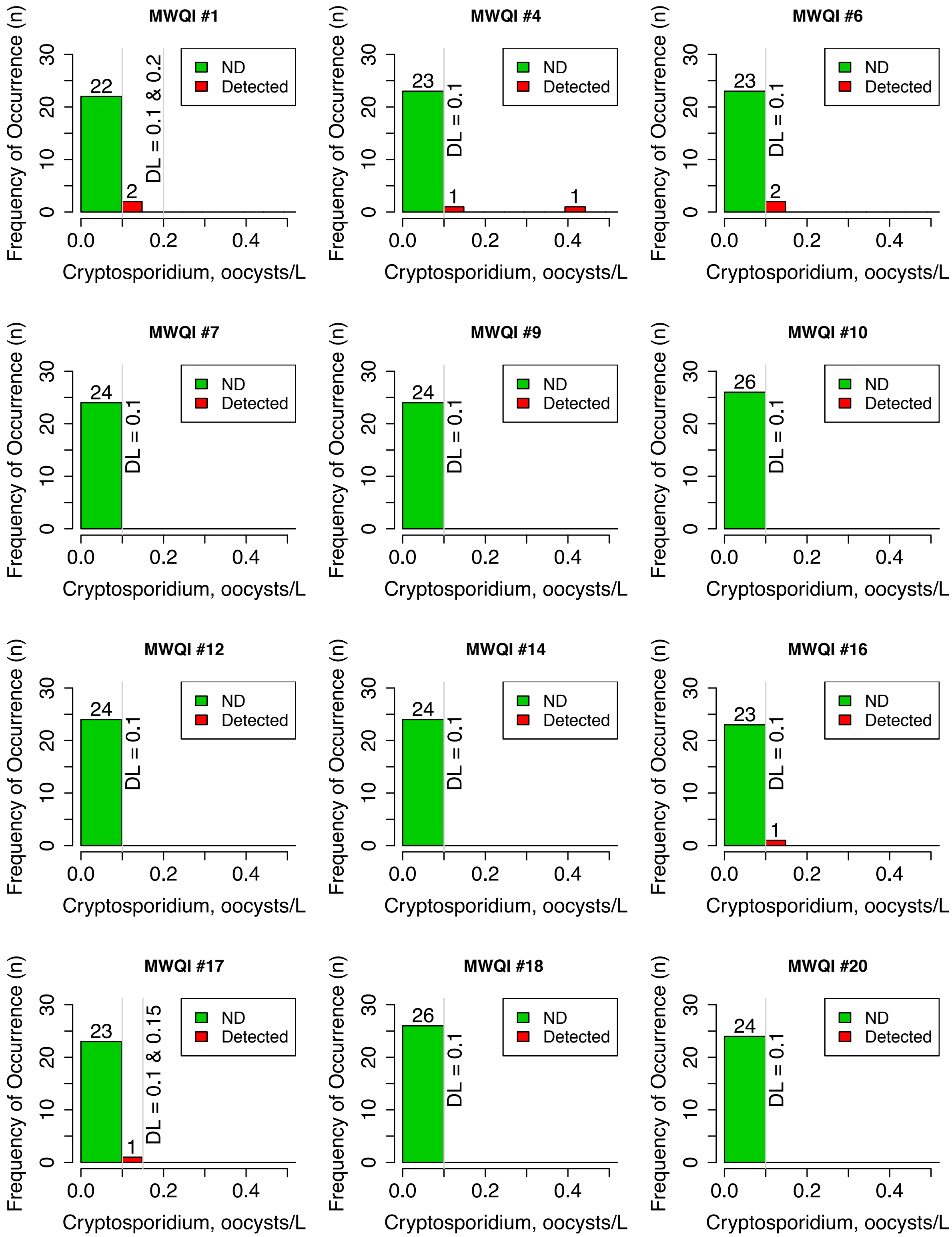

Figure 8. Ambient *Cryptosporidium* Results by Site

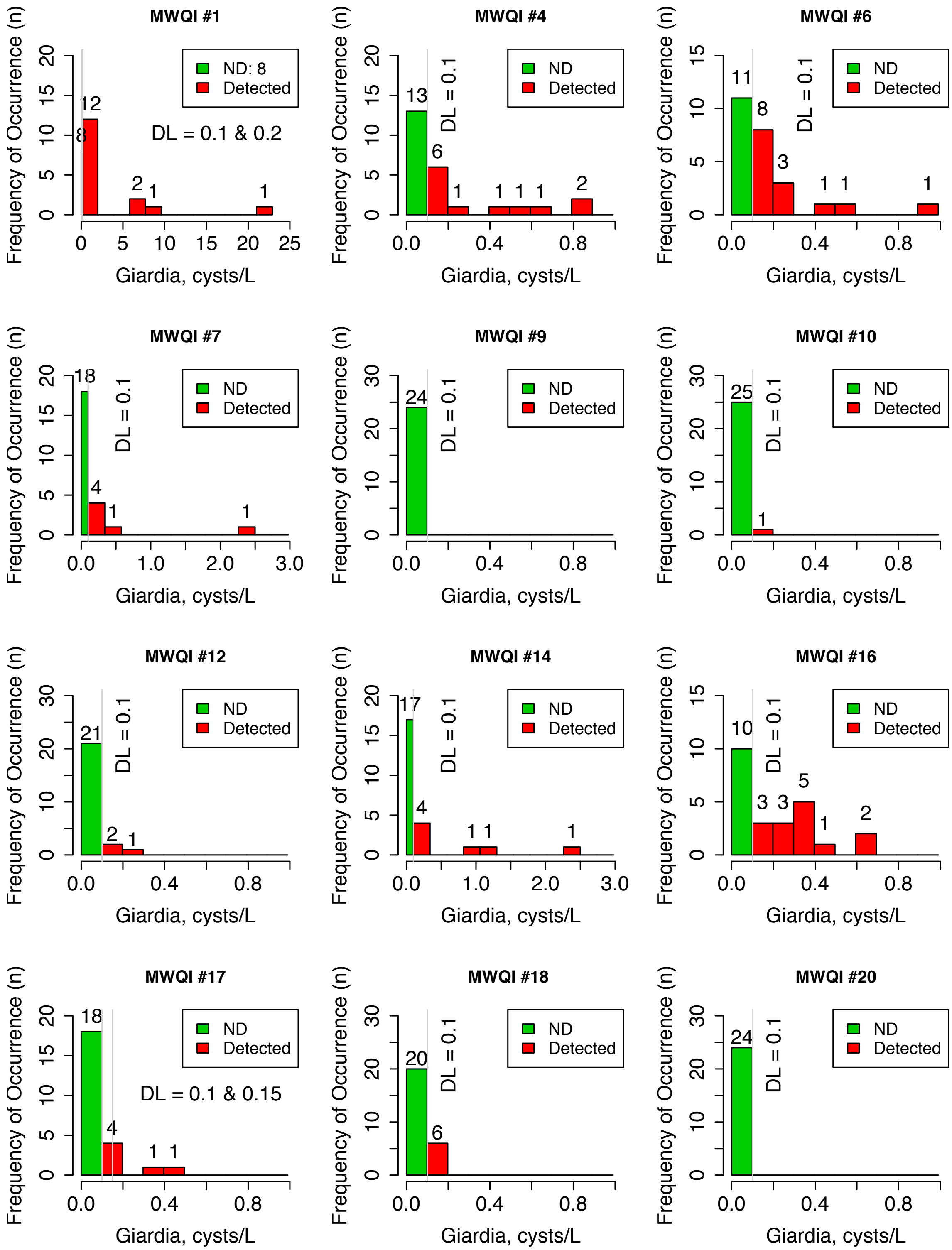

Figure 9. Ambient *Giardia* Results by Site

3.3 Data Quality Evaluation

In addition to the laboratory quality assurance (QA) program quality control (QC) samples were collected to measure the accuracy and precision of the reported results. The Pathogen Study collected matrix spike (MS) samples to assess matrix interference with the analytical method, and field duplicates to assess field precision and sample variability. In addition, the analytical laboratory performed internal control analyses of their Ongoing Precision and Recovery (OPR) samples, a component of internal lab QC for Method 1623, which involve weekly analyses of reagent water samples spiked with *Cryptosporidium* or *Giardia* oocysts/cysts to verify all performance criteria. The complete QC sample results are included in **Appendix B**, and the MS and laboratory OPR results are presented in **Table 8.**

Overall, the MS recoveries are within the range of those seen by drinking water agencies during the first round of LT2 sampling (2007), where the average MS recovery was 40% (USEPA, 2011). The MS recoveries for USEPA Method 1623 can be low, and variable depending on matrix effects, but these recovery levels are still deemed to be acceptable by LT2 measurement quality objective standards. The USEPA notes in their LT2 FAQ[7] that if the recovery rate of a MS sample is within the range of the quality control acceptance criteria identified in the analytical method (13% - 111%), the corresponding field sample is valid. The USEPA further notes that some source water matrices may make it difficult to meet the MS acceptance criteria. The USEPA accepts field samples that correspond with samples with low MS recovery for calculation of the *Cryptosporidium* bin calculation. The Pathogen Study was designed to maintain consistency with the LT2 program, which accounts for the known method recovery limitations.

3.3.1 Temporary Variance

The Pathogen Workgroup identified low matrix recoveries (<5% for *Cryptosporidium*) as a potential issue through the first three events, though laboratory QA was reported as acceptable based on the analytical method and LT2 data quality objectives, which do not consider matrix recoveries. As noted above, one key goal of the Pathogen Study was to maintain consistency with the LT2 program, which already accounts for the known method recovery limitations.[8] USEPA Method 1622 or 1623 is required for LT2 samples. The Pathogen Subgroup and the analytical laboratories identified an issue with the Immunomagnetic separation (IMS) beads used for USEPA Method 1623, an additional potential cause of the lower than expected recoveries, and developed a short-term action plan to better assess data quality and improve the understanding of the recovery limitations.

---

[7] USEPA FAQ for Public Water Systems Reporting/Compliance: https://safewater.zendesk.com/hc/en-us/articles/211399088-The-recovery-rate-of-a-matrix-spike-sample-is-below-the-quality-control-acceptance-criteria-identified-in-the-analytical-method-13-111-Is-the-corresponding-field-sample-valid-What-steps-should-be-taken-

[8] USEPA FAQ for Public Water Systems Reporting/Compliance: https://safewater.zendesk.com/hc/en-us/articles/211399088-The-recovery-rate-of-a-matrix-spike-sample-is-below-the-quality-control-acceptance-criteria-identified-in-the-analytical-method-13-111-Is-the-corresponding-field-sample-valid-What-steps-should-be-taken-

A temporary variance to the monitoring design was implemented during July and August 2015, reducing the number of sites and increasing the number of QA/QC samples collected. A memorandum[9] (See **Appendix C**) was submitted to the technical advisory committee (TAC), summarizing the issue and proposed approach. The variance was concluded after the laboratory received notification from the supplier that the IMS bead issue was resolved, and after the laboratory observed a return to typical OPR recovery results over two consecutive months.

Table 8. Ambient QA/QC Sample Results

Year	Month	Method	MS Sample Location	MS Recovery[a]		OPR Recovery[b]	
				Crypto.	*Giardia*	*Crypto.*	*Giardia*
2015	April	1623	MWQI #14	1%	1%	69%	62%
	May	1623	MWQI #1	0%	3%	22%	66%
	June	1623	MWQI #18	27%	1%	54%	84%
	July	1623	MWQI #18	0%	11%	53%	69%
		1623	MWQI #4	1%	15%	53%	69%
		1623.1	MWQI #4	0%	11%	68%	55%
	August	1623	MWQI #4	11%	74%	79%	90%
		1623	MWQI #6	17%	72%	79%	90%
		1623.1	MWQI #6	21%	64%	72%	81%
		1623 by Eurofins	MWQI #6	32%	71%	57%	47%
	September	1623	MWQI #16	32%	87%	82%	80%
	October	1623	MWQI #17	41%	70%	77%	81%
	November	1623	MWQI #10	76%	83%	71%	86%
	December	1623	MWQI #7	76%	81%	74%	85%
2016	January	1623	MWQI #9	1%	20%	75%	71%
	February	1623	MWQI #12	65%	47%	79%	61%
	March	1623	MWQI #6	0%	0%	74%	62%

[9] Larry Walker Associates, Inc. Temporary Variance to Delta Regional Monitoring Program Pathogen Monitoring Schedule to Evaluate Reagent Supply and Method Performance. Submitted to Aquatic Science Center, July, 2015.

Year	Month	Method	MS Sample Location	MS Recovery[a]		OPR Recovery[b]	
				Crypto.	*Giardia*	*Crypto.*	*Giardia*
	April	1623	MWQI #14	2%	3%	67%	82%
	May	1623	MWQI #1	13%	71%	74%	73%
	June	1623	MWQI #18	44%	81%	71%	69%
	July	1623	MWQI #4	0%	35%	75%	67%
	August	1623	MWQI #20	34%	45%	71%	54%
	September	1623	MWQI #16	91%	85%	48%	52%
	October	1623	MWQI #17	25%	73%	70%	47%
	November	1623	MWQI #10	85%	75%	66%	73%
	December	1623	MWQI #7	25%	66%	60%	64%
2017	January	1623	MWQI #9	44%	74%	80%	68%
	February	1623	MWQI #12	1%	1%	86%	76%
	March	1623	MWQI #6	0%	2%	84%	84%

Notes:

[a] EPA Method 1623 defines the acceptance criteria for MS recovery as 13% to111% for *Cryprosporidium*, and 15% to 118% for *Giardia* (Section 9.5.1 of Method 1623; Tables 3 and 4). LT2 data quality objectives do not consider MS recoveries in determining the validity of a corresponding field sample.

[b] EPA Method 1623 specifies that OPR *Cryptosporidium* recovery should be from 11 percent to 100 percent, and OPR *Giardia* recovery should be from 14 percent to 100 percent to be considered acceptable (Section 9.7.3 of Method 1623; Tables 3 and 4)

4. CONCLUSIONS

The Pathogen Study did not find *Cryptosporidium* concentrations at any of the sites that triggered additional investigations or studies. The study also found that there are no immediate expected bin level changes for water supply intakes either in the Delta or immediately upstream of the Delta. As a result, no further actions or study are necessary. Overall, *Giardia* was detected more frequently than *Cryptosporidium* at both ambient and intake locations; however, the Basin Plan does not set a threshold for the evaluation of *Giardia* levels.

The RMP assessment questions, and their answers based on study results, are presented in **Table 9**.

Table 9. RMP Assessment Questions and Study Conclusions

<table>
<tr><th>Assessment Question</th><th>Study Conclusion</th></tr>
<tr><td colspan="2">ST1 Are current pathogen levels supportive of the municipal drinking water quality beneficial use as described in the Basin Plan?</td></tr>
<tr><td>A. Are the current pathogen levels for each Delta water intake and those immediately upstream (i.e., Sacramento Area) different than the previous LT2 sampling? Are any drinking water intakes reclassified into a higher bin level?</td><td>No, there are no significant changes to pathogen levels compared to the previous LT2 sampling. Drinking water intakes would be classified the same (Bin Level 1) as in previous LT2 monitoring.</td></tr>
<tr><td>B. Are Basin Plan trigger values exceeded?</td><td>No, results were all below the Basin Plan trigger values for the WTPs evaluated.</td></tr>
<tr><td colspan="2">SPLP1 Can any changes in bin level be attributed to an identifiable event, condition, or changes in a source?</td></tr>
<tr><td>A. What are the concentrations in ambient waters upstream or downstream from intakes with observed changes to bin levels?</td><td rowspan="4">N/A, no bin level changes were observed</td></tr>
<tr><td>B. What are the concentrations in ambient waters upstream or downstream from intakes with observed changes to bin levels?</td></tr>
<tr><td>C. What is the influence of sources (agriculture, POTWs, urban runoff, upstream tributary, natural, recreation, and other) on pathogen levels at drinking water intakes?</td></tr>
<tr><td>D. Are there new discharges or changes in sources or conditions that could explain the change in bin level compared to previous LT2 monitoring?</td></tr>
<tr><td colspan="2">SPLP2 What is the viability and infectivity of pathogens at drinking water intakes?</td></tr>
<tr><td>A. What percentage of Cryptosporidium found in ambient waters and source waters can cause infection?</td><td>N/A, no study was triggered</td></tr>
<tr><td colspan="2">SPLP3 What are the factors affecting decay and growth rates and can they be quantified and characterized for the purpose of modeling?</td></tr>
<tr><td>A. Is there recent research or literature on the environmental fate of Cryptosporidium and Giardia that can be used to develop decay/growth rates in models?</td><td>N/A, no study was triggered</td></tr>
<tr><td>B. What are the observed changes in Cryptosporidium and Giardia concentrations as</td><td>N/A, no study was triggered</td></tr>
</table>

Assessment Question	Study Conclusion
a pulse of ambient water or source water moves through the watershed and Delta?	

References

Brookes, J.D., Antenucci, J., Hipsey, M., Burch, M.D., Ashbolt, N.J., and Ferguson, C. (2004) Fate and transport of pathogens in lakes and reservoirs. *Environ. Int.* **30**: 741-759.

Carey, C.M., Lee, H., and Trevors, J.T. (2004) Biology, persistence and detection of *Cryptosporidium parvum* and *Cryptosporidium hominis* oocyst. *Wat. Res.* **38**: 818-862.

Chappell, C.M., Okhuysen, P.C., Langer-Curry, R., WIdmer, G., Akiyoshi, D., Tanriverdi, S., Tzipori, S. 2006. *Cryptosporidium hominis:* Experimental challenge of healthy adults. *Am. J. Trop. Med. Hyg.* 75:851-857.

Dai, X., and Boll, J. (2006) Settling velocity of *Cryptosporidium parvum* and *Giardia lamblia*. *Water Research* **40**: 1321-1325.

Ferguson, C., Husman, A.M.D., Altavilla, N., Deere, D., and Ashbolt, N. (2003) Fate and transport of surface water pathogens in watersheds. *Crit. Rev. Environ. Sci. Technol.* **33**: 299-361.

Freire-Santos, F., Oteiza-Lopez, A.M., Vergara-Castiblanco, C.A., and Ares-Mazas, E. (2000) Study of the combined influence of environmental factors on viability of *Cryptosporidium parvum* oocysts in water evaluated by fluorogenic vital dyes and excystation techniques. *Vet. Parasitol.* **89**: 253-259.

Harwood et al, 2005. Validity of the indicator organism paradigm for pathogen reduction in reclaimed water and public health protection. Appl. Environ. Microbiol. 71:3163-3170.

Okhuysen et al. 1999. Virulence of three distinct *Cryptosporidium* isolates for healthy adults. F. Infectious Dis. 180:1275-1281.

Okhuysen, P.C., Rich, S.M., Chappell, C.L., Grimes, K.A., Widmer, G., Feng, X., Tzipori, S. 2002. Infectivity of a *Cryptosporidium parvum* isolate of cervine origin for healthy adults and interferon-γ knockout mice. *Journal of Infectious Diseases*, 185: 1320-1325.

USEPA. 2006. Source Water Monitoring Guidance Manual for Public Water Systems for the Final Long Term 2 Enhanced Surface Water Treatment Rule. Office of Water, EPA 815-R06-005.

USEPA. 2011. Report on LT2 Round 1 Cryptosporodium Matrix Spike Recovery. Office of Ground Water and Drinking Water.

Walker, M., Leddy, K., and Hagar, E. (2001) Effects of combined water potential and temperature stresses on *Cryptosporidium parvum* oocysts. *Appl. Environ. Microbiol.* **67**: 5526-5529.

Appendix A. Drinking Water Intake and Ambient Data

Ambient *Cryptosporidium* data (ocysts/L)

Location ID	Description	Source(s) Represented	Rationale for Inclusion	2015									2016													2017				
				April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan	Feb.	March	# Detects	Max	Mean
MWQI #14	Colusa Basin Ag Drain	Agriculture	Source representation	<0.1	<0.1	<0.1	NS	NS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	------	0
				<0.1												<0.1														
MWQI #1	Natomas East Main Drainage Canal	Stormwater, Agriculture	Source representation	<0.1	<0.1	<0.1	NS	NS	**0.1**	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.1	2	0.1	0.0091
					<0.1												<0.1													
MWQI #18	Sacramento River at Westin Boat Dock	Stormwater, Combined Sewer System	Proximity to intakes	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	------	0
						<0.1												<0.1												
MWQI #4	Sacramento River at Hood	Stormwater,Wastewater	General characterization	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.4**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2	0.4	0.0208
																			<0.1											
MWQI #20	Cache Slough near Ryder Island	Wetlands	Source Representation	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	------	0
																				<0.1										
MWQI #16	Mokelumne River at Benson's		Input to Delta	<0.1	<0.1	<0.1	NS	NS	< 0.1	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1	0.1	0.0045
									< 0.1												<0.1									
MWQI #17	Calaveras River at UOP Footbridge	Stormwater	Source representation	<0.1	<0.1	<0.1	NS	NS	<0.1	< 0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.15	<0.1	1	0.1	0.0045
										< 0.1												<0.1								
MWQI #10	Rock Slough at CCWD Fish Facility		General characterization	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	< 0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	------	0
											< 0.1												<0.1							
MWQI #7	Old River at Bacon Island		General characterization	<0.1	<0.1	<0.1	NS	NS	<0.1	<0.1	<0.1	< 0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	------	0
												< 0.1												<0.1						
MWQI #9	Banks Pumping Plant		Export from Delta	<0.1	<0.1	<0.1	NS	NS	<0.1	<0.1	<0.1	<0.1	< 0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	------	0
													< 0.1												<0.1					
MWQI #12	Jones Pumping Plant		Export from Delta	<0.1	<0.1	<0.1	NS	NS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0	------	0
														<0.1												<0.1				
MWQI #6	San Joaquin River near Vernalis		Input to Delta	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	NS	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	2	0.1	0.0083
															<0.1												<0.1			

Notes

NS Sites not sampled during the temporary sampling variance due to IMS reagent issues

Mean calculated using "0" for ND values, per LT2 guidance (*USEPA. 2006. Source Water Monitoring Guidance Manual for Public Water Systems for the Final Long Term 2 Enhanced Surface Water Treatment Rule. Office of Water. EPA 815-R06-005*)

Field duplicate results are shown under corresponding sample result

Ambient *Giardia* data (cysts/L)

Location ID	Description	Source(s) Represented	Rationale for Inclusion	2015									2016												2017					
				April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan	Feb.	March	# Detect	Max	Mean
MWQI #14	Colusa Basin Ag Drain	Agriculture	Source representation	<0.1	<0.1	<0.1	NS	NS	<0.1	<0.1	**0.1**	**0.9**	**1.2**	<0.1	**0.2**	<0.1	<0.1	<0.1	<0.1	<0.1	**2.4**	<0.1	**0.3**	**0.1**	<0.1	<0.1	<0.1	7	2.4	0.22
				<0.1												<0.1														
MWQI #1	Natomas East Main Drainage Canal	Stormwater, Agriculture	Source representation	<0.1	**0.4**	**0.3**	NS	NS	**21.5**	**5.8**	**7.9**	**5.9**	**0.4**	**1.4**	**0.5**	**0.3**	<0.1	**0.8**	<0.1	**0.6**	<0.1	**0.1**	**0.2**	<0.1	<0.1	<0.2	<0.1	14	22	1.94
					0.3												**0.4**													
MWQI #18	Sacramento River at Westin Boat Dock	Stormwater, Combined Sewer System	Proximity to intakes	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	**0.1**	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	5	0.1	0.02
						0.1												<0.1												
MWQI #4	Sacramento River at Hood	Stormwater,Wastewater	General characterization	<0.1	**0.6**	<0.1	<0.1	**0.2**	**0.1**	<0.1	<0.1	**0.8**	**0.4**	<0.1	<0.1	<0.1	<0.1	**0.8**	<0.1	**0.1**	**0.1**	**0.5**	**0.1**	**0.1**	<0.1	<0.1	<0.1	11	0.8	0.15
																			0.1											
MWQI #20	Cache Slough near Ryder Island	Wetlands	Source Representation	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0		0
																				<0.1										
MWQI #16	Mokelumne River at Benson's		Input to Delta	<0.1	<0.1	<0.1	NS	NS	**0.3**	<0.1	**0.1**	**0.6**	<0.1	**0.2**	**0.3**	**0.1**	**0.3**	**0.2**	**0.2**	<0.1	<0.1	**0.3**	**0.4**	**0.6**	**0.1**	<0.1	<0.1	13	0.6	0.17
									0.3												<0.1									
MWQI #17	Calaveras River at UOP Footbridge	Stormwater	Source representation	**0.4**	<0.1	<0.1	NS	NS	<0.1	< 0.1	<0.1	**0.1**	**0.1**	<0.1	<0.1	<0.1	<0.1	**0.3**	<0.1	**0.1**	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.15	<0.1	6	0.4	0.05
										< 0.1												<0.1								
MWQI #10	Rock Slough at CCWD Fish Facility		General characterization	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	< 0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	1	0.1	0.004
											< 0.1												<0.1							
MWQI #7	Old River at Bacon Island		General characterization	**0.1**	<0.1	<0.1	NS	NS	<0.1	<0.1	<0.1	**0.2**	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	**2.3**	<0.1	<0.1	**0.4**	<0.1	<0.1	**0.1**	6	2.3	0.13
												< 0.1												<0.1						
MWQI #9	Banks Pumping Plant		Export from Delta	<0.1	<0.1	<0.1	NS	NS	<0.1	<0.1	<0.1	<0.1	< 0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0		0
													< 0.1												<0.1					
MWQI #12	Jones Pumping Plant		Export from Delta	<0.1	<0.1	<0.1	NS	NS	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.2**	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	3	0.2	0.02
														<0.1												<0.1				
MWQI #6	San Joaquin River near Vernalis		Input to Delta	**0.2**	<0.1	**0.5**	**0.1**	**0.9**	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	NS	**0.4**	**0.1**	**0.1**	**0.1**	**0.1**	**0.2**	**0.1**	<0.1	<0.1	<0.1	14	0.9	0.13
															0.2												**0.1**			

Notes

NS Sites not sampled during the temporary sampling variance due to IMS reagent issues

Mean calculated using "0" for ND values, per LT2 guidance (*USEPA. 2006. Source Water Monitoring Guidance Manual for Public Water Systems for the Final Long Term 2 Enhanced Surface Water Treatment Rule. Office of Water. EPA 815-R06-005*)

Field duplicate results are shown under corresponding sample result

Location ID	Description	Source(s) Represented	Rationale for Inclusion	2015												2016												2017												2018	Max Annual
				Jan	Feb	Mar	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Mean
West Sacramento - George Kristoff WTP	Sacramento River	Drinking water intake	Upstream of Sacramento urban area				NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					0
Sacramento – Fairbairn WTP	American River	Drinking water intake	In Sacramento urban area				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1											0
Sacramento – Sacramento River WTP	Sacramento River	Drinking water intake	In Sacramento urban area				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.2**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1											0.017
EBMUD – Freeport Intake (FRWA)	Sacramento River	Drinking water intake	Downstream of Sacramento urban area				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.2**	NS (1)	NS (1)	NS (1)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NS (1)	NS (1)	NS (1)											0.017
City of Fairfield – North Bay Aqueduct	Barker Slough	Drinking water intake	North Delta water with some local watershed runoff in wet season				<0.1	**0.2**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.14	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.15	<0.1	<0.1	<0.1											0.017
Stockton – Delta WTP	San Joaquin River	Drinking water intake	In eastern Delta				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NS(1)	NS(1)	NS(1)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1											0
											<0.1										<0.1																				
CCWD – Randall Bold WTP	Western Delta/Los Vaqueros Reservoir	Drinking water intake	In western Delta				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1										0
Zone 7 Water Agency – Patterson Pass WTP	South Bay Aqueduct	Drinking water intake	100% Delta water in South Bay Aqueduct	< 0.09	NS	< 0.04	<0.08 (2)	<0.08	<0.07	<0.07	<0.07	<0.08	< 0.06	NS	NS	NS	NS	NS	< 0.07	< 0.08	<0.10	<0.1	**0.07**	<0.08	<0.08	<0.08	< 0.07														0.006
								<0.08																																	
SCVWD – Penitencia WTP	South Bay Aqueduct	Drinking water intake	Blend of South Bay Aqueduct and Lake Del Valle				<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1																0

Notes:

NS Not sampled

(1) Do not sample during the months when they are not drawing water from the Delta

(2) Lab failed QC. Resampled in May

Field duplicate results are shown under corresponding sample result

Drinking Water Intake results for *Giardia*

Location ID	Description	Source(s) Represented	Rationale for Inclusion	2015									2016												2017												2018
				April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.
West Sacramento - George Kristoff WTP	Sacramento River	Drinking water intake	Upstream of Sacramento urban area	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	<0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
Sacramento – Fairbairn WTP	American River	Drinking water intake	In Sacramento urban area	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1	**0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**	**0.3**	**0.3**	<0.1	**0.1**	<0.1	**0.2**										
Sacramento – Sacramento River WTP	Sacramento River	Drinking water intake	In Sacramento urban area	<0.1	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.2**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1										
EBMUD – Freeport Intake (FRWA)	Sacramento River	Drinking water intake	Downstream of Sacramento urban area	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	NS	NS	NS	NS (2)	NS (2)	NS (2)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	**0.4**	<0.1	<0.1	NS (2)	NS (2)	NS (2)										
City of Fairfield – North Bay Aqueduct	Barker Slough	Drinking water intake	North Delta water with some local watershed runoff in wet season	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)										
Stockton – Delta WTP	San Joaquin River	Drinking water intake	In eastern Delta	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)										
CCWD – Randall Bold WTP	Western Delta/Los Vaqueros Reservoir	Drinking water intake	In western Delta	NS	NS	NS	NS	NS	NS	NS	NS	NS	<0.1	<0.1	NS	<0.1	<0.1	**0.2**	<0.1	<0.1	<0.1	<0.1	<0.1	**0.1**	<0.1	<0.1	NS	<0.1									
Zone 7 Water Agency – Patterson Pass WTP	South Bay Aqueduct	Drinking water intake	100% Delta water in South Bay Aqueduct	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)	NA(1)													
SCVWD – Penitencia WTP	South Bay Aqueduct	Drinking water intake	Blend of South Bay Aqueduct and Lake Del Valle	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1															

Notes:

NA(1) Not Applicable. Do not analyze for Giardia

NS Not Sampled

(2) Do not sample during the months when they are not drawing water from the Delta

Field duplicate results are shown under corresponding sample result

Appendix B. QA/QC Data

Year	Month	Method	MS Sample Location	MS Recovery		OPR Recovery		Sample		Field Dup				Lab Dup			
				Crypto.	*Giardia*	*Crypto.*	*Giardia*	*Crypto.*	*Giardia*	*Crypto.*	RPD	*Giardia*	RPD	*Crypto.*	RPD	*Giardia*	RPD
2015	April	1623	Colusa Basin Ag Drain	1%	1%	69%	62%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	ND	0%
	May	1623	Natomas East Main Drainage Canal	0%	3%	22%	66%	<0.1	**0.4**	<0.1	0%	**0.3**	**29%**	ND	0%	**1.4**	**111%**
	June	1623	Sacramento River at Westin Boat Dock	27%	1%	54%	84%	<0.1	<0.1	<0.1	0%	**0.1**	N/A	ND	0%	ND	0%
	July	1623	Sacramento River at Westin Boat Dock	0%	11%	53%	69%	<0.1	<0.1								
		1623	Sacramento River at Hood	1%	15%	53%	69%	<0.1	<0.1					ND	0%	**0.1**	N/A
		1623.1	Sacramento River at Hood	0%	11%	68%	55%	<0.1	<0.1								
	August	1623	Sacramento River at Hood	11%	74%	79%	90%	<0.1	<0.1								
		1623	San Joaquin River near Vernalis	17%	72%	79%	90%	<0.1	**0.2**					ND	0%	**0.2**	0%
		1623.1	San Joaquin River near Vernalis	21%	64%	72%	81%	<0.1	<0.1								
		Eurofins MS	San Joaquin River near Vernalis	32%	71%	57%	47%										
	September	1623	Mokelumne River at Benson's Ferry	32%	87%	82%	80%	<0.1	**0.3**	<0.1	0%	**0.3**	0%	ND	0%	ND	N/A
	October	1623	Calaveras River at UOP Footbridge	41%	70%	77%	81%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	ND	0%
	November	1623	Rock Slough @ CCWD Fish Facility	76%	83%	71%	86%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	ND	0%
	December	1623	Old River at Bacon Island	76%	81%	74%	85%	<0.1	**0.2**	<0.1	0%	<0.1	N/A	ND	N/A	**0.2**	0%
2016	January	1623	Banks Pumping Plant	1%	20%	75%	71%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	ND	0%
	February	1623	Jones Pumping Plant	65%	47%	79%	61%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	ND	0%
	March	1623	San Joaquin River near Vernalis	0%	0%	74%	62%	<0.1	<0.1	<0.1	0%	**0.2**	N/A	ND	0%	ND	0%
	April	1623	Colusa Basin Ag Drain	2%	3%	67%	82%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	**0.8**	N/A
	May	1623	Natomas East Main Drainage Canal	13%	71%	74%	73%	<0.1	<0.1	<0.1	0%	**0.4**	N/A	ND	0%	**0.8**	N/A
	June	1623	Sacramento River at Westin Boat Dock	44%	81%	71%	69%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	ND	0%
	July	1623	Sacramento River at Hood	0%	35%	75%	67%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	**0.1**	N/A
	August	1623	Cache Slough nr Ryer Island	34%	45%	71%	54%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	ND	0%
	September	1623	Mokelumne River at Benson's Ferry	91%	85%	48%	52%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	ND	0%
	October	1623	Calaveras River at UOP Footbridge	25%	73%	70%	47%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	ND	0%
	November	1623	Rock Slough @ CCWD Fish Facility	85%	75%	66%	73%	<0.1	<0.1	<0.1	0%	**0.1**	N/A	ND	0%	ND	0%
	December	1623	Old River at Bacon Island	25%	66%	60%	64%	<0.1	<0.1	<0.1	0%	**0.4**	N/A	ND	0%	**0.2**	N/A
2017	January	1623	Banks Pumping Plant	44%	74%	80%	68%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	**0.1**	N/A
	February	1623	Jones Pumping Plant	1%	1%	86%	76%	<0.1	<0.1	<0.1	0%	<0.1	0%	ND	0%	ND	0%
	March	1623	San Joaquin River near Vernalis	0%	2%	84%	84%	<0.1	<0.1	<0.1	0%	**0.1**	N/A	ND	0%	ND	0%

Appendix C. Temporary Variance Memorandum

MEMORANDUM

LARRY WALKER ASSOCIATES

Brian M. Laurenson, P.E.
Hope McCaslin Taylor, Ph.D.
707 4th Street
Suite 200
Davis, CA 95616
530.753.6400
530.753.7030 fax
BrianL@lwa.com
HopeT@lwa.com
via email only

DATE: July 15, 2015

TO: Phil Trowbridge, Aquatic Science Center

Thomas Jabusch, Aquatic Science Center

CC: Delta Regional Monitoring Program Technical Advisory Committee

Elaine Archibald, Archibald Consulting

SUBJECT: **TEMPORARY VARIANCE TO DELTA REGIONAL MONITORING PROGRAM PATHOGEN MONITORING SCHEDULE TO EVALUATE REAGENT SUPPLY AND METHOD PERFORMANCE**

The Pathogen Subgroup to the Delta Regional Monitoring Program (RMP) Technical Advisory Committee (TAC) designed and is assisting in the implementation of a pathogen monitoring work plan (Pathogen Study). The Pathogen Study is based on the monitoring needs specified in the Sacramento River Basin and San Joaquin River Basin Water Quality Control Plan (Basin Plan). The Pathogen Study coordinates “external” Long Term 2 Enhanced Surface Water Treatment Rule (LT2) monitoring performed by water agencies between April 2015 and April 2017 with the Delta RMP “ambient” monitoring at key locations in and tributary to the Delta. In this way the Delta RMP ambient monitoring can support investigations and follow-up related to any identified changes in water intake pathogen (*Cryptosporidium* or *Giardia*) concentrations based on the LT2 reporting and assessment criteria. The Pathogen Subgroup performed an initial quality control (QC) review of the first three sample results collected by the Delta RMP from April 2015 through June 2015.

The Pathogen Subgroup identified low matrix recoveries (<5% for *Cryptosporidium*) as a potential issue through the first three events, though laboratory QC were acceptable based on the analytical method and LT2 measurement quality objectives, which do not consider matrix recoveries. One key goal of the Pathogen Study was to maintain consistency with the LT2 program, which already accounts for the known method recovery limitations. Environmental Protection Agency (EPA) Method 1622 or 1623 are required for LT2 samples. The Pathogen Subgroup and the analytical laboratories identified an additional potential cause of the lower than expected recoveries and developed a short term action plan to better assess data quality and improve the understanding of the recovery limitations.

This memorandum describes the expected short-term issue with the immunomagnetic separation (IMS) beads used for EPA Method 1623, the Delta RMP sample recoveries, and the recommended modifications to the sampling analysis approach.

IMS Bead Recovery Issue

EPA summarized (see Attachment A) the occurrence of a nationwide production problem with the reagent (IMS beads) used for Method 1623. The manufacturer (IDEXX) expects the problem to be resolved before August 2015. In the meantime, labs have been noting inconsistent recoveries in their Ongoing Precision and Recovery (OPR) samples, with some recoveries reduced to half of the historical performance level. The OPR samples are a component of internal lab QC for Method 1623, which involve weekly analyses of reagent water samples spiked with *Cryptosporidium* or *Giardia* oocysts/cysts to verify all performance criteria. The issue with inconsistent OPR sample recoveries applies to all LT2 work nationwide. EPA is working with laboratories to evaluate the *Cryptosporidium* and *Giardia* recoveries associated with various lots of IMS beads (Attachment A).

The primary Delta RMP and LT2-approved laboratory (BioVir) OPR results are typically >60%, but they have noted much lower OPR results for batches of IMS beads used during April-June. 2015 BioVir OPR performance is shown in Table 1.

Table 1. BioVir 2015 Ongoing Precision and Recovery (OPR) Results

BioVir Sample No.	Week No.	Date	% Giardia	% Crypto	Negative Staining Control Result
150001	1	01/05/15	57.58	61.62	neg
150054	3	01/12/15	42.42	62.63	neg
150095	4	01/19/15	39.39	63.64	neg
150112	5	01/23/15	42.00	62.63	neg
150153	6	02/02/15	79.00	80.81	neg
150194	7	02/10/15	57.00	81.82	neg
150223	8	02/16/15	47.00	56.57	neg
150262	9	02/23/15	63.00	58.59	neg
150293	10	03/02/15	59.00	54.55	neg
150321	11	03/09/15	76.00	76.77	neg
150421	13	03/25/15	62.63	70.71	neg
150476	15	04/06/15	61.62	68.69	neg
150537	15	04/09/15	40.00	52.53	neg
150599	16	04/17/15	57.00	28.28	neg
150604	17	04/20/15	65.00	23.23	neg
150752	19	05/06/15	52.00	16.16	neg

BioVir Sample No.	Week No.	Date	% Giardia	% Crypto	Negative Staining Control Result
150761	19	05/08/15	65.00	19.19	neg
150761	19	05/14/15	67.00	69.70	neg
150795	20	05/14/15	68.00	71.72	neg
150801	21	05/18/15	79.00	69.70	neg
150801	21	05/18/15	63.00	80.81	neg
150801	21	05/18/15	53.00	57.58	neg
150839	21	05/21/15	84.00	56.57	neg
150866	22	05/27/15	69.00	22.22	neg
150943	23	06/01/15	84.00	53.54	neg
150943	23	06/01/15	24.00	24.24	neg

Delta RMP Matrix Spike Recoveries

The Pathogen Subgroup review of the initial quality control data for the pathogen study identified low matrix spike (MS) recoveries, though laboratory QC (OPR sample recovery) was acceptable based on the LT2 measurement quality objectives. Matrix spike samples are ambient water samples spiked with a known quantity of *Cryptosporidium* or *Giardia* oocysts/cysts, and then analyzed to determine the effect of the matrix on the method's oocyst/cyst recovery. The first two MS samples were collected from sites with potentially more complex and variable matrices (Natomas East Main Drain and Colusa Basin Ag Drain) than the main-stem Delta locations. However, without additional information, it is not possible to confirm whether recovery problems are related to the reagent, site-specific matrix interference or other lab issues. The matrix spike sample recoveries and laboratory OPR performance for the first three months of sample collection are shown in Table 2.

Table 2. Matrix Spike (MS) and Laboratory Ongoing Precision and Recovery (OPR) Performance

		MS Recovery		OPR Recovery	
Month	**Location**	***Cryptosporidium***	***Giardia***	***Cryptosporidium***	***Giardia***
April	Natomas East Main Drainage Canal	1%	1%	69%	62%
May	Colusa Basin Ag Drain	0%	3%	22%	66%
June	Sacramento River at Westin Boat Dock	27%	1%	54%	84%

Modified Sampling and Analysis Approach

The Pathogen Study was designed to maintain consistency with the LT2 program, which already accounts for the known method recovery limitations. The matrix spike recoveries for EPA Method 1623 can be low, but still acceptable by LT2 measurement quality objective standards. However, the Pathogen Subcommittee determined that additional investigation of matrix recoveries, LT2-allowable method modifications, and alternate laboratories could inform changes to the Pathogen Study and better quantify uncertainty in the results.

The Pathogen Study is constrained to the current Delta RMP budget and cost-neutral sample collection modifications include the following:

- Reduce the total number of sites to five, limiting them to the main-stem of the Delta where the matrices are less complex and less variable and would have potentially better recovery rates. Each of the main stem sites will be sampled each month as shown in Table 3 as "active" sites.
- Conduct additional QA/QC samples to evaluate the method performance, and to compare BioVir and Eurofins performance.
    - Collect matrix spike samples from two locations per event for BioVir to better assess recovery performance in different matrices,
    - Send a matrix spike sample from one of the matrix spike locations to Eurofins to assess inter-laboratory matrix spike recovery performance. These samples will be used to assess laboratory performance and inform Year 2 Pathogen Study planning.
    - Collect an additional inter-method field duplicate and matrix spike for BioVir to analyze using Method 1623.1. Method 1623.1 is a modification to 1623 that has been shown to improve Cryptosporidium recovery by >20%. Method 1623.1 is allowed for LT2 use. These samples will assess method performance and provide a basis for any recommended changes.

The Pathogen Subcommittee recommends following this modified sampling approach at least through August 2015. The decision to switch back to the original sampling plan will be adaptively managed based on the results from these additional QA analyses, and on the resolution of the reagent issue with the manufacturer.

BioVir recently received new batches of IMS beads, and the OPRs have improved (>80%). The Pathogen Subcommittee will wait until consistent OPR results are observed before reverting to the original sampling approach. The modified sampling approach will allow evaluation of the performance of method 1623.1, with a replicate field sample and MS to be analyzed using both 1623 and 1623.1 at one location.

Table 3. RMP Pathogen Study Monitoring Locations

Location ID	Description	Short Term Status
MWQI #14	Colusa Basin Ag Drain	Inactive through August 2015
MWQI #1	Natomas East Main Drainage Canal	Inactive through August 2015
MWQI #18	Sacramento River at Westin Boat Dock	Active
MWQI #4	Sacramento River at Hood	Active
MWQI #20	Cache Slough near Ryder Island	Active
MWQI #16	Mokelumne River at Benson's Ferry	Inactive through August 2015
MWQI #17	Calaveras River at UOP Footbridge	Inactive through August 2015
MWQI #10	Rock Slough at CCWD Fish Facility	Active

MWQI #7	Old River at Bacon Island	Inactive through August 2015
MWQI #9	Banks Pumping Plant	Inactive through August 2015
MWQI #12	Jones Pumping Plant	Inactive through August 2015
MWQI #6	San Joaquin River near Vernalis	Active

Table 4. Short Term Quality Control Sample Collection Schedule

		BioVir Method 1623			BioVir Method 1623.1		Eurofins Method 1623	
Location ID	**Location Description**	**Field Sample [1]**	**Matrix Spike**	**Second Matrix Spike**	**Inter-Method Duplicate**	**Matrix Spike**	**Inter-Lab Duplicate**	**Matrix Spike**
MWQI #18	Sacramento River at Westin Boat Dock	X	June[2]	July[2]				
MWQI #4	Sacramento River at Hood	X	July[2]	Aug.	July[2]	July[2]	July[2]	July[3]
MWQI #6	San Joaquin River near Vernalis	X	Aug.	Sept.	Aug.	Aug.	Aug.	Aug.
MWQI #20	Cache Slough near Ryder Island	X	Sept.	Oct.	Sept.	Sept.	Sept.	Sept.
MWQI #10	Rock Slough at CCWD Fish Facility	X	Oct.		Oct.	Oct.	Oct.	Oct.

Notes:
[1] Field samples are collected at every active location in Table 3 each month.
[2] Monitoring has been completed for this event.
[3] Matrix spike was not analyzed due to laboratory error.
Schedule is provisional and likely will continue through August 2015, pending Pathogen Subcommittee review

Attachment A.

Environmental Protection Agency Correspondence

Rick Zimmer

From:	Miller, Carrie <Miller.Carrie@epa.gov>
Sent:	Tuesday, April 28, 2015 2:11 PM
To:	Miller, Carrie
Subject:	LT2 Monitoring for Cryptosporidium

To All Concerned:

It has come to TSC's attention that some laboratories are experiencing lower than usual crypto recovery in their quality control (QC) samples. Several laboratories and vendors are actively investigating the issue which appears to be a synergistic effect between some of the method reagents. TSC will follow up when we have more conclusive information about the cause of the recovery issue and will share any advice we become aware of as to how laboratories may address it.

Laboratories performing analyses for the LT2 follow Method 1622, 1623 or 1623.1 and any sample in a batch associated with unacceptable quality control samples is unacceptable. Per the LT2 "SOURCE WATER MONITORING GUIDANCE MANUAL FOR PUBLIC WATER SYSTEMS:"[1]

If a PWS is unable to report a valid analytical result for a scheduled sampling date due to equipment failure, loss of or damage to the sample, failure to comply with the analytical method requirements, including the quality control requirements in 40 CFR § 141.704 or the failure of an approved laboratory to analyze the sample, the PWS must collect a replacement sample. The PWS must collect the replacement sample not later than 21 days after receiving information that an analytical result cannot be reported for the scheduled date, unless the PWS demonstrates that collecting a replacement sample within this time frame is not feasible or EPA/the State approves an alternative resampling date. The PWS must submit an explanation for the delayed sampling date to EPA/the State concurrent with the shipment of the sample to the laboratory [40 CFR § 141.702(b)(2)].

PWSs may contact their state representative, on the list accessed from the link below, and request an alternative resampling date.

http://water.epa.gov/lawsregs/rulesregs/sdwa/lt2/upload/lt2contactnov20141.pdf

[1]Information taken from section 3.2.2 in the Source Water Monitoring Guidance for Public Water Systems PDF (EPA 815-R06-005 February 2006)

Thank you,

Carrie Miller
Cryptosporidium Laboratory Technical Liaison
U.S. Environmental Protection Agency
Office of Ground Water and Drinking Water
Technical Support Center, MC 140
26 West Martin Luther King Drive
Cincinnati, OH 45268
513-569-7919 phone
513-569-7191 fax