
Delta Regional Monitoring Program

Quality Assurance Program Plan

Prepared by

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San Francisco Estuary Institute-Aquatic Science Center

Version 2.2

September 30, 2016

San Francisco Estuary Institute-Aquatic Science Center
4911 Central Avenue
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Title and Approval

For

PROJECT NAME: Delta Regional Monitoring Program

Date: September 30, 2016

NAME OF RESPONSIBLE ORGANIZATION: San Francisco Estuary Institute – Aquatic Science Center (SFEI-ASC)

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1. Project Task/Organization

1.1. Roles

An organizational chart, with monitoring responsibilities noted, is provided in Figure 1-1.

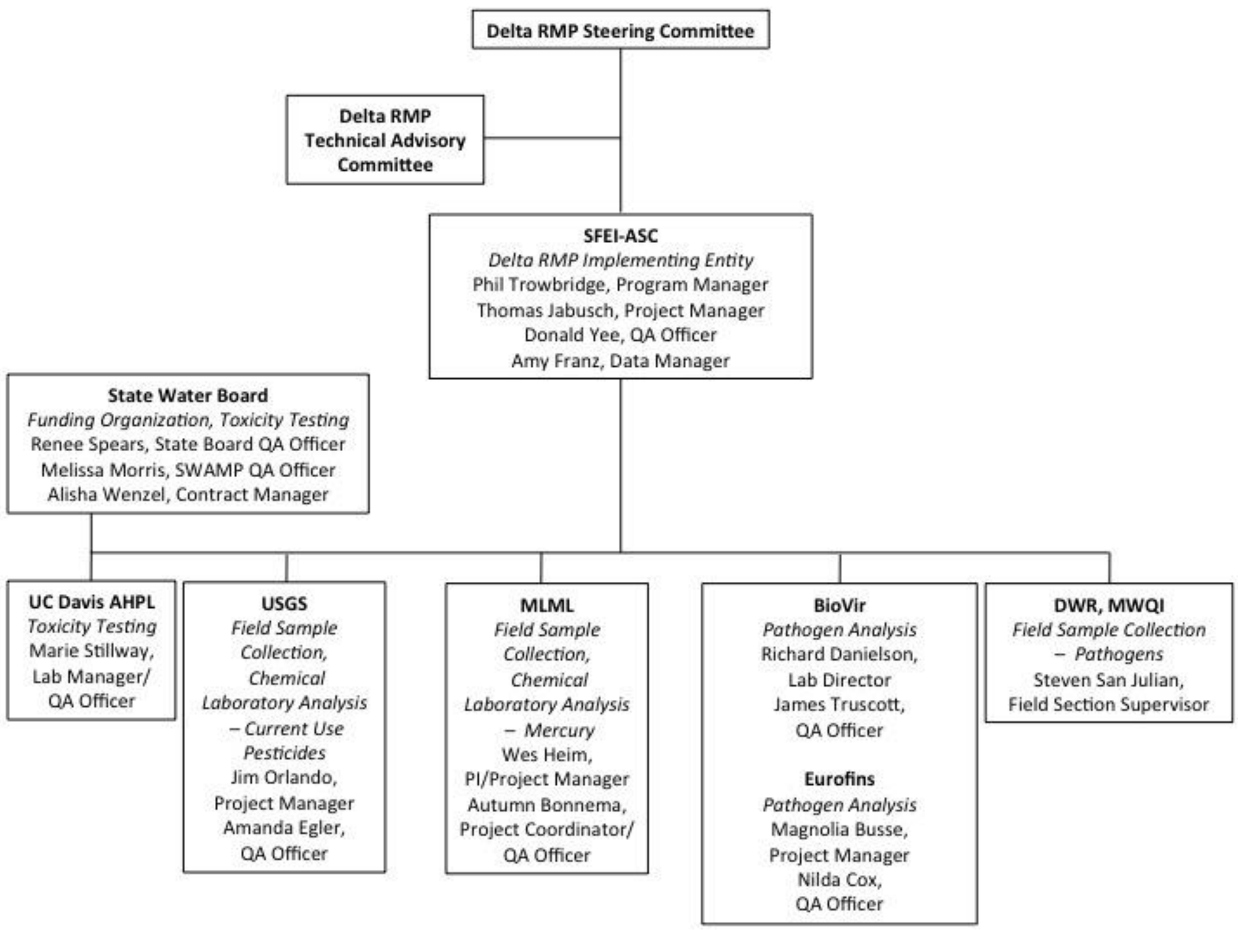

Figure 1.1. Project Organization Chart.

Under the direction of the Delta Regional Monitoring Program (Delta RMP) Steering Committee, the Technical Advisory Committee (TAC) provides technical oversight of the Delta RMP and San Francisco Estuary Institute – Aquatic Science Center (SFEI-ASC) manages and operates the program as the implementing entity.

The SFEI-ASC Project Manager is responsible for coordinating all aspects of monitoring components of this project including the organization of field sampling, scheduling of sampling days, and interactions with the contract laboratories. The SFEI-ASC Project Manager works in close consultation with the SFEI-ASC Program Manager. SFEI-ASC Program Manager and SFEI-

ASC Project Manager report directly to the Delta RMP Steering Committee. Project plans are to be reviewed annually.

The SFEI-ASC Regional Data Center Manager will ensure that data submitted by subcontractor labs are timely, complete, and properly incorporated into the Regional Data Center database, for use by statewide compilations of data, such as CEDEN or My Water Quality Estuary Portal.

SFEI-ASC's Quality Assurance Officer (QAO) role is to establish and oversee the quality assurance and quality control (QA/QC) procedures found in this QAPP, which include field and laboratory activities. The SFEI QAO will work with the Quality Assurance Officers for contracted analytical laboratories, reviewing and communicating all QA/QC issues contained in this QAPP to the laboratories. Contact information for key staff is listed in Table 0.1.

Laboratories contracted by SFEI-ASC provide high quality analytical services. The analytical laboratories will act as a technical resource to SFEI-ASC staff and management. The responsible personnel and contact information are listed above in Table 0.1.

Table 1.1. Analytical laboratories.

Analytical laboratory	Lab abbrev.	Matrix	Analytical Services	ELAP/NELAP Accreditation Number	Lab QA Manual Link
BioVir Laboratories	BioVir	Water	Cryptosporidium/ Giardia	ELAP Certificate No. 1795	Quality System Plan for Environmental Health, Inc., D/B/A Biovir Laboratories
Eurofins	Eurofins	Water	Cryptosporidium/ Giardia	ELAP Certificate No. 2944/ NELAP ID: 4034	LT2- Giardia/Crypto QAPP
Marine Pollution Studies Lab, Moss Landing Marine Labs	MPSL	Tissue, Water	Fish attributes, mercury, suspended solids	N/A	MPSL Laboratory QAP, Revision 5. February, 2006[1]
CA Department of Fish and Wildlife - Water Pollution Control Lab[2]	WPCL	Water	Chlorophyll *a*, dissolved organic carbon	ELAP Certificate No. 1622	N/A[3]
U.S. Geological Survey Organic Chemistry Research Laboratory	USGS-OCRL	Water	Field Measurements, Pesticides	N/A	N/A[4]
U.S. Geological Survey National Water Quality	USGS-NWQL	Water	Copper (dissolved),		Quality Assurance and Quality Control

[1] Contact MPSL Laboratory QAO (Table 0.1) to obtain a copy.

[2] Performs specific analytical services on behalf of MPSL.

[3] The WPCL lab QA manual is currently being updated. It will be made available when the updates are complete.

[4] USGS-OCRL currently has no standalone document describing general QA procedures. The existing QA procedures have been incorporated into the Delta RMP QAPP, as appropriate, and are also documented in SOPs.

Analytical laboratory	Lab abbrev.	Matrix	Analytical Services	ELAP/NELAP Accreditation Number	Lab QA Manual Link
Laboratory			dissolved and particulate organic carbon	N/A	
University of California Davis-Aquatic Health Program Laboratory	UCD-AHPL	Water	Toxicity, TIEs, alkalinity, ammonia, hardness	ELAP Certificate No. 2243	UCD AHPL QAM

1.2. Persons Responsible for QAPP Update and Maintenance

Changes and updates to this QAPP may be made after a review of the evidence for change by SFEI-ASC's Project Manager and QAO, and with the concurrence of the Delta RMP Technical Advisory Committee. SFEI-ASC's QAO will be responsible for making the changes, submitting drafts for review, preparing a final copy, and submitting the final for signatures. Changes are expected year to year in the early years of Delta RMP implementation.

2. Problem Definition/Background

The Delta RMP was initiated in 2008 by the Central Valley Regional Water Quality Control Board (Regional Water Board) with the primary goal of tracking and documenting the effectiveness of beneficial use protection and restoration efforts through comprehensive monitoring of water quality constituents and their effects in the Delta. The development of the Delta RMP was initially prompted by the collapse of the populations of several species of fish in the early 2000s, an event that triggered new inquiries into the potential role of contaminants in what is now termed the Pelagic Organism Decline (POD). However, these inquiries highlighted shortcomings of existing monitoring efforts to address questions at the scale of the Delta. The recognition that data from current monitoring programs were inadequate in coverage, could not easily be combined, and were not adequate to support a rigorous analysis of the role of contaminants in the POD persuaded regulatory agencies to improve coordination across multiple monitoring programs.

In addition, the Delta RMP reflects an increasing desire among water quality and resource managers throughout the state for more integrated information about patterns and trends in ambient conditions across watersheds and regions. Many stressors on beneficial uses are interrelated and must be addressed more holistically. The Delta RMP complements existing larger-scale collaborative monitoring efforts throughout the state that attempt to address questions and concerns about regional conditions and trends (e.g., San Francisco Bay RMP, Southern California Bight Monitoring Program, Surface Water Ambient Monitoring Program).

The Delta RMP Steering Committee is the decision-making body of the Delta RMP. The Steering Committee is responsible for establishing the Delta RMP's strategic direction and the policies and procedures that govern its operation. The Steering Committee may direct Delta RMP staff and advisory committees to assist in meeting the objectives and may delegate day-to-day functions of the Delta RMP to the Delta RMP's implementing entity.

The Steering Committee authorizes the implementation of agreements among the participating members and, specifically:

1. Directs the fiscal/operating agent to request and receive federal, state, local, and private funds from any source and to expend those moneys to accomplish the Delta RMP's goals
2. Approves budgets and expenditures
3. Directs the fiscal/operating agent to enter into partnerships, contracts, and other legal agreements on behalf of the Delta RMP, as necessary to fulfill the Delta RMP's mission
4. Approves Delta RMP work products and any other plans, products, or resolutions of the Delta RMP
5. Sets priorities and oversee the activities of the Technical Advisory Committees
6. Establishes and oversees the implementation of policies and procedures necessary to the day-to-day functioning of the Delta RMP

The Delta RMP Steering Committee decided that the initial Delta RMP would focus on mercury, nutrients, pathogens, and pesticides. Management questions to be answered by the monitoring were developed and provided to the TAC to design a monitoring program that would answer the management questions posed by the Steering Committee. This QAPP is addressing mercury, pathogens, and pesticides. The Delta RMP nutrient monitoring is still being developed. When the nutrient monitoring has been developed, this QAPP will be updated to include nutrient and nutrient-associated constituents.

3. Program Tasks Description

3.1. Work Statement and Products

To address the management questions posed (Appendix A), the Delta RMP will conduct sampling for pesticides (monthly), mercury (quarterly for unfiltered methylmercury and associated constituents in water and annually for fish), and pathogens (monthly). This work is planned and performed under the guidance of the Delta RMP Steering Committee with technical advice on monitoring design from the Technical Advisory Committees, which are composed of state and federal regulators, permittees, water supply, and coordinated monitoring program representatives.

Data from Status and Trends monitoring efforts will be made available annually for download via the SFEI-ASC Contaminant Data, Display and Download tool (CD3) (http://cd3.sfei.org) and subsequently incorporated into the California Environmental Data Exchange Network (CEDEN) and the California Estuaries web portal. Data will be reported in an Annual Monitoring Report, and an interpretive main report (*The Pulse of The Delta*) that will be published in intervals decided by the Steering Committee to summarize monitoring results and synthesize the information they provide in the context of the assessment and management questions that provide the framework for the monitoring program.

Table 3.1 provides a summary of key products of the Delta RMP. The Pulse of the Delta will be the main interpretive reporting vehicle for Delta RMP results. The audience of this report will be local, state, and federal decision-makers and the interested public. The data will be interpreted to answer Delta RMP management and assessment questions, based on the most appropriate statistical analyses to be used for evaluating the data in relation to a question, as guided by the TAC. Both the TAC and the SC will provide review of the Pulse of the Delta. Prior to release of the Pulse of the Delta, SFEI-ASC will provide basic annual data reports (Annual Monitoring Results Report) for review by the TAC and SC. Monitoring results will be one of the main decision factors for adaptive changes to the monitoring program. An annual SC planning meeting/workshop will identify adaptations needed to the monitoring program and will be informed by monitoring results. In addition, the TAC will have access to preliminary data through the TAC website and the password-protected data-sharing workspace of the California Estuaries web portal.

Table 3.1. Delta RMP reporting cycle.

Deliverable	Frequency	Release date
Data uploads		
Provisional data (available to TAC members)	Variable	Variable
CD3	Annually[1]	March 1
CEDEN	Annually	March 1
California Estuaries web portal	Annually	March 1
Reports		
Annual Monitoring Reports (including QA report)	Annually	March 1
Technical Reports	Variable	Variable
Pulse of the Delta	Variable	Fall

[1]Time period of data for annual reporting: pesticides (15 months: July 1 through September 30 of the following year), mercury (July 1 – June 30), pathogens (April 1 – March 31).

3.2. Evaluation of Monitoring Data

The program's mission is to inform decisions on how to protect and restore beneficial uses of water in the Delta, by producing objective and cost-effective scientific information critical to understanding regional water quality conditions and trends. Data analyses and interpretation in the Delta RMP provide answers to the assessment questions, and ultimately, the management questions.

Program participants develop the interpretation collectively in a science-based and collaborative process. The Delta RMP Steering Committee has the lead role in making statements about the core management questions. With oversight by the TAC, program staff and contracted independent scientists conduct the relevant analyses by evaluating the data against the specific monitoring questions and any stated benchmarks or performance targets. A solid review process ensures that information generated by the program is high quality, objective, and relevant.

The Delta RMP provides decision-makers and resource managers with information to focus on water quality problems, to determine what is and what is not a problem and facilitate informed decisions. However, decisions based on the data about whether there is impairment or whether and what types of actions are to be taken are made *outside* of the program. Regulatory decisions, such as 303(d) listings, will be made by the Water Board using its own process. Therefore, the Delta RMP *does not* have a detailed assessment framework for data interpretation and follow-up.

3.3. Benefical Uses and Water Quality Goals

The core management questions and assessment questions currently encompass the following beneficial uses in the Central Valley Region Basin Plan (Basin Plan, Central Valley Regional Water Board 2011) and the Bay-Delta Water Quality Control Plan (Bay-Delta Plan, State Water Board 2006):

- Cold Freshwater Habitat (COLD)
- Commercial and Sport Fishing (COMM)
- Estuarine Habitat (EST)
- Fish Migration (MIGR)
- Municipal and Domestic Water Supply (MUN)
- Preservation of Rare, Threatened, or Endangered Species (RARE)
- Water Contact Recreation (REC1)
- Noncontact Water Recreation (REC2)
- Shellfish Harvesting (SHELL)
- Fish Spawning (SPWN)
- Warm Freshwater Habitat (WARM)
- Wildlife Habitat (WILD)

Table 3.2 provides an overview of beneficial uses that are relevant to the prioritized assessment questions (Appendix B) of each of the individual monitoring elements. Table 3.3 summarizes existing numeric water quality criteria and aquatic life benchmarks for target analytes of pesticide monitoring. Chemical specific numeric criteria do not exist for all target analytes. Table 3.4 lists the regulatory targets for methylmercury that will be used in evaluations of Delta RMP data. Table 3.5 provides information on LT2 Rule bin level classification of source water, based on *Cryptosporidium* concentrations. Bin levels are used in trigger exceedance assessments of pathogen monitoring data.

Table 3.2. Beneficial Uses associated with Delta RMP monitoring elements.

Beneficial Use	Pesticides	Mercury	Nutrients[1]	Pathogens
COLD	X	X	X	
COMM		X	X	
EST	X	X	X	
MIGR	X		X	
MUN			X	X
RARE	X	X	X	
REC1			X	
REC2			X	
SHELL		X	X	
SPWN	X		X	
WARM	X	X	X	
WILD	X	X	X	

[1]Planned for future implementation.

Table 3.3. EPA Office of Water (OW) Aquatic Life Ambient Water Quality Criteria, EPA Office of Pesticide Programs (OPP) Aquatic Life Benchmarks[5], and Water Quality Objectives for target analytes of pesticide monitoring (Central Valley Water Board 1998, 2007; EPA 2000, 2015a, 2015b)(concentrations in µg/L).

Pesticide	**Water Quality Objectives**		**Water Quality Objectives**		**OW Aquatic Life Criteria**		**OPP Aquatic Life Benchmarks** *(italicized: OPP benchmark equivalents, Luo et al. 2013)*						**OPP Benchmark Equivalents**
	R5 -Delta		CA Toxics Rule				Fish		Invertebrates		Nonvascular plants	Vascular plants	Lowest reported
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Acute	Acute
Trace Elements													
Copper (dissolved)	10	—	13	9	Calculated using the Biotic Ligand Model		15.7	9.01	2.05	1.11	3.1	2300	—
Degradates													
Chlorpyrifos OA	—	—	—	—	—	—	—	—	—	—	—	—	—
Dichlorophenyl-3-methyl Urea, 3,4-	—	—	—	—	—	—	—	—	—	—	—	—	—
DDD(p,p')	—	—	—	—	—	—	—	—	—	—	—	—	—
DDE(p,p')	—	—	—	—	—	—	—	—	—	—	—	—	—
Dichloroaniline, 3,4-	—	—	—	—	—	—	—	—	—	—	—	—	—
Dichloroaniline, 3,5-	—	—	—	—	—	—	—	—	—	—	—	—	—
Dichlorophenyl Urea, 3,4-	—	—	—	—	—	—	—	—	—	—	—	—	—
Diazoxon	—	—	—	—	—	—	—	—	—	—	—	—	—
Fipronil Desulfinyl	—	—	—	—	—	—	10	0.59	100	10.3	140	>100	—
Fipronil Desulfinyl Amide	—	—	—	—	—	—	—	—	—	—	—	—	—
Fipronil Sulfide	—	—	—	—	—	—	41.5	6.6	1.065	0.11	140	>100	—
Fipronil Sulfone	—	—	—	—	—	—	12.5	0.67	0.36	0.037	140	>100	—
Malaoxon	—	—	—	—	0.065	0.013	—	—	—	—	—	—	—

[5] EPA. 2015a. Aquatic Life Benchmarks for Pesticide Registration. URL: http://www2.epa.gov/pesticide-science-and-assessing-pesticide-risks/aquatic-life-benchmarks-pesticide-registration#benchmarks. Accessed on July 8, 2016.

Pesticide	**Water Quality Objectives**		**Water Quality Objectives**		**OW Aquatic Life Criteria**		**OPP Aquatic Life Benchmarks** *(italicized: OPP benchmark equivalents, Luo et al. 2013)*						**OPP Benchmark Equivalents**
	R5 -Delta		CA Toxics Rule				Fish		Invertebrates		Nonvascular plants	Vascular plants	Lowest reported
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Acute	Acute
Tebupirimfos oxon	—	—	—	—	—	—	—	—	—	—	—	—	—
Fungicides													
Acibenzolar-S-methyl	—	—	—	—	—	—	—	—	—	—	—	—	—
Azoxystrobin	—	—	—	—	—	—	235	147	130	44	49	3400	—
Boscalid	—	—	—	—	—	—	1350	116	>2665	790	1340	>3900	—
Captan	—	—	—	—	—	—	13.1	16.5	4200	560	320	>12700	—
Carbendazim	—	—	—	—	—	—	*190*	—	*150*	—	*7700*	—	*75*
Chlorothalonil	—	—	—	—	—	—	5.25	3	1.8	0.6	6.8	630	—
Cyazofamid	—	—	—	—	—	—	>53.5	90.1	>650	<87	—	>1220	—
Cymoxanil	—	—	—	—	—	—	*29000*	—	*27000*	—	*254*	—	*254*
Cyproconazole	—	—	—	—	—	—	—	—	—	—	—	—	—
Cyprodinil	—	—	—	—	—	—	1205	230	16	8	2250	—	—
Desthio-Prothioconazole	—	—	—	—	—	—	—	—	—	—	—	—	—
Difenoconazole	—	—	—	—	—	—	405	8.7	385	5.6	98	1900	—
Dimethomorph	—	—	—	—	—	—	3100	<341	>5300	110	—	—	—
Ethaboxam	—	—	—	—	—	—	—	—	—	—	—	—	—
Famoxadone	—	—	—	—	—	—	*11*	—	*12*	—	*22*	—	*5.5*
Fenamidone	—	—	—	—	—	—	370	4.7	24.5	12.5	70	>880	—
Fenarimol	—	—	—	—	—	—	450	180	3400	113	100	—	—
Fenbuconazole	—	—	—	—	—	—	*1500*	—	*2300*	—	*330*	—	*330*
Fenhexamide	—	—	—	—	—	—	670	101	>9400	1000	4820	>2300	—
Fluazinam	—	—	—	—	—	—	18	0.69	90	68	1.1	—	—
Fludioxonil	—	—	—	—	—	—	235	19	450	<19	70	>1000	—
Fluopicolide	—	—	—	—	—	—	174.5	151	>850	190	<1.4	>3200	—
Fluoxastrobin	—	—	—	—	—	—	*435*	—	*480*	—	*350*	—	*217.5*

Pesticide	Water Quality Objectives		Water Quality Objectives		OW Aquatic Life Criteria		OPP Aquatic Life Benchmarks *(italicized: OPP benchmark equivalents, Luo et al. 2013)*						OPP Benchmark Equivalents
	R5 -Delta		CA Toxics Rule				Fish		Invertebrates		Nonvascular plants	Vascular plants	Lowest reported
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Acute	Acute
Flusilazole	—	—	—	—	—	—	—	—	—	—	—	—	—
Flutolanil	—	—	—	—	—	—	1250	233	>3400	530	8010	8010	—
Flutriafol	—	—	—	—	—	—	16500	4800	33550	310	460	780	—
Fluxapyroxad	—	—	—	—	—	—	—	—	—	—	—	—	—
Imazalil	—	—	—	—	—	—	*1480*	—	*3500*	—	*870*	—	*740*
Ipconazole	—	—	—	—	—	—	765	0.18	850	—	—	—	—
Iprodione	—	—	—	—	—	—	—	260	120	—	>130	>12640	—
Kresoxim-methyl	—	—	—	—	—	—	95	87	166	55	29.2	>301	—
Mandipropamid	—	—	—	—	—	—	—	220	3550	—	>2500	>7400	—
Metalaxyl	—	—	—	—	—	—	65000	9100	14000	100	140000	92000	—
Metconazole	—	—	—	—	—	—	*2100*	—	*4200*	—	*1700*	—	*1050*
Myclobutanil	—	—	—	—	—	—	1200	980	5500	—	830	—	—
Paclobutrazol	—	—	—	—	—	—	7950	49	120	9	40800	8	—
PCNB	—	—	—	—	—	—	50	13	385	18	—	—	—
Picoxystrobin	—	—	—	—	—	—	32.5	36	12	1	4	210	—
Propiconazole	—	—	—	—	—	—	425	95	650	260	21	4828	—
Pyraclostrobin	—	—	—	—	—	—	3.1	2.35	7.85	4	1.5	1720	—
Pyrimethanil	—	—	—	—	—	—	5050	20	1500	1000	1800	7800	—
Quinoxyfen	—	—	—	—	—	—	—	—	—	—	—	—	—
Sedaxane	—	—	—	—	—	—	—	—	—	—	—	—	—
Tebuconazole	—	—	—	—	—	—	1135	12	1440	120	1450	151.5	—
Tetraconazole	—	—	—	—	—	—	1925	300	1315	190	—	310	—
Thiabendazole	—	—	—	—	—	—	280	110	155	42	3060	2320	—
Triadimefon	—	—	—	—	—	—	2050	41	800	52	17000	—	—
Triadimenol	—	—	—	—	—	—	—	—	—	—	—	—	—

Pesticide	Water Quality Objectives		Water Quality Objectives		OW Aquatic Life Criteria		OPP Aquatic Life Benchmarks *(italicized: OPP benchmark equivalents, Luo et al. 2013)*						OPP Benchmark Equivalents
	R5 -Delta		CA Toxics Rule				Fish		Invertebrates		Nonvascular plants	Vascular plants	Lowest reported
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Acute	Acute
Trifloxystrobin	—	—	—	—	—	—	7.15	4.3	12.65	2.76	37.1	>1930	—
Triflumizole	—	—	—	—	—	—	290	33	700	67	140	720	—
Triticonazole	—	—	—	—	—	—	—	—	—	—	—	—	—
Zoxamide	—	—	—	—	—	—	78	3.48	>390	39	10	19	—
Herbicides													
Alachlor	—	—	—	—	—	—	900	187	1250	110	1.64	2.3	—
Atrazine	—	—	—	—	—	—	2650	—	360	60	<1	0.001	—
Benfluralin	—	—	—	—	—	—	—	—	—	—	—	—	—
Butralin	—	—	—	—	—	—	—	—	—	—	—	—	—
Butylate	—	—	—	—	—	—	105	—	5950	—	—	—	—
Clomazone	—	—	—	—	—	—	1450	350	2700	2200	167	30200	—
Cycloate	—	—	—	—	—	—	2250	—	1300	—	—	—	—
Cyhalofop-butyl	—	—	—	—	—	—	*790*	—	*2700*	—	*960*	—	*395*
Dacthal	—	—	—	—	—	—	15000	—	13500	—	>11000	>11000	—
Dithiopyr	—	—	—	—	—	—	—	—	—	—	—	—	—
Diuron	—	—	—	—	—	—	200	26.4	80	200	2.4	15	—
EPTC	—	—	—	—	—	—	7000	—	3250	800	1,400	5600	—
Ethalfluralin	—	—	—	—	—	—	16	0.4	30	24	25	—	—
Flufenacet	—	—	—	—	—	—	—	—	—	—	—	—	—
Fluridone	—	—	—	—	—	—	2800	480	680	—	—	—	—
Hexazinone	—	—	—	—	—	—	137000	17000	75800	20000	7	37.4	—
Metolachlor	—	—	—	—	—	—	1600	30	550	1	8	21	—
Molinate	—	—	—	—	—	—	105	390	170	340	220	3300	—
Napropamide	—	—	—	—	—	—	3200	1100	7150	1100	3400	—	—
Novaluron	—	—	—	—	—	—	>490	6.16	0.075	0.03	3549	>75.4	—

Pesticide	**Water Quality Objectives**		**Water Quality Objectives**		**OW Aquatic Life Criteria**		**OPP Aquatic Life Benchmarks** *(italicized: OPP benchmark equivalents, Luo et al. 2013)*						**OPP Benchmark Equivalents**
	R5 -Delta		CA Toxics Rule				Fish		Invertebrates		Nonvascular plants	Vascular plants	Lowest reported
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Acute	Acute
Oryzalin	—	—	—	—	—	—	1440	220	750	358	42	>15.4	—
Oxadiazon	—	—	—	—	—	—	600	33	1090	33	5.2	41	—
Oxyfluorfen	—	—	—	—	—	—	100	1.3	750	13	1.1	0.33	—
Pebulate	—	—	—	—	—	—	3150	—	3,315	—	230	1800	—
Pendimethalin	—	—	—	—	—	—	69	6.3	140	14.5	5.2	12.5	—
Penoxsulam	—	—	—	—	—	—	>51000	10200	>49250	2950	92	3	—
Prodiamine	—	—	—	—	—	—	>6.5	—	>6.5	1.5	—	—	—
Prometon	—	—	—	—	—	—	6000	19700	12850	3450	98	—	—
Prometryn	—	—	—	—	—	—	1455	620	4850	1000	1.04	11.9	—
Propanil	—	—	—	—	—	—	1150	9.1	600	86	16	110	—
Pronamide	—	—	—	—	—	—	36000	7700	>2800	600	>4000	1180	—
Simazine	—	—	—	—	—	—	3200	—	500	—	2.24	140	—
Thiazopyr	—	—	—	—	—	—	*3400*	—	*6100*	—	*40*	—	*40*
Thiobencarb	—	—	—	—	—	—	220	21	50.6	1.0	17	770	—
Triallate	—	—	—	—	—	—	600	38	45.5	14	21	2400	—
Tributhyl Phosphorotrithioate, S,S,S-	—	—	—	—	—	—	122.5	3.5	3.4	1.56	148	1100	—
Trifluralin	—	—	—	—	—	—	20.5	1.14	280	2.4	7.52	43.5	—
Insecticides													
Acetamiprid	—	—	—	—	—	—	>50000	19200	10.5	2.1	>1000	>1000	—
Allethrin	—	—	—	—	—	—	—	—	1.05	—	—	—	—
Azinphos Methyl	—	—	—	—	—	—	0.18	0.055	0.08	0.036	—	—	—
Bifenthrin	—	—	—	—	—	—	0.075	0.04	0.8	0.013	—	—	—
Carbaryl	—	—	2.1	2.1	2.1	2.1	110	6	0.85	0.5	660	1500	—

Pesticide	Water Quality Objectives		Water Quality Objectives		OW Aquatic Life Criteria		OPP Aquatic Life Benchmarks *(italicized: OPP benchmark equivalents, Luo et al. 2013)*						OPP Benchmark Equivalents
	R5 -Delta		CA Toxics Rule				Fish		Invertebrates		Nonvascular plants	Vascular plants	Lowest reported
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Acute	Acute
Carbofuran	—	—	—	—	—	—	44	5.7	1.115	0.75	—	—	—
Chlorantraniliprole	—	—	—	—	—	—	>600	110	4.9	4.5	1800	2000	—
Chlorpyrifos	0.025	0.015	—	—	0.083	0.041	0.9	0.57	0.05	0.04	140	—	0.025
Clothianidin	—	—	—	—	—	—	>50750	9700	11	11	64000	121000	—
Coumaphos	—	—	—	—	—	—	140	11.7	0.037	0.0337	—	—	—
Cyantranilipole	—	—	—	—	—	—	>5000	10700	10.2	6.56	>10000	12100	—
Cyfluthrin, Total	—	—	—	—	—	—	0.034	0.01	0.0125	0.0074	>181	—	—
Cyhalothrin, Total	—	—	—	—	—	—	—	—	—	—	—	—	—
Cypermethrin, Total	—	—	—	—	—	—	0.195	0.14	0.21	0.069	—	—	—
DDT(p,p')	—	—	1.1	0.001	1.1	0.001	—	—	—	—	—	—	—
Deltamethrin	—	—	—	—	—	—	0.29	0.017	0.055	0.0041	—	—	—
Diazinon	0.16	0.1	—	—	0.17	0.17	45	<0.55	0.105	0.17	3700	—	0.16
Dinotefuran	—	—	—	—	—	—	>49550	>6360	>484150	>95300	>97600	>110000	—
Esfenvalerate	—	—	—	—	—	—	0.035	0.035	0.025	0.017	—	—	—
Ethofenprox	—	—	—	—	—	—	1.35	23	0.4	0.17	>18.8	>26	—
Fenpropathrin	—	—	—	—	—	—	1.1	0.091	0.265	0.064	—	—	—
Fenpyroximate	—	—	—	—	—	—	0.22	0.11	0.8	0.56	1.9	>190	—
Fenthion	—	—	—	—	—	—	415	7.5	2.6	0.013	400	>2800	—
Fipronil	—	—	—	—	—	—	41.5	6.6	0.11	0.011	140	>100	—
Flonicamid	—	—	—	—	—	—	*100000*	—	*100000*	—	*3300*	—	*3300*
Imidacloprid	—	—	—	—	—	—	>41500	1200	34.5	1.05	>10000	—	—
Indoxacarb	—	—	—	—	—	—	145	150	300	75	>110	>84	—
Malathion	—	—	—	—	—	0.1	16.5	8.6	0.295	0.035	2400	>9630	—
Methidathion	—	—	—	—	0.065	0.013	1.1	6.3	1.5	0.66	—	—	—
Methoprene	—	—	—	—	—	—	380	48	165	51	—	—	—

Pesticide	Water Quality Objectives		Water Quality Objectives		OW Aquatic Life Criteria		OPP Aquatic Life Benchmarks *(italicized: OPP benchmark equivalents, Luo et al. 2013)*						OPP Benchmark Equivalents
	R5 -Delta		CA Toxics Rule				Fish		Invertebrates		Nonvascular plants	Vascular plants	Lowest reported
	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Chronic	Acute	Acute	Acute
Methoxyfenozide	—	—	—	—	—	—	>2100	530	25	6.3	>3400	—	—
Parathion, Methyl	—	—	—	—	—	—	925	<10	0.485	0.25	15000	18000	—
Pentachloroanisole	—	—	—	—	—	—	28	—	150	—	—	—	—
Permethrin, Total	—	—	—	—	—	—	0.395	0.0515	0.0106	0.0014	68	—	—
Phenothrin	—	—	—	—	—	—	—	—	—	—	—	—	—
Phosmet	—	—	—	—	—	—	35	3.2	1	0.8	—	—	—
Propargite	—	—	—	—	—	—	59	16	37	9	66.2	75000	—
Pyridaben	—	—	—	—	—	—	—	—	—	—	—	—	—
Resmethrin	—	—	—	—	—	—	0.14	0.35	1.55	—	—	—	—
Tebupirimfos	—	—	—	—	—	—	44.5	130	0.039	0.011	630	8800	—
Tefluthrin	—	—	—	—	—	—	0.03	0.004	0.035	0.008	—	—	—
Tetradifon	—	—	—	—	—	—	—	—	—	—	—	—	—
Tetramethrin	—	—	—	—	—	—	1.85	—	22.5	—	—	—	—
T-Fluvalinate	—	—	—	—	—	—	—	—	—	—	—	—	—
Thiacloprid	—	—	—	—	—	—	12600	918	18.9	0.97	45000	>95400	—
Thiamethoxam	—	—	—	—	—	—	>50000	20000	17.5	—	>97000	>90000	—
Tolfenpyrad	—	—	—	—	—	—	—	—	—	—	—	—	—
Plant Growth Regulators													
Flumetralin	—	—	—	—	—	—	—	—	—	—	—	—	—
Synergists													
Piperonyl Butoxide	—	—	—	—	—	—	950	40	255	30	—	—	—

Table 3.4. Water quality benchmarks for mercury (Central Valley Water Board 2011).

Constituent	Water Quality Objectives	
	Central Valley Basin Plan / Sacramento-San Joaquin Delta and Yolo Bypass waterways	
	Muscle tissue of trophic level 4 fish (mg/kg, wet weight)	Water (unfiltered) TMDL implementation goal (ng/L)
Mercury, Methyl	0.24[6]	0.06

Table 3.5. Bin classification for Public Water Systems (EPA 2013).

Cryptosporidium bin concentration (oocysts/L)	**Bin classification**
<0.075	Bin 1
≥ 0.075, <1	Bin 2
≥ 1, < 3	Bin 3
≥ 3	Bin 4

3.4. Constituents to be Monitored and Reported

Delta RMP monitoring will include the collection, measurement, and reporting of many parameters. The following information will be included with each sample collection:

- Site location (latitude and longitude) (Tables 7.1)
- Site sampling date and time (Tables 7.1)
- Matrix sampled (e.g., water)
- Parameter measurements (Table 3.6)
- Collection and analytical methods (Table 4.4)
- Qualifiers and comments (applied by analytical labs or by Delta RMP staff in data review)(Table 6.1)

The current implementation of the Delta RMP includes monitoring for pesticides, mercury, and pathogens. Thus, the QAPP only addresses the pesticides, mercury, and pathogens monitoring

[6] Total mercury concentrations are used as a surrogate for methylmercury concentrations in fish tissue.

elements. The pesticides monitoring element includes chemical analyses and toxicity testing. The chemical analyte groups for this monitoring element include several pesticide groups, dissolved copper, and ancillary parameters such as dissolved/particulate organic carbon and hardness. The mercury monitoring element includes the analysis of samples from water and fish. Table 3.6 provides a complete list of target parameters for the current implementation of the Delta RMP.

Table 3.6. Delta RMP target parameters and reporting units. All parameters listed under pesticide sampling will be analyzed for each pesticide sampling site at each pesticide sampling event. Mercury fish tissue parameters will be analyzed annually and mercury water sampling parameters will be analyzed quarterly. Pathogen monitoring parameters will be analyzed for each pathogen monitoring site at each monthly sampling event.

Pesticide Sampling			
Constituent	**Reporting Group**	**Matrix**	**Unit**
Oxygen, Dissolved	Field Measurements	Water	mg/L
Oxygen, Dissolved	Field Measurements	Water	% saturation
pH	Field Measurements	Water	pH
Specific Conductivity	Field Measurements	Water	µS/cm
Temperature	Field Measurements	Water	°C
Turbidity	Field Measurements	Water	FNU
Pesticide Sampling – Toxicity Testing Laboratory Analysis			
Constituent	**Reporting Group**	**Matrix**	**Unit**
Hardness as $CaCO_3$	Conventional	Water	mg/L
Ceriodaphnia dubia (Reproduction)	Water Column Toxicity	Water	young/original organisms exposed
Ceriodaphnia dubia (Survival)	Water Column Toxicity	Water	%
Hyalella azteca (Survival)[7]	Water Column Toxicity	Water	%
Pimephales promelas (Larval biomass)	Water Column Toxicity	Water	mg/original organisms exposed
Pimephales promelas (Larval survival)	Water Column Toxicity	Water	%
Selenastrum capricornutum (Growth)	Water Column Toxicity	Water	cells/mL
Pesticide Sampling – Chemical Analysis Laboratory			
Constituent	**Reporting Group**	**Matrix**	**Unit**
Dissolved Organic Carbon (DOC)	Conventional	Water	mg/L
Particulate Organic Carbon (POC)	Conventional	Water	mg/L
Total Suspended Solids (TSS)	Conventional	Water	mg/L
Copper (dissolved)	Trace Metals	Water	ug/L
Chlorpyrifos Oxon	Degradates	Water	ng/L
Dichlorophenyl-3-methyl Urea, 3,4-	Degradates	Water	ng/L

[7] Inclusion of *Hyalella* water toxicity testing is pending a final decision by the SC.

Pesticide Sampling – Chemical Analysis Laboratory			
Constituent	**Reporting Group**	**Matrix**	**Unit**
DDD(p,p')	Degradates	Water	ng/L
DDE(p,p')	Degradates	Water	ng/L
Diazoxon	Degradates	Water	ng/L
Dichlorobenzenamine, 3,4-	Degradates	Water	ng/L
Dichloroaniline, 3,5-	Degradates	Water	ng/L
Dichlorophenyl Urea, 3,4-	Degradates	Water	ng/L
Fipronil Desulfinyl	Degradates	Water	ng/L
Fipronil Desulfinyl Amide	Degradates	Water	ng/L
Fipronil Sulfide	Degradates	Water	ng/L
Fipronil Sulfone	Degradates	Water	ng/L
Malaoxon	Degradates	Water	ng/L
Tebupirimfos oxon	Degradates	Water	ng/L
Acibenzolar-S-methyl	Fungicides	Water	ng/L
Azoxystrobin	Fungicides	Water	ng/L
Boscalid	Fungicides	Water	ng/L
Captan	Fungicides	Water	ng/L
Carbendazim	Fungicides	Water	ng/L
Chlorothalonil	Fungicides	Water	ng/L
Cyazofamid	Fungicides	Water	ng/L
Cymoxanil	Fungicides	Water	ng/L
Cyproconazole	Fungicides	Water	ng/L
Cyprodinil	Fungicides	Water	ng/L
Dimethomorph	Fungicides	Water	ng/L
Desthio-Prothioconazole	Fungicides	Water	ng/L
Difenoconazole	Fungicides	Water	ng/L
Ethaboxam	Fungicides	Water	ng/L
Famoxadone	Fungicides	Water	ng/L
Fenamidone	Fungicides	Water	ng/L
Fenarimol	Fungicides	Water	ng/L
Fenbuconazole	Fungicides	Water	ng/L
Fenhexamid	Fungicides	Water	ng/L
Fluazinam	Fungicides	Water	ng/L
Fludioxonil	Fungicides	Water	ng/L
Fluopicolide	Fungicides	Water	ng/L
Fluoxastrobin	Fungicides	Water	ng/L
Flusilazole	Fungicides	Water	ng/L
Flutolanil	Fungicides	Water	ng/L
Flutriafol	Fungicides	Water	ng/L
Fluxapyroxad	Fungicides	Water	ng/L
Imazalil	Fungicides	Water	ng/L

Pesticide Sampling – Chemical Analysis Laboratory			
Constituent	**Reporting Group**	**Matrix**	**Unit**
Ipconazole	Fungicides	Water	ng/L
Iprodione	Fungicides	Water	ng/L
Kresoxim-methyl	Fungicides	Water	ng/L
Mandipropamid	Fungicides	Water	ng/L
Metalaxyl	Fungicides	Water	ng/L
Metconazole	Fungicides	Water	ng/L
Myclobutanil	Fungicides	Water	ng/L
Paclobutrazol	Fungicides	Water	ng/L
PCNB	Fungicides	Water	ng/L
Picoxystrobin	Fungicides	Water	ng/L
Propiconazole	Fungicides	Water	ng/L
Pyraclostrobin	Fungicides	Water	ng/L
Pyrimethanil	Fungicides	Water	ng/L
Quinoxyfen	Fungicides	Water	ng/L
Sedaxane	Fungicides	Water	ng/L
Tebuconazole	Fungicides	Water	ng/L
Tetraconazole	Fungicides	Water	ng/L
Thiabendazole	Fungicides	Water	ng/L
Triadimefon	Fungicides	Water	ng/L
Triadimenol	Fungicides	Water	ng/L
Trifloxystrobin	Fungicides	Water	ng/L
Triflumizole	Fungicides	Water	ng/L
Triticonazole	Fungicides	Water	ng/L
Zoxamide	Fungicides	Water	ng/L
Alachlor	Herbicides	Water	ng/L
Atrazine	Herbicides	Water	ng/L
Benfluralin	Herbicides	Water	ng/L
Butralin	Herbicides	Water	ng/L
Butylate	Herbicides	Water	ng/L
Clomazone	Herbicides	Water	ng/L
Cycloate	Herbicides	Water	ng/L
Cyhalofop-butyl	Herbicides	Water	ng/L
Dacthal	Herbicides	Water	ng/L
Dithiopyr	Herbicides	Water	ng/L
Diuron	Herbicides	Water	ng/L
EPTC	Herbicides	Water	ng/L
Ethalfluralin	Herbicides	Water	ng/L
Flufenacet	Herbicides	Water	ng/L
Fluridone	Herbicides	Water	ng/L
Hexazinone	Herbicides	Water	ng/L

Pesticide Sampling – Chemical Analysis Laboratory			
Constituent	**Reporting Group**	**Matrix**	**Unit**
Metolachlor	Herbicides	Water	ng/L
Molinate	Herbicides	Water	ng/L
Napropamide	Herbicides	Water	ng/L
Novaluron	Herbicides	Water	ng/L
Oryzalin	Herbicides	Water	ng/L
Oxadiazon	Herbicides	Water	ng/L
Oxyfluorfen	Herbicides	Water	ng/L
Pebulate	Herbicides	Water	ng/L
Pendimethalin	Herbicides	Water	ng/L
Penoxsulam	Herbicides	Water	ng/L
Prodiamine	Herbicides	Water	ng/L
Prometon	Herbicides	Water	ng/L
Prometryn	Herbicides	Water	ng/L
Propanil	Herbicides	Water	ng/L
Pronamide	Herbicides	Water	ng/L
Simazine	Herbicides	Water	ng/L
Thiazopyr	Herbicides	Water	ng/L
Thiobencarb	Herbicides	Water	ng/L
Triallate	Herbicides	Water	ng/L
Tributyl Phosphorotrithioate, S,S,S-	Herbicides	Water	ng/L
Trifluralin	Herbicides	Water	ng/L
Acetamiprid	Insecticides	Water	ng/L
Allethrin	Insecticides	Water	ng/L
Azinphos Methyl	Insecticides	Water	ng/L
Bifenthrin	Insecticides	Water	ng/L
Carbaryl	Insecticides	Water	ng/L
Carbofuran	Insecticides	Water	ng/L
Chlorantraniliprole	Insecticides	Water	ng/L
Chlorpyrifos	Insecticides	Water	ng/L
Clothianidin	Insecticides	Water	ng/L
Coumaphos	Insecticides	Water	ng/L
Cyantraniliprole	Insecticides	Water	ng/L
Cyfluthrin, Total	Insecticides	Water	ng/L
Cyhalothrin	Insecticides	Water	ng/L
Cypermethrin, Total	Insecticides	Water	ng/L
DDT(p,p')	Insecticides	Water	ng/L
Deltamethrin	Insecticides	Water	ng/L
Diazinon	Insecticides	Water	ng/L
Dinotefuran	Insecticides	Water	ng/L
Esfenvalerate	Insecticides	Water	ng/L

Pesticide Sampling – Chemical Analysis Laboratory			
Constituent	**Reporting Group**	**Matrix**	**Unit**
Ethofenprox	Insecticides	Water	ng/L
Fenpropathrin	Insecticides	Water	ng/L
Fenpyroximate	Insecticides	Water	ng/L
Fenthion	Insecticides	Water	ng/L
Fipronil	Insecticides	Water	ng/L
Flonicamid	Insecticides	Water	ng/L
Imidacloprid	Insecticides	Water	ng/L
Indoxacarb	Insecticides	Water	ng/L
Malathion	Insecticides	Water	ng/L
Methidathion	Insecticides	Water	ng/L
Methoprene	Insecticides	Water	ng/L
Methoxyfenozide	Insecticides	Water	ng/L
Parathion, Methyl	Insecticides	Water	ng/L
Pentachloroanisole	Insecticides	Water	ng/L
Permethrin, Total	Insecticides	Water	ng/L
Phenothrin	Insecticides	Water	ng/L
Phosmet	Insecticides	Water	ng/L
Propargite	Insecticides	Water	ng/L
Pyridaben	Insecticides	Water	ng/L
Resmethrin	Insecticides	Water	ng/L
Tebupirimfos	Insecticides	Water	ng/L
Tefluthrin	Insecticides	Water	ng/L
Tetradifon	Insecticides	Water	ng/L
Tetramethrin	Insecticides	Water	ng/L
T-Fluvalinate	Insecticides	Water	ng/L
Thiacloprid	Insecticides	Water	ng/L
Thiamethoxam	Insecticides	Water	ng/L
Tolfenpyrad	Insecticides	Water	ng/L
Flumetralin	Plant Growth Regulators	Water	ng/L
Piperonyl Butoxide	Synergists	Water	ng/L
Mercury – Fish Sampling			
Constituent/Measurement	**Reporting Group**	**Matrix**	**Unit**
Mercury	Trace Metals	Tissue (fillet muscle)	µg/g ww
Total Length	Fish Attributes	Tissue	mm
Fork Length	Fish Attributes	Tissue	mm
Weight	Fish Attributes	Tissue	g
Sex	Fish Attributes	Tissue	male/female
Moisture	Fish Attributes	Tissue	%

Mercury - Water Sampling			
Constituent/Measurement	**Reporting Group**	**Matrix**	**Unit**
Mercury, Methyl, total (unfiltered)	Trace Metals	Water	ng/L
Mercury, Methyl, (filtered)	Trace Metals	Water	ng/L
Mercury (unfiltered)	Trace Metals	Water	ng/L
Mercury (filtered)	Trace Metals	Water	ng/L
Chlorophyll *a*	Conventional	Water	µg/L
Dissolved Organic Carbon (DOC)	Conventional	Water	mg/L
Total Suspended Solids (TSS)	Conventional	Water	mg/L
TSS (volatile)	Conventional	Water	mg/L
Oxygen, Dissolved	Field Measurements	Water	mg/L
Oxygen, Dissolved	Field Measurements	Water	% saturation
pH	Field Measurements	Water	pH
Specific Conductivity	Field Measurements	Water	µS/cm
Pathogen Monitoring			
Constituent	**Reporting Group**	**Matrix**	**Unit**
Cryptosporidium	Pathogens	Water	oocysts/L
Giardia	Pathogens	Water	cysts/L

3.5. Geographical and Temporal Setting

The geographic scope of the Delta RMP encompasses the legal Delta (as defined by section 12220 of the Water Code), including water bodies that directly drain into the Delta, Yolo Bypass, and Suisun Bay. In addition, the base monitoring and special studies of the Delta RMP may extend upstream or downstream, if required to address specific management questions.

Monitoring sites for pesticides[8], mercury, and pathogens are described in this section. Additional information for nutrients monitoring sites will be added later.

3.5.1. Pesticides

The surface water samples for pesticide analyses are collected from fixed sites representing key inflows to the Delta that are visited monthly. Targeted event sampling in any given month may be conducted in lieu of scheduled monthly sampling. Targeted events include two wet events (1st seasonal flush, 2nd significant storm in winter) and three dry events (early spring, irrigation season sampling late spring/early summer, irrigation season sampling late summer).

Figure 3.1 shows the current water sampling sites and Table 3.7 provides an overview of the sampling schedule for pesticides. The pesticide monitoring element includes chemical analyses and toxicity testing. The parameters analyzed for this monitoring element include several

[8]Pesticide monitoring includes chemical pesticide analysis, toxicity testing, and the analysis of dissolved copper and relevant field and conventional water quality parameters at all sites.

pesticide reporting groups, dissolved copper, field parameters, and “conventional” parameters (ancillary parameters measured in the laboratory, such as dissolved/particulate organic carbon and hardness).

Table 3.7. List of site type sampling frequencies and associated parameter groups for pesticides monitoring.

Parameter Group	**Baseline site sampling frequency**	**Matrix**
Conventional parameters	Monthly	Water
Field parameters	Monthly	Water
Metals (dissolved Copper only)	Monthly	Water
Pesticides	Monthly	Water
Water column toxicity	Monthly	Water

3.5.2. Mercury

The surface water samples for mercury analyses are collected quarterly from fixed sites that align with sport fish monitoring sites.

The sport fish samples for mercury analyses are collected annually from fixed sites that represent different subareas of the Delta.

Figure 3.2 shows the mercury sampling sites. The mercury monitoring element includes fish and water sampling. The chemical analyte groups for this monitoring element include mercury and methylmercury and ancillary parameters such as chlorophyll *a*, DOC, total suspended solids, and volatile suspended solids.

3.5.3. Pathogens

Ambient pathogen monitoring sites are co-located with existing sites of the Municipal Water Quality Investigations (MWQI) program (Figure 3.3). Some of these 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. Additional samples will be collected at various Delta water supply intakes (7 drinking water intake sites with a single source, plus 2 facilities with blending from 4 drinking water intakes) in coordination with these ambient sites.

The Delta RMP Pathogen Study Design specifies monthly ambient monitoring sample collection for two years beginning in April 2015 to match the Long Term 2 Enhanced Surface Water Treatment Rule (LT2)-required water supply intake sample collection. MWQI will collect grab samples at each of the locations shown in **Table A-1** during the first week of each month on the site-specific day.

3.6. Constraints

The ability to measure some of the target compounds at the ultra-trace levels found in the ambient environment may be constrained by the detection limits routinely achievable by analytical laboratories. Target detection limits in this document represent those achieved by laboratories contracted by the Delta RMP or levels needed to obtain quantitative measurements of ambient concentrations in a majority of samples.

Another constraint is that discrete samples represent only a moment in time and may therefore not always represent conditions during other time periods.

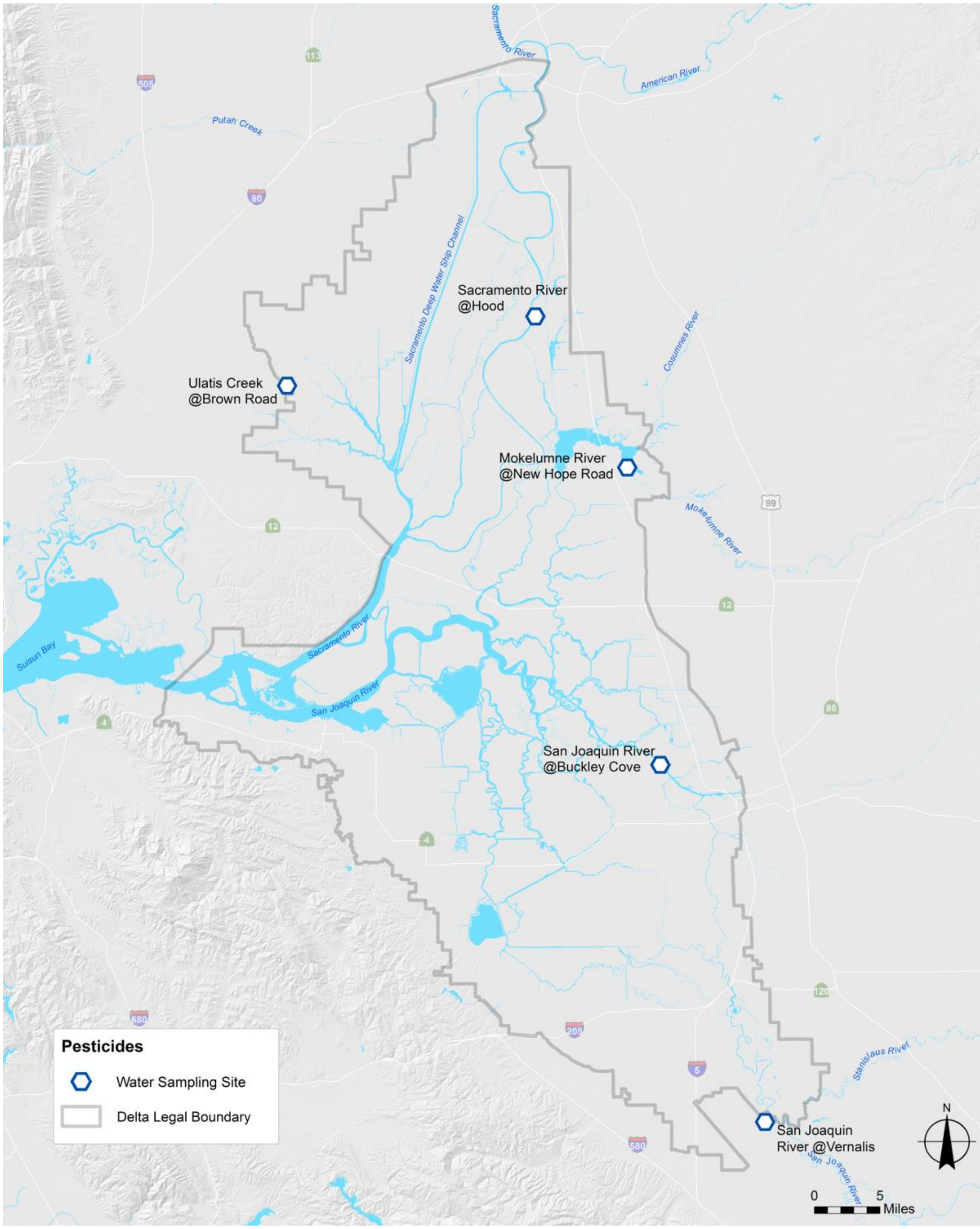

Figure 3.1. FY 2014-17 Pesticide Water Sampling Sites[9].

[9] Pesticide monitoring includes chemical pesticide analysis, toxicity testing, and the analysis of dissolved copper and relevant field and conventional water quality parameters at all sites.

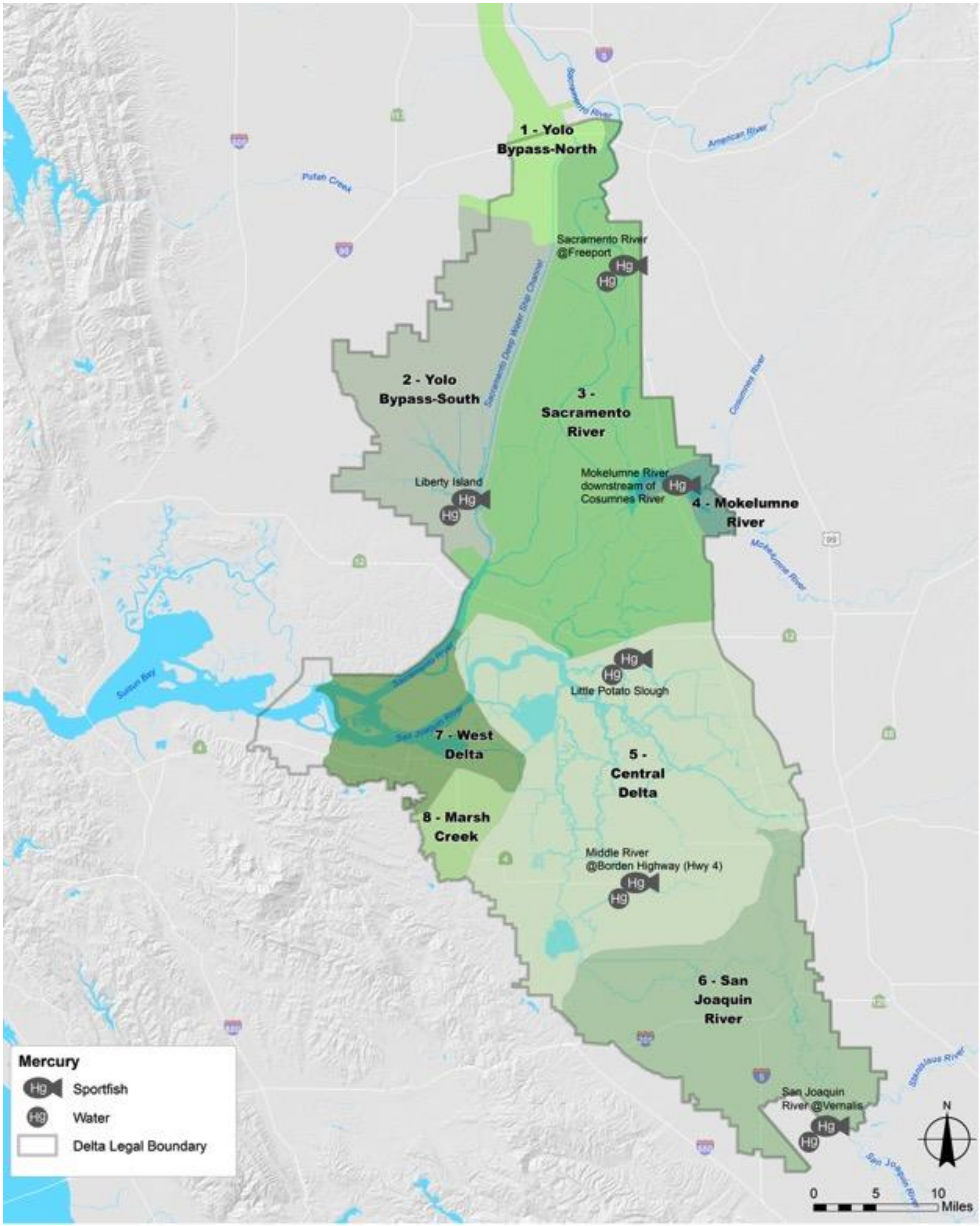

Figure 3.2. FY 2016-17 Mercury Monitoring Sites.

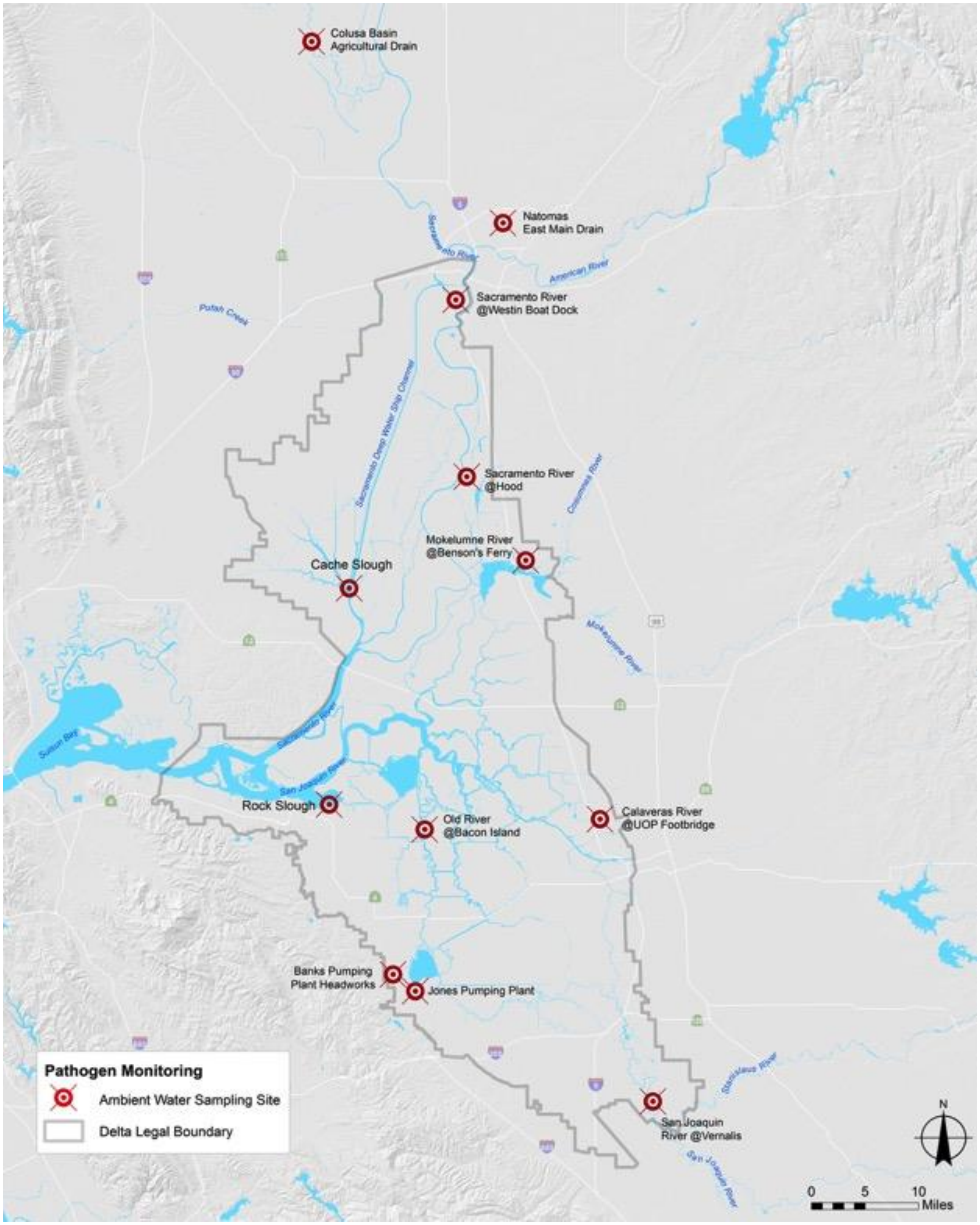

Figure 3.3. FY 2014-17 Ambient Pathogen Monitoring Sites.

4. Data Quality Objectives and Indicators, Criteria, and Control Procedures for Measurement Data

Data Quality Objectives (DQOs) aim to support defensible conclusions that address the management questions and assessment questions in Appendices A and B. Data quality indicators (DQIs) for field and laboratory measurements evaluate the following:

- Field measurements – sensitivity, precision, accuracy, completeness
- Laboratory chemical analyses – sensitivity, precision, accuracy, completeness, contamination
- Toxicity testing – precision, completeness, representativeness

The discussion in this section reviews the measurements and procedures expected to demonstrate the quality of reported data. Table 4.1 provides an overview of quality control (QC) sample types and their purpose. The quality assessment process that is used after the data have been collected to evaluate whether the Data Quality Objectives (DQOs) have been satisfied is described and illustrated in Section 17, Verification and Validation Methods.

Table 4.1. Purposes of field and laboratory QC sample types and data quality indicators applicable to the Delta RMP

QC Sample Type	Data Quality Indicator/Purpose
Calibration	Accuracy of measurement (field parameters, laboratory chemical analysis).
Calibration Check	Accuracy of calibration (field parameters, laboratory chemical analysis).
Laboratory Blanks - Method Blanks	Contamination/confirm the absence of analytes introduced in the lab (laboratory chemical analysis).
Laboratory Blanks - Instrument Blanks	Contamination/Assess the presence or absence of instrument contamination (laboratory chemical analysis).
CRM (Reference Material)	Accuracy of measurement (primarily); precision/most robust indicator of measurement accuracy; may also be used to evaluate replicate precision and recovery where average values for field samples are expected (based on historical or literature results) to fall in a non-quantitative range (laboratory chemical analysis).
Laboratory Duplicates - Matrix Spikes (MS)/Matrix Spike Duplicates (MSD)	Accuracy and precision/evaluate the effect of the sample matrix on the recovery of the compound(s) of interest and providing an estimate of analytical precision when measured in duplicate (laboratory chemical analysis).

QC Sample Type	Data Quality Indicator/Purpose
Laboratory Duplicates - Matrix Duplicates	Precision of intra-laboratory analytical process (laboratory chemical analysis)
Surrogate Spikes	Accuracy of analytical method/assess the efficiency of the extraction method for organic analytes (laboratory chemical analysis).
Internal Standards	Accuracy of analytical method/enable optimal quantitation, particularly of complex extracts subject to retention time shifts or instrument interferences relative to the analysis of standards. Internal standards can also be used to detect and correct for problems in the injection port or other parts of the instrument (laboratory chemical analysis).
Field Blanks	Contamination/To check cross- contamination during sample collection, field sample processing, and shipment. Also to check sample containers (laboratory chemical analysis). Field crews will need to include filtration in processing blanks for applicable sample types.
Field Duplicate/Replicate	Precision/Check reproducibility of field procedures. To indicate non-homogeneity. (Field Duplicate: n = 2; Field Replicate: n > 2). This sample is to be collected in the field in tandem with a regular environmental sample. To be preserved, handled and processed as a unique sample. Lab precision is covered below (laboratory chemical analysis).
Instrument Replicates	Precision of instrument (laboratory chemical analysis).
Travel/bottle blanks	Contamination/To account for contaminants introduced during the transport process between the laboratory and field site, in addition to any contamination from the source solution and container (laboratory chemical analysis).
Negative Control	To evaluate test performance and the health and sensitivity of the specific batch of organisms (laboratory toxicity testing).
Reference toxicant testing	Sensitivity, precision and accuracy of toxicity tests performed in the laboratory/Determine the sensitivity of the test organisms over time; assess comparability within and between laboratory test results; identify potential sources of variability, such as test organism health, differences among batches of organisms, changes in laboratory water or food quality, and performance by laboratory analysts (laboratory toxicity testing).

4.1. Field QC Procedures

4.1.1. Field Performance Measurements

Sensitivity is the ability of a measurement to detect small quantities of the measured component. The sensitivity of field measurements is generally determined by the output of the analytical instrument. Appropriate instruments and/or instrument settings should be chosen that generally allow differences between sites or within a site at different times being reported. Resolution on the order of approximately 1% of the maximum or range of measurements likely to be encountered is desired.

Precision of field measurements is determined by repeated measurement of the same parameter within a single sample, or samples taken in rapid succession (only when conditions are not dynamically variable). Approximately 10% of measurements, a minimum of one measurement per event, should be repeated for all measured parameters. Repeated measurement may also be accomplished by continuous logging of *in situ* probes or meters.

Accuracy of field measurements is established by periodic measurement of known standards or by recalibration to known standards. Instrument recalibration should be performed prior to each sampling day or event for user-calibrated instruments (e.g. daily for handheld field meters), or at the manufacturer-specified interval for instruments requiring factory servicing or otherwise incapable of field recalibration.

Completeness of field measurement is evaluated as a percentage of usable measurements out of the total number of measurements desired. More than 90% of field measurements should be usable. If a lower percentage is achieved for any sampling event or time period, causes shall be investigated and fixed where possible, through instrument maintenance (e.g. defouling), recalibration, repair, or replacement (with the same or different instrument type) as needed. If completeness targets are not achieved, instrument choice, settings, deployment method, maintenance, and/or other activities shall be adjusted to improve measurement reliability before the next sampling event or measurement period.

4.1.2. Field QC Measurements

Calibration of any field meters (pH, conductivity, DO, or other measurements) should be checked in the field at least once daily and recalibrated using certified standards or procedures where possible. Instruments will be recalibrated when significant drift or a calibration error is found.

Beyond initial calibration of handheld field instruments and periodic calibration checks in the field, QC measures taken for field instrument measurements should include reporting of replicates. Field measurement acceptance criteria are summarized in Table 4.2.

Table 4.2. Acceptance criteria for field measurements.

Method	Parameters	Sample type	Matrix	Frequency	Acceptable limits
YSI 6920 Water Quality Meter	DO, pH, SC, temperature, turbidity	Calibration	Water	Within 24 hrs before sampling as well as a mid-day and end-of-the-day checks against the standards	Allowable drift ± 10% for DO and Specific Conductivity, ± 0.2 for pH, ± 5 turbidity units or ± 5% of the measured value (whichever is greater) for turbidity

4.1.3. Field QC Samples

Field QC samples that are frequently collected for later lab analysis in sampling protocols are listed below:

1. Field Blanks: These account for all of the sources of contamination that might be introduced to a sample as well as those due to the immediate field environment, such as all the possible contamination sources in container and equipment preparation, transport, handling, and sampling methodology. Field blanks are generated under actual field conditions and are subjected to the same aspects of sample collection, field processing, preservation, transport, and laboratory handling as the environmental samples.
2. Field Duplicates/Replicates: These account for variability in the field collection and laboratory analysis combined.

Travel/bottle blanks may be collected at the discretion of the QAO, when an established procedure is changed or when problems are identified:

1. Travel/bottle Blanks: These account for contaminants introduced during the transport process between the laboratory and field site, in addition to any contamination from the source solution and container.
2. Equipment Blanks: These account for contamination introduced by the field sampling equipment in addition to the above sources.

Field blanks will routinely be collected and analyzed, as they will encompass all the possible contamination sources in container and equipment preparation, transport, handling, and sampling methodology. Unless otherwise specified, goals for field blanks are the same as for lab blanks, i.e., not detected. If problems are found with field blanks, other blank sample types may be collected in follow-up sampling to try and determine the source of contamination.

Field blanks for water will be generated under actual field conditions at a minimum frequency of one per 20 samples. They will be treated in both the field and laboratory procedures in as similar a manner as possible as the environmental field samples. Whole water field blanks will be taken by exposing sampling containers through a simulated process of collecting samples. Field blank collection locations will be varied over the course of a study.

In studies performed for other SFEI-ASC projects, travel/bottle blanks analyzed usually showed that they are not a significant source of contamination beyond that already included in laboratory blanks, so travel blanks are seldom collected. However, if continued contamination is identified in field blanks, travel blanks may be collected and analyzed to identify a potential source, at the discretion of the Delta RMP QAO.

Field duplicates/replicates of water samples will be routinely collected at a minimum frequency of one per 20 samples to evaluate variability including performance of the sampling system and methodology. Unless otherwise specified, precision targets and acceptance criteria for field duplicates/replicates will be the same as those for lab replicates.

4.2. Laboratory Performance Measurements for Chemical Analyses

Laboratory performance measurements are included in the QA data review to check if measurement quality objectives are met. Results of analyses of QC samples are to be reported with results of field samples. Minimum frequencies and target performance requirements for QC measures of reported analytes are specified in Table 4.3.

QC measures typically used for evaluation of laboratory and field sampling performance include the following:

1. Method (or extraction/preparation) Blanks: samples of a clean or null (e.g., empty container) matrix taken through the entire analytical procedure, including preservatives, reagents, and equipment used in preparation and quantitation of analytes in samples.
2. Field (or equipment/collection) Blanks: samples of a clean or null matrix taken through the sampling procedure, then analyzed much like an ordinary field sample.

3. Surrogate Standards: analytes introduced to samples prior to sample extraction to monitor sample extraction method recoveries.
4. Internal Standards: analytes introduce after the last sample-processing step prior to analysis, to measure and correct for losses and errors introduced during analysis, with recoveries and corrections to reported values generally reported for each sample individually.
5. Matrix Spike Samples/Duplicates: field samples to which known amounts of target analytes are added, indicating potential analytical interferences present in field samples and errors or losses in analyses not accounted for by surrogate correction.
6. Certified Reference Materials (CRM): CRMs are created or collected samples containing analytes of interest that have been analyzed and reported by multiple labs using a variety of methods to arrive at a consensus “certified” or “reference” value. Certified analytes have a higher degree of certainty in reported values due to external validation.
7. Lab Reference Materials/Laboratory Control Samples: materials collected or created by a laboratory as internal reference samples, to track performance across batches. Unlike CRMs, LRMs and LCSs seldom have external validation (i.e., measurement by another method or another lab) and are thus less certain as measures of accuracy, but are good for day-to-day indication of process control.
8. Instrument Replicates: replicate analyses of extracted material or standards that measure the instrumental precision.
9. Laboratory Replicates: replicate sub-samples of field samples, standard reference materials, lab reference materials, matrix spike samples, or laboratory control samples, taken through the full analytical procedure including all lab processes combined.

Table 4.3. Chemical-analytical QC.

Method	Sample type	Matrix	Frequency	Acceptable limits
Conventional – Chlorophyll *a*				
EPA 446.0	Laboratory Blank	Water	1 per 20 or batch	< RL
EPA 446.0	CRM	Water	1 per 20 or batch	Expected value +/- 20%
EPA 446.0	Lab Duplicate	Water	1 per batch	RPD < 25%; n/a if concentration of either sample <RL
EPA 446.0	Field Duplicates	Water	5% of all samples	RPD < 25%; n/a if concentration of either sample <RL
Conventional – DOC				
METH011.00 or TM-O-1122-92	Laboratory Blank	Water	1 per 20 or batch	< RL
METH011.00 or TM-O-1122-92	CRM	Water	1 per 20 or batch	Expected value +/- 20%
METH011.00 or TM-O-1122-92	Matrix Spikes/Duplicates	Water	1 per 20 or batch	Expected value +/- 20%; RPD < 25%
METH011.00 or TM-O-1122-92	Lab Duplicate	Water	1 per 20 or batch	RPD < 25%; n/a if concentration of either sample <RL
METH011.00 or TM-O-1122-92	Field Duplicates	Water	5% of all samples	RPD < 25%; n/a if concentration of either sample <RL
Conventional – POC				
EPA 440	Laboratory Blank	Water	1 per 20 or batch	< MDL
EPA 440	CRM	Water	1 per 20 or set	Expected value +/- 10%
EPA 440	Matrix Spikes/Duplicates	Water	1 per 20 or batch	Expected value +/- 10%
EPA 440	Lab Duplicate	Water	1 per 20 or batch	RPD < 10%
EPA 440	Instrument Blank	Water	12 hours	<MDL
EPA 440	Field Duplicates	Water	5% of all samples	RPD < 25%
EPA 440	Filter Blank	Water	1 per lot of filters or higher frequency	<MDL
Conventional – TSS, VSS				
SM 2540D or TWRI-5-A1	Laboratory Blank	Water	1 per 20 or batch	< RL

Method	Sample type	Matrix	Frequency	Acceptable limits
SM 2540D or TWRI-5-A1	Field Duplicates	Water	5% of all samples	RPD < 25%; n/a if concentration of either sample <RL
Pesticides				
USGS TM-5-C2	Calibration	Water	At each instrument set up, major disruption, and when routine calibration check exceeds specific control limits.	Linear regression, $r^2 > 0.995$ using a 7 point calibration curve ranging from 0.01 to 1 ng/uL
USGS TM-5-C2	Calibration Check	Water	Every 6 samples.	Recovery = 75 -125%
USGS TM-5-C2	Laboratory Blanks	Water	1 per 20 or batch.	< MDL
USGS TM-5-C2	Matrix Spikes/Duplicates	Water	1 per 20	Recovery 70-130%, RPD < 25%
USGS TM-5-C2	Surrogate Spikes	Water	Every sample	Recovery = 70 -130%
USGS TM-5-C2	Internal Standards	Water	Every sample	Recovery = 70 -130%
USGS TM-5-C2	Field Blanks	Water	1 per 20	< MDL
USGS TM-5-C2	Field Duplicate/ Replicate	Water	1 per 20	RPD < 25%
USGS – SIR 2012-5026	Calibration	Water	At each instrument set up, major disruption, and when routine calibration check exceeds specific control limits.	Linear regression, $r^2 > 0.995$ using an 7 point calibration curve ranging from 0.01 to 1 ng/uL
USGS – SIR 2012-5026	Calibration Check	Water	Every 6 samples.	Recovery = 75 -125%
USGS – SIR 2012-5026	Laboratory Blanks	Water	1 per 20 or batch.	< MDL
USGS – SIR 2012-5026	Matrix Spikes/Duplicates	Water	1 per 20	Recovery 70-130%, RPD < 25%
USGS – SIR 2012-5026	Surrogate Spikes	Water	Every sample	Recovery = 70 -130%
USGS – SIR 2012-5026	Internal Standards	Water	Every sample	Recovery = 70 -130%
USGS – SIR 2012-5026	Field Blanks	Water	1 per 20	< MDL

Method	Sample type	Matrix	Frequency	Acceptable limits
USGS – SIR 2012-5026	Field Duplicate/ Replicate	Water	1 per 20	RPD < 25%
Trace Metals – Copper (dissolved)				
USGS TM-5-B1	Laboratory Blank	Water	1 per 20 or batch	< MDL
USGS TM-5-B1	CRM	Water	1 per 20	Expected value +/- 25%
USGS TM-5-B1	Matrix Spikes/Duplicates	Water	1 per 20 or one batch	Expected value +/- 25%
USGS TM-5-B1	Lab Duplicate	Water	1 per 20	RPD < 25%
USGS TM-5-B1	Instrument Blank	Water	Every 6 samples	<MDL
USGS TM-5-B1	Field Duplicates	Water	5% of all samples	RPD < 25%
Trace Metals – Mercury				
EPA 7473	Laboratory Blank	Tissue	1 per 20 or batch	< RL
EPA 7473	CRM	Tissue	1 per 20 or batch	Expected value +/- 25%
EPA 7473	Matrix Spikes/Duplicates	Tissue	1 per 20 or batch	Expected value +/- 25%
EPA 7473	Lab Duplicate	Tissue	1 per 20	RPD < 25%; n/a if concentration of either sample <RL
EPA 1631, Revision E	Laboratory Blank	Water	1 per 20 or batch.	< RL
EPA 1631, Revision E	CRM	Water	1 per 20 or batch	Expected value +/- 25%
EPA 1631, Revision E	Matrix Spikes/Duplicates	Water	1 per 20 or batch	Expected value +/- 25%
EPA 1631, Revision E	Lab Duplicate	Water	1 per 20	RPD < 25%; n/a if concentration of either sample <RL
EPA 1631, Revision E	Field Duplicates	Water	5% of all samples	RPD < 25%: n/a if concentration of either sample <RL
EPA 1631, Revision E	Field Blank	Water	1 per 20 or batch	<RL
Trace Metals – Mercury, Methyl				
EPA 1630	Laboratory Blank	Water	1 per 20 or batch	< RL
EPA 1630	LCS	Water	1 per 20 or batch	Expected value +/- 30%
EPA 1630	Matrix Spikes/Duplicates	Water	1 per 20 or batch	Expected value +/- 30%
EPA 1630	Lab Duplicate	Water	1 per 20	RPD < 25%; n/a if concentration of either sample

Method	Sample type	Matrix	Frequency	Acceptable limits
				<RL
EPA 1630	Field Duplicates	Water	5% of all samples	RPD < 25%: n/a if concentration of either sample <RL
EPA 1630	Field Blank	Water	1 per 20 or batch	<RL

4.3. Laboratory Quality Control Procedures for Chemical Analyses

Prior to the initial analyses of samples for the project, each laboratory will demonstrate capability and proficiency for meeting MQOs for the Delta RMP. Performance-based measures for chemical analyses consist of two basic elements: initial demonstration of laboratory capability and on-going demonstration of capability during analysis of project samples. Initial demonstration includes documentation that sample analyses can be performed within the data quality objectives and method quality objectives listed in the QAPP (Tables 4.3, 4.4, and 4.5). On-going demonstration of capability during analysis of project samples includes laboratory participation in routine analyses (e.g. inter-comparison studies) to evaluate laboratory capabilities on a continual basis to meet MQOs listed in the QAPP.

4.3.1. Laboratory QC Measurements

4.3.1.1 Sensitivity

In this context, sensitivity refers to the capability of a method or instrument to detect a given analyte at a given concentration and reliably quantitate the analyte at that concentration. Achieving the desired sensitivity requires the selection of appropriate analytical methods. The key measurement quality objectives (MQOs) for achieving sensitivity are the desired Reporting Limit (RL) and Method Detection Limit (MDL) for analytes (Table 4.4) and the ranges and resolution of laboratory meters (Table 4.5). Additional QC information required to evaluate the sensitivity of data include laboratory or method blanks and, if appropriate, instrument blanks (Table 4.3).

4.3.1.2 Precision

Precision is the reproducibility of an analytical method and can be evaluated for any sample that is analyzed in replicate. In general, laboratory replicates of field samples are preferred as measures of precision, but in cases where average values for field samples are expected (based on historical or literature results) to fall in a non-quantitative range, other samples such as CRMs, LRMs, matrix spikes, or blank spikes can be analyzed in replicate to determine precision.

If samples other than field samples are used to evaluate precision, target concentrations should be at least high enough to be quantitative but less than 100 times those in field samples, as precision in high concentration samples is not likely representative for much lower ambient samples. When using MS/MSD, samples of a similar matrix are most relevant and thus preferred for evaluating precision.

A minimum of one field sample (or alternative sample type, e.g. MS, where sample material is insufficient or concentrations are largely not detected in field samples) per batch of samples submitted to the laboratory (minimum one per 20, or 5%, in large batches) will be processed and analyzed in replicate for precision. Previously analyzed material (e.g. from the same project in prior years, or from other projects) may also be analyzed as replicates to help ensure results in a quantitative range. The relative percent difference (RPD) among replicate samples will be less than the MQO listed in Table 4.3 for each analyte of interest. RPD is calculated as:

$$\mathrm{RPD} = \frac{\text{Difference (between replicate samples)}}{\text{Average (replicate samples)}} \times 100\%$$

Precision may be expressed relative to an MQO as a p-score:

$$p = |\text{RPD or RSD}|/\text{MQO}\%$$

If results for any analyte do not meet the MQO for precision (p-score > 1), calculations and instruments will be checked. Repeat analyses may be required to confirm the results and reduce uncertainty in the measurement. Results that repeatedly fail to meet the criteria indicate sample heterogeneity, unusually high contamination of analytes, or other causes of poor laboratory precision. If the variability is not reduced, the laboratory is obligated to halt the analysis of samples, identify the source of the imprecision, and notify the SFEI-ASC Project Manager and QAO before proceeding with further analysis. In some cases when the causes of imprecision cannot be corrected (particularly for less abundant or less important analytes in a large group reported by a single analytical method), and with the approval of the Project Manager and QAO, the results can be reported as-is and flagged for poor precision (p-score > 1) or censored if extremely poor (p-score > 2).

4.3.1.3 Accuracy

The accuracy of lab measurements will be evaluated based on data quality criteria (Table 4.3) for MS/MSD, CRM, internal standards, surrogate recoveries, initial calibration, and calibration checks.

The percent recovery for MS/MSD is calculated using the equation

$$\%\ \text{recovery} = \frac{(\text{observed} - \text{background})}{\text{theoretical}} \times 100$$

If insufficient sample is available, the analyst can run a LCS (Laboratory Control Sample) and a LCS duplicate. The calculation used is the same.

4.3.1.4 Completeness

Completeness is defined as "a measure of the amount of data collected from a measurement process compared to the amount that was expected to be obtained under the conditions of measurement" (Stanley and Verner 1985). The goal of the Delta RMP is to achieve >90% completeness for all analyses.

Completeness will be quantified as the total number of usable results divided by the total number of site visits, aggregated by all analytes of interest. However, additional factors may be considered on a case-by-case basis. For example, an analysis may result in 0% usable data for a minor group of analytes and potentially not meet the completeness goal of 90% overall as a result, but may still provide valuable data and meet the completeness criteria for all the remaining analyte results combined. In contrast, if >90% completeness could not be obtained for a group of pesticide analytes that are the most abundant in the majority of studies in the literature, it would likely need to be seen as a failure that needed immediate correction.

4.3.1.5 Contamination

Laboratory method blanks (also called extraction blanks, procedural blanks, or preparation blanks) are used to assess laboratory contamination during all stages of sample preparation and analysis. For laboratory analyses, at least one laboratory method blank will be run in every sample batch. The method blank will be processed through the entire analytical procedure in a manner identical to the samples (i.e., using the same reagents and equipment). Method blanks should contain analyte concentration less than the MDL. A method blank concentration > RL for any analytes of interest will require corrective action (e.g., checking of reagents, re-cleaning and re-checking of equipment) to identify and eliminate the source(s) of contamination before proceeding with sample analysis. If eliminating the blank contamination and reanalysis is not possible, results for all impacted analytes in the analytical batch shall be flagged. In addition, a detailed description of the contamination sources and the steps taken to identify and eliminate/minimize them shall be included in the transmittal letter. Subtracting method blank results from sample results is not permitted.

4.3.1.6 Comparability

The Delta RMP adheres to EPA guidance, specified SOPs, and SWAMP-comparable QA measures. Therefore, results can be compared with other projects and laboratories that adhere to the same or compatible protocols and QA measures.

4.3.1.7 Data analysis

Data will be analyzed using appropriate graphical tools, spatial analyses, and statistical tests as described in the Delta RMP Communications Plan.

Table 4.4. Summary of Reporting Limits (RL) and Method Detection Limits (MDL) of Delta RMP constituents.

Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory/ laboratories	Method used
Oxygen, Dissolved	Water	Field Parameters	0.5	0.5	mg/L	MPSL (mercury monitoring), USGS (pesticide monitoring)	National Field Manual for the Collection for Water-Quality Data, Chapter A6, Field Measure-ments
pH	Water	Field Parameters	NA	NA	NA	MPSL (mercury monitoring), USGS (pesticide monitoring)	
Specific Conductivity	Water	Field Parameters	10	10	uS/cm	MPSL (mercury monitoring), USGS (pesticide monitoring)	
Temperature	Water	Field Parameters	NA	NA	NA	MPSL (mercury monitoring), USGS (pesticide monitoring)	
Turbidity	Water	Field Parameters	1	1	FNU	USGS	
Alkalinity as $CaCO_3$	Water	Conventional	12	4	mg/L	AHPL	SM 2320B
Ammonia as N	Water	Conventional	0.15	0.05	mg/L	AHPL	SM 4500-NH3F
Chlorophyll *a*	Water	Conventional	30	24	µg/L	WPCL	EPA 446.0
Hardness as $CaCO_3$	Water	Conventional	6	2	mg/L	AHPL	SM 2340C
Dissolved Organic Carbon	Water	Conventional	0.23	0.23	mg/L	WPCL (mercury monitoring), USGS (pesticide monitoring)	TM O-1122-92, METH011.00
Particulate Organic Carbon	Water	Conventional	0.05	0.05	mg/L	USGS	EPA 440
Copper, dissolved	Water	Trace Metals	0.8	0.8	ug/L	USGS	TM-5-B1
Mercury, total	Tissue	Trace Metals	0.012	0.004	µg/g ww	MPSL	EPA 7473
Mercury, total (unfiltered)	Water	Trace Metals	0.200	0.200	ng/L	MPSL	EPA 1631E
Mercury, dissolved (filtered)	Water	Trace Metals	0.200	0.200	ng/L	MPSL	EPA 1631E
Mercury, Methyl, total (unfiltered)	Water	Trace Metals	0.031	0.02	ng/L	MPSL	EPA 1630
Mercury, Methyl, dissolved (filtered)	Water	Trace Metals	0.031	0.02	ng/L	MPSL	EPA 1630
Chlorpyrifos Oxon	Water	Degradates	5.0	5.0	ng/L	USGS	TM-5-C2

Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory/ laboratories	Method used
Dichlorophenyl-3-methyl Urea, 3,4-	Water	Herbicides	3.5	3.5	ng/L	USGS	USGS – SIR 2012-5026
DDD (p,p')	Water	Degradates	6.1	6.1	ng/L	USGS	TM-5-C2
DDE (p,p')	Water	Degradates	6.9	6.9	ng/L	USGS	TM-5-C2
Diazoxon	Water	Degradates	5.0	5.0	ng/L	USGS	TM-5-C2
Dichloroaniline, 3,4-	Water	Degradates	3.2	3.2	ng/L	USGS	USGS – SIR 2012-5026
Dichloroaniline, 3,5-	Water	Degradates	7.6	7.6	ng/L	USGS	TM-5-C2
Dichlorophenylurea, 3.,4-	Water	Degradates	3.4	3.4	ng/L	USGS	USGS – SIR 2012-5026
Fipronil Desulfinyl	Water	Degradates	1.6	1.6	ng/L	USGS	TM-5-C2
Fipronil Desulfinyl Amide	Water	Degradates	3.2	3.2	ng/L	USGS	TM-5-C2
Fipronil Sulfide	Water	Degradates	1.8	1.8	ng/L	USGS	TM-5-C2
Fipronil Sulfone	Water	Degradates	3.5	3.5	ng/L	USGS	TM-5-C2
Malaoxon	Water	Degradates	5.0	5.0	ng/L	USGS	TM-5-C2
Tebupirimphos Oxon	Water	Degradates	2.8	2.8	ng/L	USGS	TM-5-C2
Acibenzolar-S-methyl	Water	Fungicides	3.0	3.0	ng/L	USGS	
Azoxystrobin	Water	Fungicides	3.1	3.1	ng/L	USGS	TM-5-C2
Boscalid	Water	Fungicides	2.8	2.8	ng/L	USGS	TM-5-C2
Captan	Water	Fungicides	10.2	10.2	ng/L	USGS	
Carbendazim	Water	Fungicides	4.2	4.2	ng/L	USGS	USGS – SIR 2012-5026
Chlorothalonil	Water	Fungicides	4.1	4.1	ng/L	USGS	TM-5-C2
Cyazofamid	Water	Fungicides	4.1	4.1	ng/L	USGS	USGS – SIR 2012-5026
Cymoxanil	Water	Fungicides	3.9	3.9	ng/L	USGS	USGS – SIR 2012-5026
Cyproconazole	Water	Fungicides	4.7	4.7	ng/L	USGS	TM-5-C2
Cyprodinil	Water	Fungicides	7.4	7.4	ng/L	USGS	TM-5-C2
Desthio-Prothioconazole	Water	Fungicides	3.0	3.0	ng/L	USGS	USGS – SIR 2012-5026
Difenoconazole	Water	Fungicides	10.5	10.5	ng/L	USGS	TM-5-C2
Dimethomorph	Water	Fungicides	6.0	6.0	ng/L	USGS	TM-5-C2
Ethaboxam	Water	Fungicides	3.8	3.8	ng/L	USGS	USGS – SIR 2012-5026
Famoxadone	Water	Fungicides	2.5	2.5	ng/L	USGS	TM-5-C2

Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory/ laboratories	Method used
Fenamidone	Water	Fungicides	5.1	5.1	ng/L	USGS	TM-5-C2
Fenarimol	Water	Fungicides	6.5	6.5	ng/L	USGS	TM-5-C2
Fenbuconazole	Water	Fungicides	5.2	5.2	ng/L	USGS	TM-5-C2
Fenhexamid	Water	Fungicides	7.6	7.6	ng/L	USGS	TM-5-C2
Fluazinam	Water	Fungicides	4.4	4.4	ng/L	USGS	TM-5-C2
Fludioxonil	Water	Fungicides	7.3	7.3	ng/L	USGS	TM-5-C2
Fluopicolide	Water	Fungicides	3.9	3.9	ng/L	USGS	TM-5-C2
Fluoxastrobin	Water	Fungicides	9.5	9.5	ng/L	USGS	TM-5-C2
Flusilazole	Water	Fungicides	4.5	4.5	ng/L	USGS	TM-5-C2
Flutolanil	Water	Fungicides	4.4	4.4	ng/L	USGS	TM-5-C2
Flutriafol	Water	Fungicides	4.2	4.2	ng/L	USGS	TM-5-C2
Fluxapyroxad	Water	Fungicides	4.8	4.8	ng/L	USGS	TM-5-C2
Imazalil	Water	Fungicides	10.5	10.5	ng/L	USGS	TM-5-C2
Ipconazole	Water	Fungicides	--	--	ng/L	USGS	TM-5-C2
Iprodione	Water	Fungicides	4.4	4.4	ng/L	USGS	TM-5-C2
Kresoxim-methyl	Water	Fungicides	4.0	4.0	ng/L	USGS	TM-5-C2
Mandipropamid	Water	Fungicides	3.3	3.3	ng/L	USGS	USGS – SIR 2012-5026
Metalaxyl	Water	Fungicides	5.1	5.1	ng/L	USGS	TM-5-C2
Metconazole	Water	Fungicides	5.2	5.2	ng/L	USGS	TM-5-C2
Myclobutanil	Water	Fungicides	6.0	6.0	ng/L	USGS	TM-5-C2
Paclobutrazol	Water	Fungicides	6.2	6.2	ng/L	USGS	TM-5-C2
PCNB	Water	Organochlorines	3.1	3.1	ng/L	USGS	TM-5-C2
Picoxystrobin	Water	Fungicides	4.2	4.2	ng/L	USGS	TM-5-C2
Propiconazole	Water	Fungicides	5.0	5.0	ng/L	USGS	TM-5-C2
Pyraclostrobin	Water	Fungicides	2.9	2.9	ng/L	USGS	TM-5-C2
Pyrimethanil	Water	Fungicides	4.1	4.1	ng/L	USGS	TM-5-C2
Quinoxyfen	Water	Fungicides	3.3	3.3	ng/L	USGS	TM-5-C2
Sedaxane	Water	Fungicides	--	--	ng/L	USGS	TM-5-C2
Tebuconazole	Water	Fungicides	3.7	3.7	ng/L	USGS	TM-5-C2
Tetraconazole	Water	Fungicides	5.6	5.6	ng/L	USGS	TM-5-C2
Thiabendazole	Water	Fungicides	3.6	3.6	ng/L	USGS	USGS – SIR 2012-5026
Triadimefon	Water	Fungicides	8.9	8.9	ng/L	USGS	TM-5-C2

Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory/ laboratories	Method used
Triadimenol	Water	Fungicides	8.0	8.0	ng/L	USGS	TM-5-C2
Trifloxystrobin	Water	Fungicides	4.7	4.7	ng/L	USGS	TM-5-C2
Triflumizole	Water	Fungicides	6.1	6.1	ng/L	USGS	TM-5-C2
Triticonazole	Water	Fungicides	6.9	6.9	ng/L	USGS	TM-5-C2
Zoxamide	Water	Fungicides	3.5	3.5	ng/L	USGS	TM-5-C2
Alachlor	Water	Herbicides	1.7	1.7	ng/L	USGS	TM-5-C2
Atrazine	Water	Herbicides	2.3	2.3	ng/L	USGS	TM-5-C2
Benefin	Water	Herbicides	2.0	2.0	ng/L	USGS	TM-5-C2
Butralin	Water	Herbicides	2.6	2.6	ng/L	USGS	TM-5-C2
Butylate	Water	Herbicides	1.8	1.8	ng/L	USGS	TM-5-C2
Clomazone	Water	Herbicides	2.5	2.5	ng/L	USGS	TM-5-C2
Cycloate	Water	Herbicides	1.1	1.1	ng/L	USGS	TM-5-C2
Cyhalofop-butyl	Water	Herbicides	1.9	1.9	ng/L	USGS	TM-5-C2
Dacthal	Water	Herbicides	2.0	2.0	ng/L	USGS	TM-5-C2
Diuron	Water	Herbicides	3.2	3.2	ng/L	USGS	USGS – SIR 2012-5026
Dithiopyr	Water	Herbicides	1.6	1.6	ng/L	USGS	TM-5-C2
EPTC	Water	Herbicides	1.5	1.5	ng/L	USGS	TM-5-C2
Ethalfluralin	Water	Herbicides	3.0	3.0	ng/L	USGS	TM-5-C2
Flufenacet	Water	Herbicides	4.7	4.7	ng/L	USGS	TM-5-C2
Fluridone	Water	Herbicides	3.7	3.7	ng/L	USGS	USGS – SIR 2012-5026
Hexazinone	Water	Herbicides	8.4	8.4	ng/L	USGS	TM-5-C2
Metolachlor	Water	Herbicides	1.5	1.5	ng/L	USGS	TM-5-C2
Molinate	Water	Herbicides	3.2	3.2	ng/L	USGS	TM-5-C2
Napropamide	Water	Herbicides	8.2	8.2	ng/L	USGS	TM-5-C2
Novaluron	Water	Herbicides	2.9	2.9	ng/L	USGS	TM-5-C2
Oryzalin	Water	Herbicides	5.0	5.0	ng/L	USGS	USGS – SIR 2012-5026
Oxadiazon	Water	Herbicides	2.1	2.1	ng/L	USGS	TM-5-C2
Oxyfluorfen	Water	Herbicides	3.1	3.1	ng/L	USGS	TM-5-C2
Pebulate	Water	Herbicides	2.3	2.3	ng/L	USGS	TM-5-C2
Pendimethalin	Water	Herbicides	2.3	2.3	ng/L	USGS	TM-5-C2
Penoxsulam	Water	Herbicides	3.5	3.5	ng/L	USGS	USGS – SIR 2012-5026

Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory/ laboratories	Method used
Prodiamine	Water	Herbicides	5.2	5.2	ng/L	USGS	TM-5-C2
Prometon	Water	Herbicides	2.5	2.5	ng/L	USGS	TM-5-C2
Prometryn	Water	Herbicides	1.8	1.8	ng/L	USGS	TM-5-C2
Propanil	Water	Herbicides	10.1	10.1	ng/L	USGS	TM-5-C2
Pronamide	Water	Herbicides	5.0	5.0	ng/L	USGS	TM-5-C2
Simazine	Water	Herbicides	5.0	5.0	ng/L	USGS	TM-5-C2
Thiazopyr	Water	Herbicides	4.1	4.1	ng/L	USGS	TM-5-C2
Thiobencarb	Water	Herbicides	1.9	1.9	ng/L	USGS	TM-5-C2
Triallate	Water	Herbicides	2.4	2.4	ng/L	USGS	TM-5-C2
Tributyl Phosphorotrithioate, S,S,S-	Water	Herbicides	3.1	3.1	ng/L	USGS	TM-5-C2
Trifluralin	Water	Herbicides	2.1	2.1	ng/L	USGS	TM-5-C2
Acetamiprid	Water	Insecticides	3.3	3.3	ng/L	USGS	USGS – SIR 2012-5026
Allethrin	Water	Insecticides	4.1	4.1	ng/L	USGS	TM-5-C2
Bifenthrin	Water	Insecticides	4.7	4.7	ng/L	USGS	TM-5-C2
Carbaryl	Water	Insecticides	6.5	6.5	ng/L	USGS	TM-5-C2
Carbofuran	Water	Insecticides	3.1	3.1	ng/L	USGS	TM-5-C2
Chlorantraniliprole	Water	Insecticides	4.0	4.0	ng/L	USGS	USGS – SIR 2012-5026
Chlorpyrifos	Water	Insecticides	2.1	2.1	ng/L	USGS	TM-5-C2
Clothianidin	Water	Insecticides	3.9	3.9	ng/L	USGS	USGS – SIR 2012-5026
Coumaphos	Water	Insecticides	3.1	3.1	ng/L	USGS	TM-5-C2
Cyantraniliprole	Water	Insecticides	4.2	4.2	ng/L	USGS	USGS – SIR 2012-5026
Cyfluthrin, total	Water	Insecticides	5.2	5.2	ng/L	USGS	TM-5-C2
Cyhalothrin, total	Water	Insecticides	4.5	4.5	ng/L	USGS	TM-5-C2
Cypermethrin, total	Water	Insecticides	5.6	5.6	ng/L	USGS	TM-5-C2
DDT (p,p')	Water	Insecticides	3.5	3.5	ng/L	USGS	TM-5-C2
Deltamethrin	Water	Insecticides	3.5	3.5	ng/L	USGS	TM-5-C2
Diazinon	Water	Insecticides	0.9	0.9	ng/L	USGS	TM-5-C2
Dinotefuran	Water	Insecticides	4.5	4.5	ng/L	USGS	USGS – SIR 2012-5026
Esfenvalerate	Water	Insecticides	3.9	3.9	ng/L	USGS	TM-5-C2

Constituent	Matrix	Reporting group	RL	MDL	Unit	Analyzing laboratory/ laboratories	Method used
Ethofenprox	Water	Insecticides	2.2	2.2	ng/L	USGS	TM-5-C2
Fenpropathrin	Water	Insecticides	4.1	4.1	ng/L	USGS	TM-5-C2
Fenpyroximate	Water	Insecticides	5.2	5.2	ng/L	USGS	TM-5-C2
Fenthion	Water	Insecticides	5.5	5.5	ng/L	USGS	TM-5-C2
Fipronil	Water	Insecticides	2.9	2.9	ng/L	USGS	TM-5-C2
Flonicamid	Water	Insecticides	3.4	3.4	ng/L	USGS	USGS – SIR 2012-5026
Imidacloprid	Water	Insecticides	3.8	3.8	ng/L	USGS	USGS – SIR 2012-5026
Indoxacarb	Water	Insecticides	4.9	4.9	ng/L	USGS	TM-5-C2
Malathion	Water	Insecticides	3.7	3.7	ng/L	USGS	TM-5-C2
Methoprene	Water	Insecticides	6.4	6.4	ng/L	USGS	TM-5-C2
Methoxyfenozide	Water	Insecticides	2.7	2.7	ng/L	USGS	USGS – SIR 2012-5026
Methidathion	Water	Insecticides	7.2	7.2	ng/L	USGS	TM-5-C2
Parathion, Methyl	Water	Insecticides	3.4	3.4	ng/L	USGS	TM-5-C2
Pentachloroanisole	Water	Insecticides	6.5	6.5	ng/L	USGS	TM-5-C2
Permethrin, total	Water	Insecticides	3.4	3.4	ng/L	USGS	TM-5-C2
Phenothrin	Water	Insecticides	5.1	5.1	ng/L	USGS	TM-5-C2
Phosmet	Water	Insecticides	4.4	4.4	ng/L	USGS	TM-5-C2
Propargite	Water	Insecticides	6.1	6.1	ng/L	USGS	TM-5-C2
Pyridaben	Water	Insecticides	5.4	5.4	ng/L	USGS	TM-5-C2
Resmethrin	Water	Insecticides	5.7	5.7	ng/L	USGS	TM-5-C2
Tebupirimfos	Water	Insecticides	1.9	1.9	ng/L	USGS	TM-5-C2
Tefluthrin	Water	Insecticides	4.2	4.2	ng/L	USGS	TM-5-C2
Tetradifon	Water	Insecticides	3.8	3.8	ng/L	USGS	TM-5-C2
Tetramethrin	Water	Insecticides	2.9	2.9	ng/L	USGS	TM-5-C2
Thiacloprid	Water	Insecticides	3.2	3.2	ng/L	USGS	USGS – SIR 2012-5026
Thiamethoxam	Water	Insecticides	3.4	3.4	ng/L	USGS	USGS – SIR 2012-5026
Tolfenpyrad	Water	Insecticides	2.9	2.9	ng/L	USGS	USGS – SIR 2012-5026
Piperonyl butoxide	Water	Synergists	2.3	2.3	ng/L	USGS	TM-5-C2
Flumetralin	Water	Plant Growth Regulator	5.8	5.8	ng/L	USGS	TM-5-C2

-- = MDL/RL not yet determined.

Table 4.5. Summary of instrument ranges and resolution for laboratory meters.

Constituent	Matrix	Reporting group	Instrument Range	Resolution	Unit	Analyzing laboratory	Instrument used
Oxygen, Dissolved	Water	Conventional	0 to 20	0.1	mg/L	AHPL	YSI 58
pH	Water	Conventional	1 to 16	0.01	NA	AHPL	Beckman 255
Specific Conductivity	Water	Conventional	0 to 499.9 0 to 4999	0.1 1	uS/cm	AHPL	YSI 30
Temperature	Water	Conventional	-200 to 100	0.1	°C	AHPL	Onset HOBOware

4.3.2. Laboratory QC Samples

Data from the laboratory should include at the least the following QC data:

1. Surrogate Recovery (for all field and QC samples, if applicable)
2. Method Blank
3. Matrix Spike Recovery (if applicable)
4. Replicate precision (field, CRM, matrix spike, blank matrix spike samples)
5. Certified/Lab Reference Material (CRM/LRM) Recovery (if applicable)

Surrogate spikes should be included in all samples where appropriate for the analysis. Although surrogate spike recoveries can be used to estimate and correct for losses of the target analytes in the analytical process, unusually low or high recoveries reflect analytical issues that are not overcome simply by surrogate correction, because at low recoveries, surrogate correction factors become inversely larger. It is generally left to the professional judgment of the lab's QAO to set appropriate control/acceptance limits and corrective actions for surrogate recoveries.

Method blanks should be run at a minimum frequency of one per analytical batch (for analytical batches consisting of up to 20 field samples) or per 20 (field) samples for larger analytical batches. Results for laboratory method blanks, combined with those for field blanks, can help identify whether probable causes of sample contamination originated in the field or in laboratory analyses. If both field and lab method blanks have similar levels of contamination, it is likely caused primarily in lab procedures. If field blanks have higher contamination, sample collection methods are likely the cause. Raw results for method blanks should be reported.

Matrix spikes (MS) should be run at a minimum frequency of one per batch or per 20 samples. Matrix spike results are to be reported, along with the expected result (unspiked sample concentration + spike concentration), and a recovery estimate. The spiking concentrations should be high enough to produce an expected result sufficiently over the analytical variability in quantifying the unspiked sample to quantify recovery (at least ~3 times the unspiked result), but also low enough to be a relevant accuracy indicator in the concentration range of field samples (below 100x and preferably nearer 10x the unspiked result). In cases where analytes are mostly not detected in unspiked samples, a concentration range of that magnitude (10-100x) over the MDL may be appropriate to use instead.

Precision can be determined with all sample types analyzed and reported in replicate. Lab replicates (split and analyzed in the laboratory) of field samples are generally the preferred indicator of precision for typical field samples, as the target analyte concentration range, matrix, and interferences are most similar to previous analyzed samples or samples from nearby sites. However, sometimes field sample concentrations are below detection limits for many analytes, so replicate results on CRMs, LRMs, MS/MSDs, or blank spikes (LCSs) may be needed to supplement and obtain quantitative precision estimates. These alternative sample types, in particular blank spikes (LCSs), should not serve as the primary or exclusive indicator of measurement precision without prior approval by the Project Manager and QAO. LCSs are often created from a clean laboratory matrix, so they are likely not representative of the measurement precision routinely achievable in more complex matrices of real field-originated samples. RPDs should be calculated as described previously and reported for all samples analyzed in replicate.

Certified reference material (CRM) or other externally established performance testing samples should be run at a minimum frequency of one per analytical batch (for analytical batches consisting of up to 20 field samples) or per 20 (field) samples for larger analytical batches. Results should be reported along with the expected values and recoveries (as % of the expected value), where available for target analytes in appropriate matrices. In some cases, no widely available reference materials have been established and laboratories maintain internal lab reference materials (LRM) to track the relative internal accuracy of an analytical method. CRMs are likely the most robust indicators of measurement accuracy, given requirements for consensus among labs as well as validation through different methods of measurement. Reference values for CRMs or internal LRMs, although less rigorous (fewer labs in consensus, or only one analytical method provided), provide at least some indicator of measurement accuracy. Although poor recoveries on these uncertified values may be used to flag potentially unreliable data for use in data analyses and decision-making, they should not be used to cite or sanction a lab for “failing” to meet MQO requirements.

Table 4.6 lists recovery surrogate standards used for pesticide analyses and associated measurement quality objectives.

Table 4.6. Recovery surrogate standards used for pesticide analyses and associated measurement quality objectives.

Recovery surrogate standard	Matrix	Method	Acceptable limits (% recovery)
$^{13}C_3$-atrazine	Water	TM-5-C2	70-130%
Di-N-propyl-d_{14} trifluralin	Water	TM-5-C2	70-130%
Monuron	Water	USGS – SIR 2012-5026	70-130%
Imidacloprid-d_4	Water	USGS – SIR 2012-5026	70-130%

4.4. Data Quality Indicators and Test Acceptability Criteria for Toxicity Testing and Associated Water Quality Measurements

In the context of the RMP, toxicity monitoring should be viewed primarily as a set of tools to help identify pesticides that are causing significant aquatic toxicity in the Delta. Because toxicity testing is an integrative tool, it can determine effects of multiple constituents concurrently, and can be more cost-effective than chemical analysis of individual constituents.

Toxicity Identification Evaluations (TIEs) are planned for Delta RMP samples where there is $\geq$ 50 percent effect within 96 hours of the test period. TIEs should be initiated within 48 hours of the observation of the TIE trigger being met in the initial sample screening (see also Section 8.3). The primary goal of Delta RMP TIE testing is to identify whether pesticides are causing or contributing to observed toxicity, and if so, which pesticides (or degradates, or any of the inert ingredients in the formulated product) are the drivers. A secondary goal is to identify other factors (i.e., water quality conditions or other toxicants) contributing to reduced survival, growth, or reproduction.

Data quality indicators for toxicity testing and associated water quality measurements are outlined in Table 4.7, and test acceptability criteria are summarized in Table 4.8. Test results will be rejected when measurement quality objectives and test acceptability criteria are not met. However, the sample may be retested and qualified with an extended holding time if SFEI-ASC and the Delta RMP SC permit. Toxicity data will be qualified in instances where data does not meet accuracy and precision criteria below.

The water quality measurements specifically coupled to toxicity tests are intended to help interpret toxicity test data. Quality control practices and MQOs parallel those used for field meter instrumentation. Meters are calibrated at the beginning of each day and calibration checks are performed when measurements for the day exceed 20 readings for each meter. Meters are recalibrated when drift exceeds the MQO for accuracy in Table 4.7 below. Field duplicates are expected to fall within the precision MQOs below and data are qualified in instances when these are exceeded.

Table 4.7. Measurement quality objectives for toxicity testing and associated water quality measurements.

Toxicity Testing Laboratory Analysis			
Parameter	Accuracy	Precision	Completeness
pH	± 0.2	± 0.5 pH units	90%
Specific Conductance	± 0.5%	± 10%	90%
Temperature	± 0.1	± 10%	90%
Dissolved Oxygen	± 0.2	± 10%	90%
Ammonia	± 0.5%	± 10%	90%
Hardness	Standard Reference Material (SRM) within 80 to 120% recovery	RPD < 20%	90%
Alkalinity	SRM within 80 to 120% recovery	RPD < 20%	90%
Toxicity Testing	N/A	Reference toxicant performance, based on cumulative control charts: LC_{50} and/or EC_{25} within 2 standard deviations of the running mean from at least 20 data points	90%

Table 4.8. Summary of test acceptability criteria.

Species	Duration	Endpoint(s)	Method	Test acceptability criteria
S. capricornutum	4-days	Growth	UCD AHPL SOP1-1	Mean cell density of at least 2 X 10^5 cells/mL in the controls; and variability (CV%) among control replicates ≤20%
C. dubia	6-8 days	Survival, Reproduction	UCD AHPL SOP1-2	≥ 80% survival of all control organisms and an average of 15 or more young per surviving female in the control solutions. 60% of surviving control females must produce three broods

Species	Duration	Endpoint(s)	Method	Test acceptability criteria (required)
H. azteca[10]	4 days	Survival	UCD AHPL SOP1-6	≥ 90% survival
P. promelas	7-days	Survival, Biomass	UCD AHPL SOP1-3	≥ 80% survival in controls; average dry weight per surviving organism in control chambers equals or exceeds 0.25 mg/surviving fish

4.4.1. Quality Assurance Activities

All toxicity test protocols are based on methods outlined in "Summary of Test Conditions and Test Acceptability Criteria" tables in EPA (2002 a and b). Deviations from protocols must be reported to the QAO, the project manager, and in interim and final reports, depending on the degree of departure and the objective of the test. Deviations may or may not invalidate a test result. Before rejecting or accepting a test result as valid, the degree of the deviation and the potential or observed impact of the deviation on the test result will be evaluated. Predetermined deviations in protocols such as alternate test procedures or use of surrogate species must be discussed and approved prior to test initiation. Data quality indicators for this project will consist of the following:

Variability and bias

The Delta RMP has several mechanisms to ensure that variability and bias are minimized throughout the project. Technicians are trained according to standard laboratory protocols to ensure that samples are collected and analyzed in a consistent manner. Reference toxicant tests will be conducted throughout the project to ensure that organism sensitivity remains constant over time. The relative percent difference between field duplicate water quality measurements will be measured to ensure technicians are analyzing samples in a consistent manner. Ambient samples are tracked and labelled with site codes and SampleID numbers rather than associated with waterbody names to reduce technician bias of samples, and laboratory test replicates are initiated with test organisms randomly to reduce bias of organism health.

[10] Inclusion of *Hyalella* water toxicity testing is pending a final decision by the SC.

Test sensitivity

The Delta RMP utilizes the required minimum number of replicates specified by EPA to ensure adequate test sensitivity. Test sensitivity is also evaluated through reference toxicant testing, which measures both the laboratory performance and the relative sensitivity of the test species over time.

Positive control tests. Reference toxicant tests will be performed concurrently for each event for *H.azteca* and *P. promelas*. Reference toxicant tests for *C. dubia* and *S. capricornutum* will be performed monthly according to EPA test method for in-house cultures.

Zinc chloride ($ZnCl_2$) will be used as the reference toxicant for *S. capricornutum*; sodium chloride (NaCl) will be the reference toxicant used for the *C. dubia, H. azteca*, and *P. promelas* species. The LC_{50} (the concentration at which 50% of test organisms exhibit mortality) for survival or EC_{25} sublethal endpoint (the concentration at which 25% of test organisms exhibit a response) for each reference toxicant test is compared to the laboratory's running mean to ascertain whether it falls within the acceptable range. EPA test method manuals include the added caution that reference toxicant test results should not be used as a *de facto* criterion for rejection of individual receiving water tests. Reference toxicant tests do provide information on trends in organism sensitivity and laboratory performance that can be useful in evaluating and interpreting toxicity test results. For this reason, EPA has recommended evaluating the following elements of reference toxicant test results in the review of the receiving water test data: the degree to which the reference toxicant tests result is outside of control chart limits: the width of the limits; the direction of a deviation (toward increased test organism sensitivity or toward decreased test organism sensitivity); the test conditions of both the ambient or site water and the reference toxicant tests; and the objective of the test. The EPA acceptable range is within two standard deviations of the running mean. If the LC_{50} and/or EC_{25} fall outside of the upper and lower two standard deviation limits, test organism sensitivity may be atypical and results of ambient sample toxicity tests conducted nearest to the time when the reference toxicant test was performed will be qualified as either more sensitive or less sensitive than usual. See EPA 2002a for more information.

Precision

Precision is the degree to which independent analyses of a given sample agree with one another. It is the reproducibility, consistency and repeatability of results. UCD AHPL assesses precision through field duplicates. A field duplicate is a second sample collected in a separate container, immediately after the initial/primary test sample. Field duplicates are tested concurrently with its primary sample and the results are evaluated to determine precision of field and laboratory staff. Field duplicate samples are in agreement when they are both either statistically similar, or statistically different from the control. Field duplicates will be conducted at a rate of 5% of total project sample count.

The relative percent difference (RPD) between duplicates is calculated on water chemistry measurements using the following formula:

$$RPD = \left(\frac{\left[2 * \left| Dup1 - Dup2 \right| \right]}{\left[Dup1 + Dup2 \right]} \right) * 100$$

Accuracy

Accuracy of toxicity tests cannot be directly measured because of the lack of data to support a standard organism response against comparable test results. However, inferences can be made regarding accuracy from reference toxicant tests in order to assess the sensitivity of the organisms in a known concentration of toxicant, and to determine that the organisms' response is within acceptable limits. Accuracy of instruments will be evaluated using the formula for accuracy listed in Appendix A of the SWAMP QAPrP and will follow the MQOs listed in Table 4-7.

Completeness

The Delta RMP strives for a minimum of 90% completion of data. For toxicity tests, completeness is defined by the total number of samples that met Test Acceptability Criteria for each species divided by the total number of useable samples submitted to the laboratory for each species. An individual sample may not be usable if its conductivity is well above or below conductivities typically found in freshwater. These conductivity thresholds are different for each species. Toxicity completeness is assessed by the number of useable results divided by the total number of samples collected.

For water quality data associated with toxicity testing, data will be considered complete when each sample is measured within a sample batch that meets the accuracy requirements for the reference material (hardness, alkalinity and total ammonia), or meter drift (DO, EC and pH) is within acceptable limits.

Representativeness

In terms of laboratory toxicity testing of ambient samples, representativeness refers to the degree to which data accurately reflect the presence or absence of toxic contaminants in the environment at the sites where samples are collected. Location of sampling sites, sample preservation and appropriate species selection are important considerations for representativeness.

Comparability

The Delta RMP documents adhere to EPA test methods, SOPs and QA measures specified in the QAPP, and acceptable reference toxicant test results. Therefore, results can be compared with other projects and laboratories that adhere to the same EPA protocols and QA measures.

Data analysis

Toxicity tests will be conducted using a single-concentration test design. Data from laboratory toxicity tests will be analyzed according to the EPA standard single concentration statistical protocols (EPA, 2002, Appendix H). The EPA method of data analysis involves the comparison of each sample to one control (laboratory control or a conductivity control), and calculates the test result according to the standardized statistical approach used in aquatic toxicology.

Comprehensive Environmental Toxicity Information System™ (CETIS; Tidepool Scientific, McKinleyville, CA, USA) toxicity data analysis and database) software application will be used to calculate Effect Concentration and Lethal Concentration values (EC_{25} for sublethal endpoints and LC_{50} for survival endpoints) for reference toxicant tests.

4.4.2. Quality Control

Table 4.9 provides a summary of QC measures and also lists the toxicity endpoints that trigger a TIE. Table 4.10 provides MQOs related to toxicity testing. Section 8.3 Corrective Actions provides information on quality control actions when acceptance limits (i.e. “action limits”) are exceeded.

Table 4.9. Quality Control Measures for toxicity testing.

Method	Analyte/Test	Matrix	Holding Time/ Preservation	Acceptability Limit
SM 2320B; UCD AHP SOP 6-5	Alkalinity (as $CaCO_3$)	Water	14 days; Cool to 0 to 6°C	NA
SM 4500-NH3F; UCD AHP SOP 6-3	Ammonia	Water	48 hours, 28 days if acidified Cool to 0 to 6°C; samples may be preserved with 2 mL of H_2SO_4 / L	< 5 mg/L
SM 2510B; UCD AHP SOP 8-7	Conductivity	Water	28 days; Cool to 0 to 6°C; if analysis is not completed within 24 hours of sample collection, sample should be filtered through a 0.45 micron filter and stored at ≤6 °C	Addition of conductivity controls in test batches: > 1500 µS/cm for *S. capricornutum*, < 100 or > 1900 µS/cm for *C. dubia,* < 100 or > 1900 µS/cm for *P. promelas*; and < 100 mS/cm or > 10,000 µS/cm for *H. azteca*.
SM 4500OG; UCD AHP SOP 8-9	Dissolved Oxygen	Water	48 hours; Cool to 0 to 6°C; add 1 g FAS crystals per liter if residual chlorine is	< 8.6 mg/L (saturation) (*H. azteca* < 8.9 [saturation] mg/L)

Method	Analyte/Test	Matrix	Holding Time/ Preservation	Acceptability Limit
			present	
SM 2340C; UCD AHP SOP 6-1	Hardness	Water	14 days; Cool to 0 to 6°C	NA
SM 4500H+B; UCD AHP SOP 8-8	pH	Water	NA	6-9
SM 2550B	Temperature	Water	NA	25 + 1 °C (*H. azteca* 23 + 1°C) Test temperatures must not deviate (i.e., maximum minus minimum temperature) by more than 3°C during the test
EPA 1003.0	*S. capricornutum*	Water	48 hours; Cool to 0 to 6°C	Laboratory Control must meet test acceptability criteria listed in Table 4.8 TIE trigger: >50% reduction in cell growth
EPA 1002.0	*C. dubia*	Water	36 hours; Cool to 0 to 6°C	Laboratory Control must meet test acceptability criteria listed in Table 4.8 TIE trigger: >50% mortality in 96 hours
EPA 1000.0	*P. promelas*	Water	36 hours; Cool to 0 to 6°C	Laboratory Control must meet test acceptability criteria listed in Table 4.8 TIE trigger: >50% mortality in 96 hours

Table 4.10. Measurement Quality Objectives for toxicity testing.

Method	Analyte/Test	Quality Control	Frequency of Analysis	Control Limit/ MQO
SM 2320B; UCD AHP SOP 6-5	Alkalinity (as $CaCO_3$)	Reference Material	Per analytical batch	±10%
		Laboratory Blank	Per analytical batch	<12 mg/L
SM 4500-NH3F; UCD AHP SOP 6-3	Ammonia	Reference Material	Per analytical batch	±10%
		Laboratory Blank	Per analytical batch	<0.15 mg/L
SM 2510B; UCD AHP SOP 8-7	Conductivity	Calibration Standard: Internal Cell Constant	Per analytical batch (at least once daily)	Per manufacturer's specifications
SM 4500OG; UCD AHP SOP 8-9	Dissolved Oxygen	Oxygen Saturated Water at 25°C	Per analytical batch (at least once daily)	Per analytical method or manufacturer's specifications
SM 2340C; UCD AHP SOP 6-1	Hardness	Reference Material	Per analytical batch	±10%
		Laboratory Blank	Per analytical batch	<6 mg/L
SM 4500H+B; UCD AHP SOP 8-8	pH	Calibration Standard	Per analytical batch (at least once daily)	Per manufacturer's specifications
SM 2550B	Temperature	Certified Thermometer	Once annually	±0.5°C
Chronic Toxicity Testing	All species	Laboratory Control Water	Per analytical batch	Must meet all test acceptability criteria for the species of interest (see Table 4.8)
		Conductivity Control Water	Per analytical batch when conductivity parameters are above or below the species' tolerance (see Table 4.9a)	Follow EPA guidance on interpreting data
		Additional Control Water	Per analytical batch when manipulations are performed on one	No statistical difference between the laboratory control water and each adidional control water

Method	Analyte/Test	Quality Control	Frequency of Analysis	Control Limit/ MQO
			or more ambient sample within each analyitical batch	within an analytical batch
		Reference Toxicant Tests	Monthly for in-house cultured organisms or per analytical batch when organisms are commercially supplied.	Last plotted data point (LC50 or EC50/25) must be within 2 SD of the cumulative mean (n=20)
		Sample Duplicate	5% total project sample count (3 per year)	Recommended acceptable RPD <20%
		Field Blank	One per year	No statistical difference between the laboratory control water and the field blank within an analytical batch
		Bottle Blank	Two per year	No statistical difference between the laboratory control ater and the bottle blank within an analytical batch

4.4.3. Project-specific corrective action limits

Individual results produced by the Delta RMP are not intended to trigger enforcement actions, even though collectively the data may guide management actions by other parties through planning. Consequently, there are no project-specific corrective actions required for the data. However, any corrective actions that are warranted shall be made at the discretion of the QAO following the SWAMP Guidance:

<u>Laboratory Control Water</u>: If tested with in-house cultures, affected samples and associated quality control must be retested within 24 hours of test failure. If commercial cultures are used, they must be ordered within 16 h of test failure for the earliest possible receipt. Retests must be initiated within 30 h of receipt, depending on the need for organism acclimation. The laboratory should try to determine the source of the control failure, document the investigation and document the steps taken to prevent a recurrence.

Conductivity Control Water: Affected ambient samples and associated quality control must be flagged to reflect that conductivity may be outside of the physiological tolerance for the species tested.

Additional Control Water: Based on the objectives of the study, a water sample that has similar qualities to the test sample may be used as an additional control (e.g. pH adjustments, continuous aeration). Results that show statistical differences from the laboratory control should be flagged. The laboratory should try to determine the source of variation, document the investigation and document the steps taken to prevent a recurrence. This is not applicable for TIE method blanks.

Reference Toxicant Tests: If the LC50 exceeds +/- two standard deviations of the running mean of the last 20 reference toxicant tests the associated ambient test should be flagged as either more or less sensitive than normal.

Field Duplicate: Visually inspect the samples to determine if a high RPD between results could be attributed to sample heterogeneity. For duplicate results varying due to matrix heterogeneity, or where ambient concentrations are below the reporting limit, qualify the results and document the heterogeneity. Results that do not meet SWAMP RPD criteria should be flagged, regardless of whether the sample is heterogeneous or not. The project coordinator should be notified so that the sampling team can identify the source of variation and perform corrective action prior to the next sampling event.

Field Blanks: If contamination of the field blanks and associated samples is known or suspected, the laboratory should flag the affected data. The project coordinator should be notified so that the sampling team can identify the contamination source(s) and perform corrective action prior to the next sampling event.

Bottle Blanks: If contamination of the equipment blanks and associate sample is known or suspected, the laboratory should flag the affected data. The laboratory manager should be notified so that the laboratory technicians can identify the contamination source(s) and perform corrective actions prior to the next sampling event.

Calibration Standard: Recalibrate the instrument. Affected samples and associated quality control must be reanalyzed following successful instrument recalibration.

Laboratory Blank: Reanalyze the blank to confirm the result. Investigate the source of contamination. If the source of the contamination is isolated to the sample preparation, the entire batch of samples, along with the new laboratory blanks and associated QC samples, should be prepared and/or re-extracted or analyzed. If the source of contamination is isolated to the analysis procedures, reanalyze the entire batch of samples. If reanalysis is not possible, the associated sample results must be flagged to indicate the potential presence of contamination.

4.5. Performance-based method concept for the determination of LT2 pathogens (Cryptosporidium and Giardia)

The Delta RMP pathogen (*Cryptosporidium* and *Giardia*) monitoring is designed as the ambient monitoring component of the Regional Board's Basin Plan Amendment to establish a Drinking Water Policy to protect source water, and is being conducted concurrently with the drinking water agencies' required Long Term 2 (LT2) Enhanced Surface Water Treatment Rule monitoring (as described in the Delta RMP Pathogen Study Design Summary). The Pathogen Study is intended to satisfy data needs and monitoring for any follow-up required if Basin Plan trigger values are exceeded during LT2 monitoring. The direction from the Central Valley Drinking Water Policy Workgroup is that data collected for the RMP pathogen monitoring should be consistent with data collected during LT2 monitoring.

EPA Method 1623 was developed to support the support promulgation of EPA's LT2. Its purpose is to support the assessment of protozoan (*Cryptosporidium* and *Giardia*) pathogen occurrence in raw surface waters used as source waters for drinking water treatment plants. EPA Method 1623 provides quality control (QC) acceptance criteria for *Cryptosporidium* and *Giardia,* but notes that some sample matrices may prevent the acceptance criteria from being met. EPA notes that field samples with matrix spike recoveries below the QC acceptance criteria identified in Method 1623 (13%-111% for *Cryptosporidium* and 15%-118% for *Giardia*) are valid, and will be accepted for determining LT2 bin concentrations. To be consistent with the LT2 data, the RMP will consider data outside the acceptance criteria to be valid, but will flag such results.

The Pathogen Study may use EPA Method 1623.1, which is reported to have higher *Cryptosporidium* recoveries. The QC acceptance criteria identified in Method 1623.1 for matrix spike recoveries are 32%-100% for *Cryptosporidium* and 8%-100% for *Giardia*.

To be approved for LT2 protozoan testing using Method 1623 and 1623.1, laboratories are required to demonstrate acceptable performance for *Cryptosporidium* and *Giardia*. EPA Method 1623 and 1623.1 are performance-based methods applicable to the determination of *Cryptosporidium* and *Giardia* in aqueous matrices. Demonstration of acceptable performance includes initial and ongoing precision and recovery tests, which are conducted using spiked reagent water and matrix samples. Each laboratory that uses this method is required to operate a formal quality assurance (QA) program that addresses and documents data quality, instrument and equipment maintenance and performance, reagent quality and performance, analyst training and certification, and records storage and retrieval. The minimum analytical requirements of this program consist of an initial demonstration of laboratory capability (IDC) through performance of an initial precision and recovery (IPR) test, and ongoing demonstration of laboratory capability and method performance through the matrix spike (MS) test, the method blank test, an ongoing precision and recovery (OPR) test, staining controls, and analyst verification tests. Laboratory performance is compared to established performance criteria to determine if the results of analyses meet the performance characteristics of the method. A principal analyst verifies the quality and accuracy of all sample results. Laboratory performance is compared to established performance criteria to determine if the results of analyses meet the performance characteristics of the method. Table 4.11 summarizes the minimum QC requirements for Method 1623, and Table 4.12 summarizes the minimum QC requirements for Method 1623.1. Details are described in EPA Method 1623 and 1623.1.

Table 4.11. QC requirements and acceptance criteria for determination of *Cryptosporidium* and *Giardia* in aqueous matrices (EPA Method 1623)

QC sample or procedure	Frequency	Acceptable limits
Cryptosporidium		
IPR	Each equipment/supply change	Mean Recovery = 24 -100%/RSD ≤ 55%
Method Blank	1 per 20 or week	No false positives
OPR	1 per 20 or week	Recovery = 22 -100%
Matrix Spikes	1 per 20	Recovery = 13-111%/RPD ≤ 61%
Matrix Spikes/Duplicates	Initial use and each procedural change	Recovery = 13-111%/RPD ≤ 61%
Positive staining control	Every batch	No false negatives
Negative staining control	Every batch	No false positives
Verification of analyst performance	Monthly	< 10% difference in counts
Giardia		
IPR	Each equipment/supply change	Mean Recovery = 24 -100%/RSD <49%
Method Blank	1 per 20 or week	No false positives
OPR	1 per 20 or week	Recovery = 14 -100%
Matrix Spikes	1 per 20	Recovery = 15-118%/ RPD ≤ 30%
Matrix Spikes/Duplicates	Initial use and each procedural change	Recovery = 15-118%/ RPD ≤ 30%
Positive staining control	Every batch	No false negatives
Negative staining control	Every batch	No false positives
Verification of analyst performance	Monthly	< 10% difference in counts

Table 4.12. QC requirements and acceptance criteria for determination of *Cryptosporidium* and *Giardia* in aqueous matrices (EPA Method 1623.1)

QC sample or procedure	Frequency	Acceptable limits
Cryptosporidium		
IPR	Each equipment/supply change	Mean Recovery = 38 -100%/RSD < 37%
Method Blank	Each IPR and OPR set	No false positives
OPR	1 per 20 or week	Recovery = 33 -100%
Matrix Spikes	1 per 20	Recovery = 32 -100%/RSD < 46%
Matrix Spikes/Duplicates	Initial use and each procedural change, and multi-lab validation of modification	Recovery = 32 -100%/RSD < 46%
Positive staining control	Every batch	No false negatives
Negative staining control	Every batch	No false positives
Verification of analyst performance	Monthly	< 10% difference in counts
Giardia		
IPR	Each equipment/supply change	Mean Recovery = 27 -100%/RSD < 39%
Method Blank	Each IPR and OPR set	No false positives
OPR	1 per 20 or week	Recovery = 22 -100%
Matrix Spikes	1 per 20	Recovery = 8 -100%/RSD ≤ 97%
Matrix Spikes/Duplicates	Initial use and each procedural change, and multi-lab validation of modification	Recovery = 8 -100%/RSD ≤ 97%
Positive staining control	Every batch	No false negatives
Negative staining control	Every batch	No false positives
Verification of analyst performance	Monthly	< 10% difference in counts

5. Special Training Needs and Certification

5.1. Specialized Training or Certifications

Because the Delta RMP uses performance-based methods for laboratory evaluation, laboratory certifications (e.g. by NELAP/ELAP[11]) for the analyses planned are preferred but not required. The laboratory providing analytical support to the Delta RMP must have a designated on-site QA Officer for the particular analytical component(s) performed at that laboratory. This individual will serve as the point of contact for the SFEI-ASC QA staff in identifying and resolving issues related to data quality.

To ensure that the samples are analyzed in a consistent manner throughout the duration of the program, key laboratory personnel will participate in an orientation session conducted during an initial site visit or via communications with SFEI-ASC staff. The purpose of the orientation session is to familiarize key laboratory personnel with this QAPP and the Delta RMP QA/QC program. Participating laboratories may be required to demonstrate acceptable performance before analysis of samples can proceed, described in subsequent sections. Laboratory operations will be evaluated on a continual basis through technical systems audits, and by participation in laboratory inter-comparison programs.

Personnel in any laboratory performing analyses will be well versed in good laboratory practices (GLPs), including standard safety procedures. It is the responsibility of the analytical laboratory manager, and/or safety staff to ensure that all laboratory personnel are properly trained. Each laboratory is responsible for maintaining a current safety manual in compliance with the Occupational Safety and Health Administration (OSHA) or equivalent state or local regulations. The safety manual will be readily available to laboratory personnel. Proper procedures for safe storage, handling, and disposal of chemicals will be followed at all times; each chemical will be treated as a potential health hazard and GLPs will be implemented accordingly.

Personnel collecting samples must have been trained on the field sampling methods described in the QAPP. For pesticides monitoring, the USGS field sampling coordinator will be responsible for training the USGS field staff. For pathogen monitoring, MWQI will be responsible for training the field staff. The sign-in sheet of the training can be the documentation of the training.

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[11]Environmental Laboratory Accreditation Program (ELAP). ELAP provides evaluation and accreditation of environmental testing laboratories to ensure the quality of analytical data used for regulatory purposes to meet the requirements of the State's drinking water, wastewater, shellfish, food, and hazardous waste programs

5.2. Training Certification and Documentation

Contractors performing sampling are responsible for providing training to their staff and maintaining records of all trainings. Those records can be obtained if needed from contractors through their respective QA or Safety Officers.

5.3. Training Personnel

Each contract laboratory's QA Officer and Safety Officer shall provide and/or designate staff to provide training to their respective personnel. All personnel responsible for sampling will be trained in field sample collection and safety prior to the first day they are schedule to sample for the Delta RMP.

6. Documents and Records

All Delta RMP documents will be provided to the Steering Committee, which includes the Regional Board.

SFEI-ASC will collect records for sample collection, field analyses, laboratory chemical analyses, toxicity testing, and pathogen analyses. Samples sent to analytical laboratories will include a Chain-of-Custody (COC) form. The analytical laboratories will maintain records of sample receipt and storage, analyses, and reported results.

SFEI-ASC will maintain hardcopy or scanned files of field notes and measurements, as well as laboratory submitted documentation and results at the SFEI-ASC main office. The SFEI-ASC Data Manager will be responsible for the storage and organization of information.

Contract laboratories will also be responsible for maintaining copies of project documentation originating from their respective laboratories, with backup archival storage offsite where possible. All SOPs used for the Delta RMP will be stored indefinitely in case future review is necessary.

Quality Assurance Documentation

All laboratories will have the latest revision of the Delta RMP QAPP. In addition, the following documents and information will be current and available to all laboratory personnel participating in the processing of Project samples, as well as to SFEI-ASC program officials:

1. Laboratory QA Plan: Clearly defined policies and protocols specific to a particular laboratory, including personnel responsibilities, laboratory acceptance criteria and corrective actions to be applied to the affected analytical batches, qualification of data, and procedures for determining the acceptability of results.
2. Laboratory Standard Operating Procedures (SOPs): Containing instructions for performing routine laboratory procedures, such as logging, labelling, and storage of samples, cleaning of equipment, checking of reagents, etc., that are not necessarily part of any analytical methodology for specific analytes or analyte types.

3. Laboratory Analytical Methods: Step-by-step instructions describing exactly how a method is implemented in the laboratory for a particular analytical procedure. Contains all analytical methods utilized in the particular laboratory for the Delta RMP.
4. Instrument Performance Information: Information on instrument baseline noise, calibration standard response, analytical precision and bias data, detection limits, etc. This information should be reported for the periods during which Delta RMP samples are analyzed.
5. Control Charts: Control charts are useful in evaluating internal laboratory procedures and are helpful in identifying and correcting systematic error sources. Contract laboratories are encouraged to develop and maintain control charts whenever they may serve in determining sources of analytical problems.

Copies of laboratory methods, SOPs, and QA plans are available by request from the SFEI-ASC QA Officer. Some laboratory methods and SOPs may be edited to exclude proprietary details about the analyses. Quality assurance documents are reviewed to assure conformance to program needs by the Delta RMP Project Manager and QAO or their designees.

Copies of all records will be maintained at SFEI-ASC and at the laboratory for a minimum five years after project completion, after which they may be discarded, except for the database at SFEI-ASC, which will be maintained without discarding. All data will be backed up and secured at a remote location (i.e., separate from the SFEI-ASC office). As needed, data recovery can be initiated by contacting the back-up facility for restoration and this will be covered through SFEI-ASC overhead.

All participants listed in Table 0.1 will receive the most current version of the Delta RMP QAPP.

6.1. Report Package Information

Analytical results, including associated quality control samples, will be provided to SFEI-ASC by the analytical laboratories. The laboratories analyze samples according to the hold times listed in the Delta RMP QAPP, but the final report may be finalized for review up to 90 days after samples are received from the laboratory. Exceedances of the standard turnaround time should be discussed with and approved by the Delta RMP Project Manager and QAO.

Laboratory personnel will verify, screen, validate, and prepare all data, including QA/QC results, in accordance with the Delta RMP's QAPP and will provide (upon request) detailed QA/QC documentation that can be referred to for an explanation of any factors affecting data quality or interpretation. Any detailed QA/QC data not submitted as part of the reporting package (see below) should be maintained in the laboratory's database for future reference.

Laboratories will provide electronic copies of the tabulated analytical data (including associated QA/QC information outlined below) in a format agreed upon with the Delta RMP Project/Data Manager or designee.

Each Electronic Data Deliverable (EDD) report will consist of the following: Analytical and QA data results in an appropriate CEDEN format and CRM certificates (when applicable).

Results should be flagged by the laboratory for exceedances of Delta RMP MQOs for completeness, sensitivity, precision, and accuracy, using data quality codes as defined by CEDEN's list of codes, which have been adopted by the Delta RMP for reporting data. The data quality codes should be provided in the LabResult table in the ResQualCode and QACode fields. A list of commonly used result qualifier codes and QA codes are provided in Tables 6.1 and 6.2, respectively. A completed list of codes is available on CEDEN's Controlled Vocabulary web page. Details on the measurements and procedures that are expected to be used to demonstrate the quality of reported data can be found in Section 4, Quality Objectives, Criteria, and Control Procedures for Measurement Data.

6.1.1. Analytical and QA data results

Toxicity data that is generated using funds provided by SWAMP will be submitted to the Office of Information Management and Analysis (OIMA) by the data provider using SWAMP data templates, SWAMP formatting, completeness and business rules and through the SWAMP's Data Checker. This online tool alerts users to data that do not conform to the business rules outlined in the applicable SWAMP Data Management Plan or the values established in SWAMP's LookUp Lists. Data must be reviewed and verified for format, completeness, and quality control requirements, including result qualifications and appropriate sample and batch comments, prior to submission to OIMA. The laboratory must be reachable to answer questions regarding the data submittal if necessary. If the data is determined to be incomplete or requiring significant corrections, the data may be returned to the laboratory for correction and re-submission. Once these data have been approved by SWAMP, the appropriate SWAMP Data Manager will provide the data within the California Environmental Data Exchange Network's (CEDEN) electronic data deliverable (EDD) templates to SFEI/ASC for further processing. SFEI-ASC staff is encouraged to contact the OIMA Help Desk with any data questions they may have.

Results for field measurements, pesticides, copper, DOC/POC and pathogens will be submitted in the EDD template supplied by SFEI-ASC. Tabulated data will include the following information for each sample (when applicable):

1. Sample identification: Unique sample ID, site code, site name, collection date, collection time, analysis date, sample type (field or QC types), and matrix (water).
2. Analytical methods: Preparation, extraction, and quantitation methods (codes should reference SOPs submitted with the data submission package). Also include preparation, extraction, and analysis dates.
3. Analytical results: Analyte name, fraction, result, unit, method detection limit (MDL), and reporting limit (RL) for all target parameters. The appropriate data qualifiers should be submitted with the results.

Required additional data include:

- Control results (for toxicity tests)

- Summary and individual replicate results, including water quality parameters (for toxicity tests)
- Lab replicate results (and field replicates, when sent for analysis)
- Quality assurance information for each analytical chemistry batch:
- CRM or LRM results: absolute concentrations measured, certified value, and % recovery relative to certified or expected value.
- Matrix (or blank) spike results: include expected value (native + spike) for each analyte, actual recovered concentrations, and calculated % recovery.
- Method blank sample results in units equivalent to field sample results (e.g., if the field samples are reported as ng/g, method blanks are given in the same units).
- Field and lab replicate results and calculated %RPD or %RSD.

6.1.2. Electronic Data Deliverable Template

SFEI-ASC is a Regional Data Center (RDC) for the State of California and uses templates, standardized vocabulary and business rules developed and maintained by CEDEN to manage data for field collection, chemistry, taxonomy, tissue, toxicity, and bioassessment sampling. SFEI-ASC will provide training and guidance to collection agencies and laboratories on how to use the CEDEN templates.

Prior to field collection, SFEI-ASC will provide the field collection agency a copy of the CEDEN Locations and ChemResults tables to be populated with information about the sample collection.

Prior to analyses, SFEI-ASC will provide the laboratory with a copy of the appropriate CEDEN template (populated by the field collection agency with information about the sample collection) and documentation for populating the CEDEN template. The documentation details attributes of each field including field name, data type, whether the field is required or not, the appropriate lookup list for approved vocabulary and a description of each field. The CEDEN templates and documentation are available on-line from CEDEN at http://www.ceden.org/ceden_datatemplates.shtml. Lookup list values are available on the CEDEN Controlled Vocabulary website.

Table 6.1. CEDEN controlled vocabulary for result qualifiers.

Result Qualifier Name	Result Qualifier Code
Absent	A
Colonial	COL
Confluent Growth	CG
Cw/C - Confluent Growth with Coliforms	w/C
Cw/oC - Confluent Growth without Coliforms	/oC
Detected Not Quantifiable	DNQ
Equal To	=
Field Estimated	JF
Greater Than	>
Greater than or equal to	>=
Less Than	<
Less than or equal to	<=
No Reportable Sum	NRS
No Reportable Total	NRT
No Surviving Individuals	NSI
Not Analyzed	NA
Not Detected	ND
Not Recorded	NR
Percent Recovery	PR
Present	P

Table 6.2. Common CEDEN QA codes.

QACode	QADescr
BRK	No concentration sample container broken
BRKA	Sample container broken but analyzed
BS	Insufficient sample available to follow standard QC procedures
DO	Coelution
DS	Batch Quality Assurance data from another project
H	A holding time violation has occurred
IL	RPD exceeds laboratory control limit
IP	Analyte detected in field or lab generated blank
IU	Percent Recovery exceeds laboratory control limit
J	Estimated value - EPA Flag
M	A matrix effect is present
NBC	Value not blank corrected
None	None - No QA Qualifier
R	Data rejected - EPA Flag
SC	Surrogate Corrected Value
Other QA Codes	
BB	Sample > 4x spike concentration
BE	Low surrogate recovery; analyzed twice
BLM	Compound unidentified or below the RL due to overdilution
BT	Insufficient sample to perform the analysis
BY	Sample received at improper temperature
BZ	Sample preserved improperly
CS	QC criteria not met due to analyte concentration near RL
CT	QC criteria not met due to high level of analyte concentration
D	EPA Flag - Analytes analyzed at a secondary dilution

QACode	QADescr
DRM	Spike amount less than 5X the MDL
EU	LCS is outside of acceptance limits. MS/MSD are accept., no corr.
EUM	LCS is outside of control limits
FO	Estimated maximum possible concentration (EMPC)
GN	Surrogate recovery is outside of control limits
GR	Internal standard recovery is outside method recovery limit
H24	Holding time was > 24 hours for Bacteria tests only
H6	Holding time was > 6 hrs but < 24 hours for Bacteria tests only
HH	Result exceeds linear range; concentration may be understated
HR	Post-digestion spike
HT	Analytical value calculated using results from associated tests
IF	Sample result is greater than reported value
JA	Analyte positively identified but quantitation is an estimate
LC	Laboratory Contamination
N	Tentatively Identified Compound
NC	Analyte concentration not certifiable in Certified Reference Material
NMDL	No Method Detection Limit reported from laboratory
NRL	No Reporting Limit reported by the laboratory
PG	Calibration verification outside control limits
PJ	Result from re-extract/re-anal to confirm original MS/MSD result
PJM	Result from re-extract/re-anal to confirm original result
QAX	When the native sample for the MS/MSD or DUP is not included in the batch reported
RE	Elevated reporting limits due to limited sample volume
SCR	Screening level analysis

6.1.3. Standard Operating Procedures (SOPs)

The laboratory submitted SOPs for preparation, extraction, and analytical methods upon approving the QAPP. The SOPs are listed in Appendix D in this QAPP. The QA Officer/Project Manager will need to approve any changes in methods.

6.2. Data Reporting Requirements

Each laboratory shall establish a system for detecting and reducing transcription and calculation errors prior to reporting data.

Data will be reported in CEDEN templates or provided in a comparable format approved by SFEI's Data Manager. Chemical-analytical data and pathogen data will be reported in CEDEN's Water Quality (WQ) template. Toxicity data will be reported to SWAMP using the SWAMP toxicity template. The minimum fields required for data reported in the CEDEN WQ template for the Lab Results tab are: StationCode, SampleDate, ProjectCode, CollectionTime, CollectionMethodCode, SampleTypeCode, Replicate, CollectionDepth, UnitCollectionDepth, LabBatch, AnalysisDate, MatrixName, MethodName, AnalyteName, FractionName, UnitName, LabReplicate, Result, ResQualCode, MDL, RL, QACode. These fields should include true values (not nulls). Other fields such as preparation code and extraction method should be filled out to the extent possible. The minimum fields required for data reported in the CEDEN WQ template for the Lab Batch tab are: LabBatch and LabAgencyCode. Batches must be reviewed for QC completeness and any deviation in QC results should be documented in the accompanying case narrative. The required fields will be identified in the template in green font. The EDD template provided to the laboratory by SFEI will have the fields concerning field collection of the samples already populated.

Documentation containing definitions, field length, field requirement, and associated lookup lists (if applicable) for each field is available on the CEDEN website (http://www.ceden.org/ceden_datatemplates.shtml).. Fields requiring controlled vocabulary can be identified by hovering over the field name in the template and referring to the lookup list that is referenced. Lookup lists are available on the CEDEN website at http://www.ceden.org/CEDEN_Checker/Checker/LookUpLists.php.

Only data that have met MQOs or that have deviations explained appropriately will be accepted from the laboratory. When QA requirements have not been met, the samples will be reanalyzed when possible. Only the results of the reanalysis should be submitted, provided they are acceptable.

Reporting turnaround times for submission of results from sample analyses are specified in contracts with the analytical laboratories. However, samples should be extracted and analyzed within the holding times specified for the analytical methods used (Table 9-2). Turnaround time requirements specified in subcontracts are generally 90 days or less.

6.3. Data Storage/Database

Data are managed by SFEI-ASC Data Services as established in Section 13. Upon completion of QA/QC review and data validation, data are compiled into the SFEI-ASC RDC database and distributed to the project managers.

Data that are approved for public release are made available through SFEI-ASC's Contaminant Data Display and Download (CD3) tool, usually within one year of sample collection. Data will also be made available through CEDEN's Advanced Query tool.

7. Sampling Process Design

7.1. Study Area and Period

Sample collection points and a justification for site selection for the different elements are described in the specific designs for each of the Delta RMP monitoring elements (Appendix B). The Delta RMP monitoring sites are located in and upstream of the Delta (Figures 3-1, 3-2, and 3-3). The monitoring sites for pesticide surface water sampling represent key inflows to the Delta (Figure 3-1). The monitoring sites for mercury sampling represent different subareas of the Delta (Figure 3-2). Ambient pathogen monitoring sites (Figure 3-3) are co-located with existing sites of the Municipal Water Quality Investigations program.

Sampling timing and frequency varies for the different elements of the monitoring program:

- Pesticide sites are visited monthly. The monthly visits capture two wet events (first flush rain, 2nd significant storm in winter) and three dry events (1st irrigation, 2nd irrigation, and snow melt/spring runoff).
- Mercury monitoring includes annual sport fish sampling at six sites and quarterly water sampling at 5 of these sites. Both sportfish and water sampling will begin in 2016.
- Pathogen ambient water monitoring occurs monthly at 12 sites.

Collected data are used to evaluate future data needs and adjust the sampling and analysis plan as needed to optimize data collection in an adaptive manner. The program will be continually adjusted to optimize data collection. The monitoring design is described in the Monitoring Design Summary document.

7.2. Sampling Sites

Table 7.1. Sampling sites and schedule.

Site Name	Site Code	Target Latitude	Target Longitude	Sampling frequency	Sampling Day
Pesticides					
Mokelumne R @ New Hope Road	544SAC002	38.23611	-121.41889	Monthly	3rd Tuesday
Sacramento R @ Hood	510SACC3A	38.36691	-121.52037	Monthly	3rd Tuesday
San Joaquin R @ Buckley Cove	544LSAC13	37.97667	-121.37889	Monthly	3rd Tuesday
San Joaquin R @ Vernalis/Airport Way	541SJC501	37.67556	-121.26417	Monthly	3rd Tuesday
Ulatis C @ Brown Rd	511ULCABR	38.30667	-121.79472	Monthly	3rd Tuesday
Mercury					
Cache Slough at Liberty Island Mouth	510ADVLIM	38.24213	-121.68539	Fish: Annually Water: Quarterly	Not specified
Little Potato Slough	544LILPSL	38.09627	-121.49602	Fish: Annually Water: Quarterly	Not specified
Middle R @ Borden Hwy (Hwy 4)	544MDRBH4	37.89083	-121.48833	Fish: Annually Water: Quarterly	Not specified
Lower Mokelumne R 6	544ADVLM6	38.25542	-121.44006	Fish: Annually	Not specified
Sacramento R @ Freeport	510ST1317	38.4556	-121.50189	Fish: Annually Water: Quarterly	Not specified
San Joaquin R @ Vernalis/Airport Way	541SJC501	37.67556	-121.26417	Fish: Annually Water: Quarterly	Not specified
Pathogens					
Banks Pumping Plant	KA000331	37.81480	-121.61573	Monthly	1st Wednesday
Cache Slough nr Ryder Island	B9D81281401	38.22500	-121.67481	Monthly	1st Tuesday
Calaveras R @ UoP Footbridge	B9D75891188	37.98003	-121.33648	Monthly	1st Tuesday
Colusa Basin Ag Drain	A0294500	38.80197	-121.72552	Monthly	1st Monday
Jones Pumping Plant	B9C74781351	37.79690	-121.58550	Monthly	1st Wednesday
Mokelumne R @ Benson Ferry	B9D81531264	38.25461	-121.43658	Monthly	1st Tuesday
Natomas East Main Drainage Canal	A0V83671280	38.61110	-121.467300	Monthly	1st Monday
Old R @ Bacon Island	B9D75811344	37.96910	-121.57290	Monthly	1st Monday
Rock Slough @ CCWD Fish Facility	B9C75861385	37.99550	-121.70180	Monthly	1st Monday
Sacramento R @ Hood	B9D82211312	38.36691	-121.52037	Monthly	1st Tuesday

Site Name	Site Code	Target Latitude	Target Longitude	Sampling frequency	Sampling Day
Sacramento R @ Westin Boat Dock	B9D83221310	38.53003	-121.53091	Monthly	1st Tuesday
San Joaquin R @ Vernalis/Airport Way	B0702000	37.67556	-121.26417	Monthly	1st Tuesday

8. Sampling Methods

The quality of samples collected in the field is addressed through a number of procedures. Proper selection of equipment, supplies and training for use of those items ensures that collection procedures and materials do not or minimally affect samples. Collection and analyses of appropriate quality control samples allows measurement and assessment of artifacts or influences of sampling on sample characteristics, to differentiate uncertainties and variability introduced by the sampling process from those inherent in the monitored system. This section will describe quality assurance and quality control procedures implemented for the Delta RMP.

8.1. Field Equipment and Supplies

Sampling equipment and supplies will vary depending on the project element. Sample containers appropriate to the matrices being sampled and the analyses to which they will be subjected will be chosen. All containers should meet or exceed the required trace limits established by the US EPA in the document EPA/540/R-93/051, Specifications and Guidance for Contaminant-Free Sample Containers. Chemical-resistant powder-free nitrile and polyethylene gloves will be worn and clean-hands dirty-hands protocols will be followed to minimize contamination of exposed samples. Field cleaning procedures of sampling equipment will be employed to minimize cross-contamination between samples for the parameters of interest.

Field personnel will refer to the detailed workplan for the appropriate Delta RMP sampling element to ensure that all equipment and supplies are brought in the field. However, at a minimum the following supplies are required for the respective project elements:

Fish

Boats (electro-fishing and/or for setting nets)

Waterproof labels

Bone saw, gill nets (various sizes), filet knives, fish picks, shackles, pliers, sharpening stone

Rod and reels, bait, tackle box, landing net, live bait container

Plastic ice chests, inflatable buoy, floats, anchor chains, anchors, patch kit

Heavy-duty aluminum foil (prepared), zipper-closure polyethylene bags

Otter trawls

Blocks

Measuring boards, tape measure, id keys, Teflon cutting boards

Rod and reels, landing net

Water

Sampling containers and labels

Collection devices appropriate for site

Powder-free nitrile gloves

Field meters

Deionized water squirt bottle

Field sheet (see Appendix E)

Coolers and ice

Chain-of-custody form (see Appendix F)

8.2. Field Sample Collection and Quality Assurance Procedures

8.2.1. *Surface Water Sample Collection*

Samples for pesticide monitoring are collected monthly as grab samples 0.5 meters below surface. Specific targeted events sampling described in Table 8.1 will replace routine monthly sample collection as appropriate. The triggers and criteria for events sampling are summarized in Table 8.1.

Water samples for mercury monitoring are collected quarterly.

The Delta RMP Pathogen Study Design Summary specifies monthly ambient monitoring sample collection for two years beginning in April 2015 to match the Long Term 2 Enhanced Surface Water Treatment Rule (LT2)-required water supply intake sample collection. MWQI will collect grab samples at each of the locations shown in Figure 7.2 during the first week of each month on the site-specific day. The specified sample collection depth for the pathogen sampling is 1 meter/3 feet. MWQI may postpone or cancel sample collection due to safety or logistical concerns.

References and links for accessing SOPs for surface water sample collection are provided in Appendix D.

Table 8.1. Sampling event triggers for pesticide events sampling.

Event	Sampling Triggers	Criteria	Notes
Wet			
1st seasonal flush (Water Year)	• Guidance plots project significant increase (~25%) in flow at four sites: lower Sacramento River, lower American River, San Joaquin River at Vernalis, and Mokelumne River.	• Preceded by $\geq$30 days dry weather (Sac SW criteria).	• *Sample events to hit all sites in 1 to 2 days.* • *When favorable storm conditions and runoff are forecast coordinate directly with AHP lab.* • *Alert AHPL 7 days in advance of upcoming storm for organism preparation and 2 days in advance about likelihood of adequate precipitation*
Significant winter storm	• Guidance plots project significant increase (~25%) at four sites: lower Sacramento River, lower American River, San Joaquin River at Vernalis, and Mokelumne River.	• Minimum 2 weeks since 1st flush sample event.	• *If collect more than 1 event sample in the same month, do not sample in following month.* • *When favorable storm conditions and runoff are forecast coordinate directly with AHP lab.* • *Alert AHPL 7 days in advance of upcoming storm for organism preparation and 2 days in advance about likelihood of adequate precipitation*
Dry			
Early Spring	• No triggers, can sample in a particular month (March-April).	• None	• *Meant to capture snowmelt but recognize significant impact of upstream dams.* • *Coordinate sampling schedule with AHP lab 7 or more days in advance.*

Event	Sampling Triggers	Criteria	Notes
1st irrigation season sampling (late spring/ early summer)	• No triggers, can sample in a particular month (May-June).	• None	• *Meant to capture late winter and spring pesticide applications (post storms).* • *Account for planting/ pesticide application timing.* • *Coordinate sampling schedule with AHP lab 7 or more days in advance.*
2nd irrigation season sampling (late summer)	• No triggers, can sample a particular month (August).	• None	• *Meant to capture summer pesticide applications (rice, etc.).* • *Account for planting/ pesticide application timing.* • *Coordinate sampling schedule with AHP lab 7 or more days in advance.*

Collection of water samples for analysis of pesticides and toxicity testing:

USGS personnel will collect water samples for analysis of pesticides, dissolved copper, and toxicity testing. At sites where streamflow is affected by tides, samples will be collected on the ebb tide. Due to the large volumes of water required per site, per event (40 liters for toxicity testing and 2-4 liters for pesticide analyses), all samples will be collected as grab samples. Water will be collected by submerging pre-cleaned 4 liter (toxicity), 1 liter (pesticides) combusted amber glass bottles, and acid rinsed 3 liter (copper, DOC and POC) Teflon bottles 0.5 meters below the water surface (Table 8.2). Sample bottles for dissolved copper, DOC and POC will be rinsed three times with site water prior to filling, and containers will be filled completely, leaving no headspace, to minimize volatilization. Following sample collection at each site water samples for the analysis of hardness and alkalinity will be collected by pouring sample water from the 3L Teflon bottle into precleaned 500ml plastic bottles.

The amount of water to be filtered in order to obtain a sufficient quantity of material for the POC analysis depends on the suspended-sediment concentration and/or the concentration of humic and other substances that cause colored water, such as organic and inorganic colloids. Approximate suspended-materials concentration volume of sample to be filtered (mL):

Suspended materials concentration (mg/L)	Volume of sample to be filtered (mL)
1 – 30	250
> 30 – 300	100
> 300 – 1,000	30
> 1,000	10

Number, type and timing of field collected QA/QC samples will be determined by the USGS OCRL and will meet or exceed SWAMP guidelines (http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/mqo/6_syn_water.pdf. Measurements of basic field parameters (temperature, pH, specific conductance, dissolved oxygen concentration, dissolved oxygen saturation, and turbidity) will be made at the time of sample collection using a YSI 6920V2 multiparameter meter calibrated with appropriate standards.

Collection of water samples for analysis of mercury and methylmercury:

MPSL personnel will collect water samples for analysis of unfiltered and filtered total mercury, unfiltered and filtered methylmercury, and ancillary parameters. During annual events when fish sampling occurs, water samples will be collected after fish are collected. Collecting and processing water samples for analysis of mercury at a low (subnanogram per liter) level requires use of ultratrace-level techniques for equipment cleaning, sample collection, and sample processing. Samples will be collected according to MPSL Field SOP v1.1; ultratrace-level techniques for equipment cleaning and sample collection (USGS National Field Manual, Chapter A5.6.4.B. Low Level Mercury); and the clean-hands dirty-hands collection methods where appropriate. It is important to follow the clean-hands dirty-hands collection method when collecting total and methylmercury samples to avoid sample contamination.

A depth-integrated sample will be collected from a boat at the point in the channel where discharge is the greatest (Table 8.2). Sample collection will occur in an area where the boat does not interfere with the sample, with the collector wearing clean polyethylene gloves.

Sample containers will consist of 4-L clear glass bottles (Table 8.2). Samples will be processed and filtered in the lab (MPSL).

The depth-integrated water sample will be collected following MPSL Field SOP v1.1 using a bucket sampler (SWAMP Clean Water Team SOP SOP 2.1.1.4) modified to accommodate a 4L glass bottle (I-Chem Part # 145-4000) and collect trace metal samples cleanly. Briefly, the following modifications are made for trace clean collection of aqueous mercury samples. All exposed metal is eliminated from the bucket sampler by replacing the standard bucket with a

NDS plastic 6” diameter container that is suitable for accommodation of a 4L bottle. A web of clean C-Flex tubing is used to hold the bottle in place while sampling. Tubing will be replaced prior to each sampling event, or sooner if thought to have come in contact with surfaces known to be possible contamination sources, such as the boat deck. Plastic-covered lead weights are fastened with plastic fasteners to the outside bottom of the bucket to allow sufficient weight to lower the sampler through the water column. A clean polypropylene line is attached to the bucket and used to lower and raise the sampler through the water column. The sampling bucket and line will be kept clean by storing in new clean plastic bagd between uses and not allowing contact with surfaces on the sampling platform that known to be potential sources of contamination.

Lowering and raising the 4L bottle through the water column at a sufficient rate so that the bottle is not completely filled upon retrieval will collect a depth-integrated sample. A new pre-cleaned 4L glass bottle (MPSL-101) will be used for each site. Field blanks will be collected at a rate of 5%, or a minimum of 1 field blank per collection event.

Section 9.1. describes field sample handling and shipping procedures and Table 9.1. provides information on storage and hold time requirementrs

Collection of water samples for analysis of LT2 pathogens:

Samples will be collected for the Delta RMP Pathogen Study following the general field procedures described in the Municipal Water Quality Investigations (MWQI) Program Field Manual. Specific protocols for *Cryptosporidium* and *Giardia* sampling follow EPA Method 1623.

MWQI will collect one field duplicate sample per event on a sequentially rotating site schedule. MWQI will fill one 10-L cubitainer for each sample and shipped to the laboratory on ice for analysis by EPA Method 1623 (Hold time: 96 hours).

MWQI will use a stainless steel bucket and a stainless steel funnel for grab sampling. MWQI will rinse sampling devices twice with ambient water prior to sampling. Sampling devices will be decontaminated between sites by rinsing with de-ionized water. MWQI Sample Collection Teams will fill out field data sheets immediately after sample collection. All sample containers will be labeled with the date, location sampled or unique site ID, parameter to be measured, and sample preparation (unfiltered).

Table 8.2. Sample container type and volume used for each parameter group for collection of water samples. (Section 9.1 provides more information on field sample handling and shipping procedures. Table 9.1 provides information about storage and hold time requirements for each parameter group.)

Program Element	Parameter Group	Bottle type*	Number of bottles/event	Sample Volume/Site

Program Element	Parameter Group	Bottle type*	Number of bottles/event	Sample Volume/Site
Mercury	Trace metals Conventional[12]	Clear glass	5	4L
Pathogens	Pathogens	LDPE cubitainer	15	950 mL
Pesticides	Water toxicity	Amber glass	40	4L/bottle x 8 bottles
Pesticides	Pesticides	Amber glass	5	1L
Pesticides	Copper, DOC, POC, Hardness, Alkalinity	Teflon	5	3L

8.2.2. *Fish Sample Collection*

Sport fish samples for mercury monitoring are collected annually. The appropriate sample collection method may vary by site and will be determined by the MPSL field sample collection team.

References and links for accessing SOPs for fish sample collection are provided in Appendix D.

Collection of fish tissue samples for analysis of total mercury:

Fish will be collected in accordance with MPSL-102a, Section 7.4. Because habitats may vary greatly, there is no one method of collection that is appropriate. Field crews will evaluate each fishing site to determine the correct method to be employed. Potential sampling methods include, but are not limited to: electroshocking, seining, gill netting, and hook and line. Field crew will determine the appropriate collection method based on physical site parameters such as depth, width, flow, and accessibility. Field crew will indicate the collection method on data sheets (Appendix E).

The targeted fish species is largemouth bass. The goal is to collect 11 individuals spanning a range of total length from 200 - 500 mm at each site (Table 8.3). Specimens of similar predator species may be collected if the desired number of individuals of the primary target fish species in the desired size range cannot be collected at a site.

[12] Conventional parameters (DOC, TSS, VSS) will be analysed in sample aliquots.

Further details on sample collection can be found in MPSL-102a, Section 7.4 (see Appendix D for reference and link).

Table 8.3. Target species, number of individuals, and size ranges for collection of fish tissue samples.

Program Element	Parameter Group	Primary Target [1]	Number of Individuals	Individuals/ Site (Size)
Mercury	Mercury	Largemouth Bass	66	11 total: 2X(200-249 mm), 2X(250-304 mm), 5X(305-407 mm), 2X(>407 mm)

[1]Collect similar predator species (e.g., smallmouth bass, Sacramento pikeminnow) if primary target is not available.

8.3. Corrective Action

Field Sampling

If goals stated for the collection of samples or the measurement of water quality parameters are not achieved, samples will be recollected or measurements repeated, where possible, after necessary re-calibrations of equipment or re-evaluation of the sampling scenario. All necessary steps for corrective action will be documented on the field form and on entered into the electronic version of the Field Sampling Report that is maintained by SFEI-ASC. The individuals responsible for assuring that the field staff are properly trained and implement the Field Sampling SOPs are the Field Collection Coordinators (i.e., MPSL Project Coordinator, MWQI Sample Collection Team Lead, and USGS Sampling Coordinator), SFEI-ASC Project Manager, and the QA Officer.

Field sampling quality goals include the meeting of data quality objectives for:

- Completeness of sample collection
- Representativeness
- Accuracy and precision (as indicated by field duplicates)
- Avoidance of contamination (as indicated by field blanks, equipment blanks, and travel blanks)

If any data indicate that quality objectives are not being met, Field Collection Coordinators will consult with their Principal Investigator (if applicable), Laboratory Manager, and the SFEI-ASC QAO to determine if the failure is most likely due to field or laboratory procedures/methods. If it is determined that field methods are the likely cause, the PI will work with the field sampling team to ensure that protocols are being followed correctly and if any additional protocols (specific to this project) need to be implemented.

Laboratory Chemical Analyses

If chemical analytical laboratory results[13] fail to meet the QA requirements outlined in the Delta RMP QAPP and it is determined that laboratory procedures are the likely cause, then the PI (if applicable) and Laboratory Manager will ensure that proper procedures as outlined in the QAPP are being implemented and to develop any additional procedures to bring QA sample results in line with measurement quality objectives. Corrective actions will be documented, resolved, and followed-up on following the process for corrective actions that is outlined by the SWAMP. The process is based on the SWAMP Corrective Action Form, and is applied to sample results that fail to meet the technical and non-technical requirements of SWAMP and its associated projects.

Toxicity Testing

Data Quality Indicators and test acceptability criteria for toxicity testing are listed in Tables 4.7 and 4.8, respectively. MQOs and TIE triggers are summarized in Table 4.9 and 4.10. The AHPL QAO will be alerted when these thresholds are exceeded. The AHPL QAO may take the following actions, if applicable:

Ammonia: When a sample's ammonia-nitrogen measurement exceeds 5 mg/L, the ambient sample may be retested at different pH levels to determine what effect ammonia-nitrogen levels have on test organisms. Commensurate controls will be included and data analysis will follow the guidelines provided and listed in SWAMP Chronic Freshwater Toxicity Testing Quality Control Table.

Conductivity: When a sample's conductivity meets or exceeds the acceptability threshold for each species, a high or low conductivity control will be included in the test to determine whether high or low conductivity may have a role in reduced mortality, growth or reproduction. Alternate controls will be noted in the toxicity transformer workbook and statistical comparisons will follow EPA and SWAMP guidelines.

Dissolved Oxygen: When a sample's dissolved oxygen exceeds 8.6 mg/L (for *S. capricornutum*, *C. dubia* and *P. promelas*; 8.9 mg/L for *H. azteca*) following the sample warming period, the sample will be gently aerated prior to sample renewal, in order to degas harmful dissolved gases. If a sample's dissolved oxygen level is less than 4.0 mg/L, the ambient sample will be constantly aerated to ensure adequate oxygen levels for the duration of the test, as well as including a concurrent aeration control. Data analysis will follow the guidelines provided in the SWAMP Chronic Freshwater Toxicity Testing Quality Control Table.

pH: When a sample's pH is below 6 or exceeds 9, the sample will be tested at its original pH and also adjusted to 7.5. A pH method blank will also be tested that includes an adjustment to the

[13] Including chlorophyll *a*.

ambient sample's original pH and then returned to 7.0. Data analysis will follow the guidelines provided in the SWAMP Chronic Freshwater Toxicity Testing Quality Control Table.

Temperature: Sample temperatures must not deviate by more than 3°C of the target test temperature for the duration of the test. If sample temperatures exceed this range, steps will be taken to minimize sample temperature deviations, such as adjusting environmental chamber temperatures to a tighter range or moving a test into a more temperature-regulated testing area, and data will be flagged accordingly.

Toxicity: If a sample test species exhibits $\geq$ 50% mortality within 96-hours, the AHPL QAO or Laboratory Manager will contact the SFEI-ASC Project Manager within 24 hours to discuss potential a follow-up with a toxicity identification evaluation in order to determine what class of chemical(s) is causing toxicity. The Delta RMP TAC's TIE subcommittee will decide potential TIEs.

If a sample test species exhibits 100% mortality in 48 hours, the AHPL QAO or Laboratory Manager will contact the SFEI-ASC Project Manager within 24 hours, and a dilution series test will be set up as soon as organisms are available (potential courier limitations).

Tests are conducted according to procedures and conditions as described in the SOPs provide in Appendix D. Beyond those identified, deviations from these recommended conditions are reported to the UCD AHPL QAO. The PI and SFEI-ASC QAO and Project Manager will be notified of these deviations.

In the event of an SOP/QAPP deviation or corrective action, a deviation/corrective action form will be prepared, completed, signed and the SFEI-ASC QAO and Project Manager notified. Best professional judgment will be used in interpretation of results obtained when protocol deviations have occurred. All deviations and associated interpretations will be reported in interim and final laboratory reports. Protocol amendments will be submitted to the SFEI-ASC QAO and Project Manager. Upon approval, protocol amendments will be employed.

Pathogen Analysis

Failure to meet IPR or OPR quality control acceptance criteria indicates systemic problems the laboratory must address prior to processing any samples.

9. Sample Handling and Custody

9.1. Field Sample Handling and Shipping Procedures

Pesticides

Sample containers will be labeled with the location, date, and time collected and packed in ice chests with sufficient wet ice to maintain sample transport criteria. Field sheets and chain-of-custody forms (COC) will be filled out at the time of collection and will include site ID, site description, collection date/time, container type, sample preservation, field water chemistry measurements, sampler(s) name and requested analyses. All forms will be included with the appropriate samples during shipping. Samples for pesticide analysis will be delivered to the USGS OCRL laboratory in Sacramento California. If upon arrival at the OCRL samples are found to be warm (ice melted) or if sample containers are broken the Project Manager and Principal Investigator will be immediately notified. Ice chests are examined upon delivery to ensure that samples have been properly chilled (acceptable temperature range = 0 - 6 °C).

Water samples for pesticide analyses will generally be processed to extraction upon arrival at the OCRL. If this is not possible, the samples will be refrigerated at 0 - 6 °C in the dark for a period not to exceed the OCRL holding time requirement of 48 hours between sample collection and extraction. Upon arrival of samples, appropriate laboratory processing forms noting unique laboratory ID, site name, collection time and date, receiving technician's name, requested analysis, and date and time of receipt will be filled out. Signed copies of COCs will be maintained with the appropriate OCRL field and laboratory forms.

Samples for dissolved copper analysis and DOC/POC analysis will be processed at the USGS OCRL, within 24 hours of collection. Samples for dissolved copper analysis will be filtered using 0.45-micrometer (µm) filters and acidified to pH less than 2 with 2 ml of 7.5N nitric acid. Samples for DOC analysis will be filtered using 0.7-um pore size, pre-combusted glass-fiber filters, collected in 125-mL baked amber glass bottles, and acidified using 4.5N sulfuric acid. The 0.7-um pore size filter holding the retained suspended material will be used for the POC analysis and will be wrapped in an aluminum foil square of appropriate size.

Samples for dissolved copper, DOC, and POC will be placed in a cooler on wet ice and shipped overnight to the USGS NWQL in Lakewood, CO.

Receipt temperature and sample condition (broken/compromised containers, incorrect preservatives, holding time exceedance, etc.) will be recorded by receiving laboratories.

Toxicity Testing

Toxicity test samples will be delivered to the UC Davis AHP Laboratory in Davis, California, within 24 hours of sample collection. Upon arrival at AHPL, toxicity testing samples will be immediately removed from the ice-chests and the laboratory staff receiving the coolers will complete the accompanying COC. The AHPL will initiate tests within 36 hours of sample collection, although under rare circumstances, this holding time may be extended to 120 hours for precipitation-based events, when courier delivery schedules on weekends and holidays limit the availability of test organisms. In these instances the AHPL will contact the SFEI-ASC QAO and Project Manager, and associated data will be flagged in interim and final reports.

Table 9.1 provides information about storage and hold time requirements for each parameter group.

Table 9.1. Storage and hold time requirements for each parameter group.

Parameter group	Storage	Hold time (Collection to Extraction, where applicable)	Hold time (Extraction to analysis, where applicable)	Storage (Extraction to analysis, where applicable)
Chlorophyll *a*	0 - 6°C in dark	Filtration within 24 hours of collection	28 days	- 20°C in dark
Copper, dissolved	0 - 6°C in dark	Filter in the field as soon as possible after collection	180 days	0 - 6°C in dark
DOC/POC	0 - 6°C in dark	Filtration within 24 hours of collection	DOC: 30 days/ POC: 100 days	0 - 6°C in dark
Mercury, total (Water)	0 - 6°C in dark	Preserve with 0.5% v:v pretested 5% BrCl or 12N HCl within 48 hours of collection	90 days	Room temperature
Mercury, total (Tissue)	0 - 6°C in dark	Cool to < 6°C within 24 hrs of collection	1 year	- 20°C
Mercury, dissolved (Water)	0 - 6°C in dark	Filter and preserve with 0.5% v:v pretested 12N HCl within 48 hours of collection	90 days	Room temperature
Methylmercury, total (Water)	0 - 6°C in dark	Preserve with 0.5% v:v pretested 12N HCl within 48 hours v	6 months	0 - 6°C in dark
Methylmercury, dissolved (Water)	0 - 6°C in dark	Filter as soon as possible after collection; preserve with 0.5% v:v pretested 12N HCl within 48 hours of collection	6 months	0 - 6°C in dark
Pesticides	0 - 6°C in dark	Extract within 48 hours of collection	Not to exceed 30 days	- 20°C in dark
Toxicity	0 - 6°C in dark	Initiate Test 36 h after sample collection	NA	NA
Pathogens	1˚ - 20˚ C	Elute within 96h of sample collection	7 days from completion of slide preparation	1˚ - 20˚ C

Mercury

Sample containers will be labeled with the location, date, and time collected and packed in ice chests with sufficient wet ice to maintain sample transport criteria. Field sheets and chain-of-custody forms (COC) will be filled out at the time of collection and will include site ID, site description, collection date/time, container type, sample preservation, field measurements, sampler(s) name, and requested analyses. All forms will be included with the appropriate samples during shipping. Samples will be delivered to MPSL in Moss Landing, CA, or WPCL in Rancho Cordova, CA, as appropriate. If upon arrival at either laboratory, samples are found to be warm (ice melted) or if sample containers are broken the Project Manager and Principal Investigator will be immediately notified. Ice chests are examined upon receipt to ensure that samples have been properly chilled (acceptable temperature range = 0 - 6 °C).

Water samples will be delivered to either MPSL or WPCL within requisite holding times, where laboratory personnel will filter preserve water samples following Table 9.1.

Upon arrival of samples, appropriate laboratory processing forms noting unique laboratory ID, site name, collection time and date, receiving technician's name, requested analysis, and date and time of receipt will be filled out. Samples for dissolved mercury and dissolved methylmercury analysis will be filtered using 0.45-micrometer (µm) filters and acidified to 0.5% with pre-tested BrCl as appropriate within 48 hours of collection.

Samples for chlorophyll *a* analysis will be collected and filtered using a syringe sample method within 24 hours of collection. Samples will be filtered by forcing water with a 60-mL syringe through a filter holder containing a 25-mm glass microfiber filter. The 60-mL syringe and an in-line filter holder are rinsed three times with the ambient water before filtration. The syringe is then filled with 60 mL of ambient water. The filter holder is then removed and a 25-mm glass microfiber filter is placed inside. The filter holder is then screwed onto the syringe and the ambient water is then flushed through the filter. The filter holder is removed every time more water needs to be drawn into the syringe. The process is then repeated until the desired amount of chlorophyll *a* is present (usually 60 to 360 mL depending on the water clarity). When filtering is complete, the filter holder is opened and the filter is removed with tweezers without touching the chlorophyll *a*. The filter is then folded in half, then again, in half with the chlorophyll *a* inside the folds. The folded filter is then wrapped in aluminum foil and placed in an envelope labeled with the site information and the volume filtered. The envelope is then immediately placed on dry ice until transferred to WPCL

Receipt temperature and sample condition (broken/compromised containers, incorrect preservatives, holding time exceedance, etc.) will be recorded by receiving laboratories.

Fish will be processed according to MPSL 102a, except where noted here. Collected fish will be partially dissected in the field. At the dock, the fish is placed on a measuring board covered with clean aluminum foil or plastic; fork and total length are recorded. Weight is recorded if the fish is large enough for the scale. The fish will then be placed on the covered cutting board, where the head, tail, and guts are removed using a clean cleaver (scrubbed with Micro™, rinsed with tap and deionized water). The fish cross section is tagged with a unique numbered ID, wrapped in aluminum foil, and placed in a clean labeled bag. When possible, parasites and body anomalies are noted. The cleaver and cutting board are re-cleaned with Micro™, rinsed with tap and deionized water between fish species, per site if multiple stations are sampled.

Further details on sample collection and processing can be found in the SAP (See Appendix D for reference and link).

Fish samples will be wrapped in aluminum foil and frozen on dry ice for transportation to the laboratory, where they will be stored at -20°C until dissection and homogenization. Lab homogenates will be frozen until analysis is performed. Frozen tissue samples have a 12-month hold time from the date of collection. If a hold-time violation has occurred, data will be flagged appropriately in the final results. Holding times for each analyte can be found in Table 9.1.

Pathogens

A courier will deliver samples to Biovir (primary lab). Eurofins will pick up one field duplicate sample per event (secondary lab). Samples must be kept on ice. The laboratories must elute the samples within 96 hours (4 days) of sample collection.

10. Analytical Methods

10.1. Field Analytical/Measurement Methods

The field collection teams will record measurements performed in the field on field sheets (electronic or paper) then enter them into a CEDEN template for subsequent entry in the Delta RMP database by SFEI-ASC. Samples collected in the field are to be placed in containers and stored under conditions appropriate for the analyses to be performed. Any unusual sample characteristics or circumstances preventing normal sample handling will also be noted in the field sheet. On return from the field, the sampling crew will prepare samples for immediate shipping to analytical laboratories or store them under appropriate conditions for subsequent shipping

To minimize discrepancy in field results and provide useful, accurate scientific data, all personnel participating in field sampling are required to follow the guidelines set out in the USGS National Field Manual for the Collection of Water-Quality Data (for pesticide element), the MPSL Field SOP v1.1 (for mercury element), and the MWQI Program Field Manual (for pathogen study).

Operation of any field instruments should be checked at least one day before sampling. If failure of an instrument should occur, a backup instrument should be checked and calibrated. All sampling and measurement modifications or failures that occur in the field due to instrument malfunction will be recorded on the Field Form and the Field Reference Sheet. The Field Collection Coordinators, SFEI-ASC Project Manager, and the QAO will be responsible for ensuring that staff documents all deviations from planned operations and schedule repairs and/or additional training as needed.

10.2. Laboratory Methods

For the methods selected for a particular application, the Laboratory Project Manager must be able to demonstrate and document that the methods performance meets the data quality requirements of the project. Two separate factors are involved in demonstrating method applicability: First, demonstrating that the laboratory can perform the method properly in a clean matrix with the analytical system under control, and second, demonstrating that the method selected generates “effective data” in the matrix of concern. The former addresses lab or operator training and proficiency, while the latter demonstrates that the selected method performs with the appropriate selectivity, sensitivity, bias and precision, in the actual analytical matrix, to achieve project goals.

Table 10.1 provides a summary of analytical methods and instruments used by the Delta RMP.

Table 10.1. Summary of analytical methods and instruments.

Parameter group	Methods	Instrument	Proprietary?
Chlorophyll *a*	*In Vitro* determination by visible spectrophotometry (EPA 446.0)	Genesis 10S	No
Copper, dissolved	Collision/reaction cell inductively coupled plasma–mass spectrometry (USGS TM-5-B1)	cICP-MS (Agilent 7500ce)	No
DOC	UV catalyzed persulfate oxidation and infrared (IR) spectrometry (USGS Test Method O-1122-92)	Carbon Analyzer, Dohrmann DC-80, DC-180, or equivalent, with a direct concentration read-out.	No
DOC	Organic Carbon, Total (Combustion or Oxidation) (EPA 415.1)	Teledyne Tekmar TOC Torch	No
Mercury (Tissue)	Thermal decomposition amalgamation and atomic absorption spectrophotometry (EPA 7473)	Milestone DMA80	No
Mercury (Water)	Oxidation, purge and trap, and cold vapor atomic fluorescence spectrometry (EPA 1631, Revision E)	Tekran 2600	No
Methylmercury (Water)	Distillation, aqueous ethylation, purge and trap, and cold vapor atomic fluorescence spectrometry (EPA 1630)	Tekran 2700	No
POC	Elemental analysis (EPA 440.0)	Carbon Analyzer, Dohrmann DC-80, DC-180, or equivalent, with a direct concentration read-out.	No

Parameter group	Methods	Instrument	Proprietary?
Pesticides[14]	Gas Chromatography/ Mass Spectrometry (USGS TM-5-B1)	Agilent 7890 GC with a 5975 c mass spectrometer with a DB-5ms column (30 m × 0.25 mm × 0.25 µm, Agilent)	No
Pesticides	Liquid chromatography with tandem mass spectrometry (LC/MS/MS).	Agilent 1260 HPLC coupled to a 6430 tandem MS system with a Zorbax Eclipse XDB-C18 column (2.1 mm × 150 mm× 3.5 mm; Agilent).	No

10.2.1. Laboratory SOPs

All analytical method SOPs can be downloaded from the SFEI-ASC Google Drive, unless the SOPs are proprietary. Copies of laboratory SOPs are also stored at SFEI-ASC but cannot be released to any external parties without prior consent of the laboratory when they are marked as proprietary.

10.2.2. Corrective Actions Procedures

Corrective actions procedures for analytical laboratories are summarized in Table 10.2. Additional details are described in Section 4.3.

Table 10.2. Corrective actions procedures for analytical laboratories.

Laboratory QC Sample Type	Corrective action
Matrix Spikes	The spiking level should be near the midrange of the calibration curve or at a level that does not require sample dilution. Reanalyze the matrix spike to confirm the result. Review the recovery obtained for the matrix spike duplicate. Review the results of the other QC samples (such as reference materials) to determine if other analytical

[14] See Table 3.2 for a detailed list of target analytes for each method

	problems are a potential source of the poor spike recovery.
Field Blanks	If target analytes are found in field blanks, sampling and handling procedures will be reevaluated and corrective actions taken. These may consist of, but are not limited to, a) obtaining sampling containers from new sources, b) training of personnel, c) discussions with the laboratory, d) invalidation of results, e) greater attention to detail during the next sampling event, or f) other procedures deemed appropriate.
Field Replicate	If criteria are exceeded, field sampling and handling procedures will be evaluated and problems corrected through greater attention to detail, additional training, revised sampling techniques, or other procedures deemed appropriate to correct the problems.

10.3. Sample Archive and Disposal

Project samples will not be disposed of until all analyses are complete and analytical and QC results have been reviewed and approved by the Project Manager and the QAO.

11. Instrument/Equipment/Supplies

Contract laboratories maintain equipment in accordance with their respective SOPs, which include those specified by the manufacturer and those specified by the method. Under the performance-based approach, the adequacy of contract laboratory testing, inspection, and maintenance procedures are determined through regular review of results for analysis of field and QC samples for all submitted data.

Prior to use in the field (typically within 24 hours prior to sampling), handheld water quality instruments are calibrated against appropriate standards and, if possible, checked against a standard from a different source. For some measurements such as dissolved oxygen, probes are often calibrated to ambient conditions (water-saturated air) rather than to known standards. In such cases, the field staff should verify appropriate qualitative instrument response (e.g. in water deoxygenated by sparging, sodium sulfite addition, or other means). All calibrations are documented on a calibration checklist on the individual instrument or its case with date, time, and operator name. If an instrument cannot be calibrated or is not reading correctly, a backup instrument will be used to measure water quality parameters.

For single or multiparameter water quality meters, the following standards are typically used to calibrate:

1. pH – commercially available standards pH 4, 7, 10. Perform a 2-point calibration covering the range of expected measurements. Use the 3rd pH standard (or standard supplied by another manufacturer) as a check standard to verify calibration accuracy.
2. Specific Conductance – perform a single-point calibration and use two check standards bracketing the expected measurement range.
3. Dissolved oxygen – use calibration procedure recommended by manufacturer, typically in water-saturated air.
4. Temperature – check against thermometer of known accuracy at least yearly (preferably quarterly). An ice water bath of approximately 0°C can be used to semi-quantitatively verify temperature probe response but may vary due to uncontrolled factors such as container size and geometry, ice/water disequilibrium, or the presence of melting point-lowering contaminants.

Laboratories maintain calibration practices as part of their method SOPs. Calibration procedures are described generally below.

Upon initiation of an analytical run, after each major equipment disruption, and whenever on-going calibration checks do not meet recommended MQOs, the system will be calibrated with a full range of analytical standards. Immediately after this procedure, the initial calibration must be verified through the analysis of a standard obtained from a different source than the standards used to calibrate the instrumentation, prepared in an independent manner, and ideally having certified concentrations of target analytes (e.g., a certified solution). The calibration curve is acceptable if it has an r^2 of 0.995 or greater for all analytes present in the calibration mixtures. If not, the calibration standards, as well as all the samples in the batch, must be re-analyzed. All calibration standards will be traceable to an organization that is recognized for the preparation and certification of QA/QC materials (e.g., NIST, NRCC, US EPA, etc.).

Calibration curves will be established for each analyte and batch analysis from a calibration blank and a multi-point calibration (as described or required in the method), covering the range of expected sample concentrations. If the instrument response is demonstrated to be linear over the entire concentration range to be measured in the samples and use of a single-point calibration is described or allowed in the method, the use of a calibration blank and one single standard that is higher in concentration than the samples may be appropriate. Otherwise, only data within the working calibration range (above the MDL) should be reported (i.e. extrapolation is not acceptable). Samples outside the calibration range will be diluted as appropriate, and reanalyzed.

Laboratories maintain internal SOPs for inspection and quality checking of supplies. Under a PBMS approach, these procedures are presumed to be effective unless field and QC data from analyses indicate otherwise. SFEI-ASC will then work with the laboratory to identify the causes and address deficiencies in the SOPs that resulted in those problems. If the problem is serious and cannot be corrected by the laboratory, the SFEI-ASC Project Manager and QAO will discuss and identify alternatives, including changing the sampling materials and methods, the extraction and analytical methods, the laboratory, or any combination of these.

12. Non-direct Measurements (Existing Data)

Non-Delta RMP data (e.g., Irrigated Land Regulatory Program) may be used in determining ranges of expected concentrations in field samples, characterizing average conditions (e.g., temperature, barometric pressure) for calculations, and other purposes. These data will be reviewed against the data quality objectives stated in Section 4 and used only if they meet all of the specified criteria. Data not meeting MQOs should be used only in a qualitative manner for developing conceptual models and prioritizing future data needs.

Hydrologic data (stage, flow, etc.) will be obtained from existing gauges and recorders located at or near designated monitoring locations

The Delta RMP will not conduct any additional monitoring of pesticide chemistry and toxicity in sediments. Instead, sediment toxicity and chemistry data collected by the Surface Water Ambient Monitoring Program (SWAMP) Stream Pollution Trends (SpoT) monitoring will be included in the initial assessment. The SpoT QAPP is available on the SPoT website.

13. Data Management

The collection agencies and laboratories provide data to SFEI-ASC in appropriate CEDEN templates (as provided by SFEI-ASC) within the timeframe stipulated in the contract, usually 90 days or less. The laboratories should use the current on-line data checker to review data for vocabulary and business rule violations prior to submitting to SFEI-ASC (contact DS@sfei.org for the current URL). SFEI-ASC will work with the labs to address vocabulary and business rule issues identified from using the data checker. SFEI-ASC will work with CEDEN to populate the lookup lists with new values as identified by the labs from using the on-line data checker.

Toxicity data that is funded by SWAMP should be submitted to SWAMP by the data provider using SWAMP templates and the SWAMP data checker. Once these data have been approved by SWAMP, the SWAMP Data Manager should provide the data in CEDEN EDD templates to SFEI/ASC for further processing.

The laboratories should report data as outlined in Section 6.2, Data Reporting Requirements. Data are maintained at SFEI as established in Section 6. SFEI-ASC tracks each data set, from submittal to final upload to the RDC database. Once all expected data have been received, expert staff on SFEI-ASC's Data Services team process the data using a series of queries designed to identify any issues remaining with the format of the data. The QA Officer or designee then reviews data for quality assurance and quality control and appropriate CEDEN QA codes are applied to the dataset. The QA officer or designee writes a report for each dataset outlining the quality of the data. This report highlights any issues that need to be addressed by the laboratory, project manager, or data management staff.

The QA Summary Report includes the following details:

Lab

Matrix

Analyte

Reporting Issues for Lab to Review

Formatting Issues for Data Manager to Review

QA Review

Dataset completeness

Overall acceptability

MDLs sensitivity

QB averages (procedural, field blank)

Average precision from replicate field sample

Accuracy (using a variety of SRMs or Matrix spike QRECs)

Comparison of dissolved and total phases

Comparison to previous years

Ratio Checking Summary

Sums Summary

In addition, specialized senior scientists further review organics datasets such as PCBs, PBDEs, and pesticides. Data are then compiled into the RDC database and distributed to the project managers. Data that are approved for public release are made available through SFEI-ASC's Contaminant Data Display and Download tool (CD3), usually within one year of sample collection. Data will also be made available through CEDEN's Advanced Query tool. The contact individual responsible for steps and tasks of data management is Amy Franz.

SFEI-ASC maintains regular backups of their enterprise databases both to disk and tape, nightly and weekly, respectively. The RDC database, specifically, is also backed up hourly. As a further protective measure, copies of the tapesets are stored both onsite and offsite. The lifetime of the backup files on tape is about 2-3 weeks. Additionally, a backup of the RDC database from the first of every month is stored on disk indefinitely, allowing for quick restore and review of archived data as the need warrants.

14. Assessment and Response Actions

Initially, a desktop or on-site performance audit will be performed by the QAO and designated staff to determine if each laboratory can meet the requirements of the QAPP and to assist the laboratory where needed. Review of current NELAP and/or state ELAP certification of a laboratory for the analyses performed for the Delta RMP may be accepted in some cases in lieu of an on-site audit. Reviews may be conducted at any time during the scope of the study. Results will be reviewed with participating laboratory staff and corrective action recommended and implemented, where necessary. Furthermore, laboratory performance will be assessed on a continual basis through laboratory intercomparison studies (round robins) where available, such as those conducted by the National Institute of Standards and Technology (NIST).

If data quality issues are identified, a preliminary meeting will be held between SFEI-ASC's QAO and the Project Manager to discuss possible solutions. If necessary, a corrective action plan will be developed in consultation with the appropriate lab(s), the corrective actions taken, and the issue and its resolution summarized in a brief report or memorandum. A summary of these issues will be maintained in the Project files, and will be noted in any reporting that includes affected data.

15. Reports to Management

The reporting goal of the Delta RMP is to generate communication products that inform and educate target audiences about Delta water quality conditions and trends. The information in such products is targeted at the highest priority questions faced by managers. The program achieves its full value only to the extent that the data it produces are synthesized, interpreted, and reported in a manner accessible to its various audiences. The Delta RMP will produce an Annual Monitoring Report, which documents the activities of the program each year; an interpretive main report (*The Pulse of The Delta*) that summarizes monitoring results and synthesizes the information they provide; and technical reports that document specific studies and synthesize information from diverse sources in relation to specific topics and prioritized assessment questions.

The Annual Monitoring Report will present the results of the previous July-June fiscal year of sampling. Interpretation of the results will be very basic. The main purpose of this report is to share the final data with project partners and collaborators in a timely way. The Annual Monitoring Report also includes a QA memo that summarizes any QA problems and documents any non-conformances with the QAPP.

The QAO is responsible for summarizing potential QA issues with reported data and communicating those issues to the Project Manager. The QAO also reviews any SFEI-ASC analyses and reports generated from the data, to ensure that QA issues are appropriately acknowledged and addressed.

16. Data Review, Verification, and Validation

After data are submitted and included in the Delta RMP database, SFEI-ASC staff examines the data set for completeness (e.g., correct numbers of samples and analyses, appropriate QC sample data included) and accuracy (e.g., in sample IDs), and spot-check for consistency with hardcopy results reported by the laboratory. The SFEI-ASC QAO or designee will examine submitted QA data for conformance with MQOs, specified previously (Section 4). Data that are incomplete, inaccurate, or failing MQOs without appropriate explanation will be referred back to the laboratory for correction or clarification. The Project Manager and QAO will discuss data failing MQOs with laboratory staff to determine whether modifications to analytical methods can be made to improve results on reanalysis. If problems cannot be readily corrected (insufficient sample, irremovable interferences, or blank contamination based on past attempts with the lab), results outside the MQOs will be flagged using CEDEN codes appropriate for the specific deviations to alert data users to uncertainties in quantitation. Results greatly outside the target MQO range (z-scores or p-scores >2, e.g., for acceptance criteria of ±25%, >±50%)[15] may be censored and not reported.

In addition to contamination and other artifacts introduced by sampling and analytical methods, errors may arise at many points in the processing and transmittal of data generated for the Delta RMP. Characteristics of reported data are examined to identify possible problems in the generation and transmission of data. Data submitted to the Delta RMP are compared to values in the literature for comparable environments and from previous monitoring to evaluate if they are within the expected range of values for a given study. Simple statistics (e.g., minimum, maximum, mean, median) may be generated to quickly identify data sets or individual data points greatly outside of their expected range. Anomalous individual points will be examined for transcription errors. Unit conversions and sample quantitation calculations may be reviewed to identify larger and systematic errors.

17. Verification and Validation Methods

Data are submitted to SFEI-ASC in electronic form. The QAO or designated project staff verify that results for appropriate field and QC samples are reported by comparing the sample types and numbers provided against those specified in the detailed project plan, chain of custody forms, and/or contracts. Reviewed data are recorded as checked by initials and dates to ensure that electronic and hardcopy reports agree. The contract laboratory's QA Officer (QAO) performs checks of all of its records and the laboratory's Director or Project Manager will recheck 10%. All checks by the laboratory may be reviewed by SFEI-ASC. Issues are noted in a narrative list and communicated to the field or laboratory teams as needed to correct any problems found (e.g. unanalyzed samples left in storage, transcription errors).

As part of the validation process, data are evaluated as meeting or failing MQOs.

Exceedances of MQOs not already noted by the laboratory are flagged in any electronic databases and communicated to the analyzing laboratory for possible recalculation and/or reanalysis. Reconciliation and correction of errors in reported data will be addressed by consultation among SFEI-ASC's Project Manager, SFEI-ASC's QAO, and SFEI-ASC Analyst(s) with

[15] z-score = |result – expected value|/acceptable deviation. See Section 4.3.1. Laboratory QC Measurements for a definition of the p-score.

the Laboratory's QAO, Laboratory and/or Project Manager, and appropriate lab personnel. The involved parties will agree upon any corrections.

Analyses sometimes produce results that fail MQOs and may not be possible to overcome for a small number of analytes within a large group of related compounds. For example, there may be contamination that is impossible to eliminate for all analytes, when analyses are conducted at ultra-trace levels. With agreement of the SFEI-ASC Project Manager and QAO in consultation with the Laboratory, results for sample groups with data outside of MQOs may be flagged rather than reanalyzed, to indicate the greater uncertainty in the quantitation of those data. Results on individual analytes that are greatly outside the target MQO range (e.g. z-scores >2) will be censored as needed rather than subjected to repeated analysis. Reports, graphs, tables, or summary statistics generated from datasets with censored data should note their exclusion or other handling.

Repeated analysis may not fix any issues but rather just mask variability, creating a false impression of the quantitative certainty of results. Contamination of method blanks can sometimes represent a temporary source of contamination, and flagging results of batches in which contamination is found in blanks is appropriate. Sample results in batches with detected blank contamination will be flagged (for field samples with analyte concentration >3x those found in method blanks, "IP" when applied by the reporting lab, or "VIP" if added later by SFEI-ASC) or censored (for results <3x those in blanks) by SFEI-ASC, but data users should be aware of the possible influence of sporadic contamination in other batches analyzed around the same time, particularly for samples with low concentrations similar to those in blanks.

Similar analogies can be made with failures of precision or accuracy QC measurements. Individual failures may fall within the range of the true variance in the measurement, e.g. NIST acceptance ranges are sometimes in excess of ±50% of the mean values, and while reporting only successful reanalysis batches may appear to produce more consistent and certain results, without fundamental changes to the analytical process, the underlying uncertainty may only have been masked/censored rather than truly reduced for the reported field samples. This is not to say that reanalyses are never warranted or desirable, but rather to underscore that improved results on QC measurements, which can sometimes be achieved simply by repeat analysis and discarding previous failed results, should not be confused with improved measurements, which are only achieved by making real substantive changes to the sampling and/or analytical methods. If reanalysis is to be attempted, it is therefore imperative that the Project Manager and QAO work in consultation with laboratory staff to identify and change the factors that may have led to MQO deviances, rather than simply repeat the analysis until the QC passes. For MQO deviations (z-score or p-score >1) for which causes are not identified and that are not fixed by corrective actions, field sample results may be qualified, or censored if grossly deviating (z-score or p-score >2). The QC data used for determination of flagging is subject to the availability of data on various QC sample types and the professional judgment of the QAO. Decisions will be documented in a narrative summary of the QA review. Where possible, data for flagging recovery should be 1) in a similar matrix as samples, 2) with externally validated expected values, 3) in a quantitative range, and 4) in a similar concentration range as field samples. Thus for evaluating recovery, the order of preference is generally CRM>LRM>MS>LCS, with exceptions and changes in preference made for factors such as non-certified values, certified values with wide uncertainty bands, and concentrations greatly different from those in field samples. Similarly, for evaluation and flagging of lab precision, QC samples should be 1) in the same matrix as field samples, 2) isolate lab variation from other causes, 3) in a quantitative range, and 4) in a similar concentration range as field samples, where available. For evaluating precision then, the preferred sample types for replicates are: lab > field > MS ~ CRM > LCS, again with exceptions made depending on the available sample types, their inherent variability, concentration ranges, and other factors. Flags applied to data are to be selected from among those approved by CEDEN appropriate for the specific MQO failure (e.g., “GBC - CRM analyte recovery not within control limits” to a CRM result outside of acceptance targets, “IU - Percent Recovery exceeds laboratory control limit” for field samples reported at the time if the deviation appears random, or “LHB - Result positively biased, flagged by lab”, if results appear systematically high biased). The bases for any flagging of field samples will be documented in a narrative summary of the QA review.

The QA/QC requirements presented in the preceding sections are intended to provide a common foundation for each laboratory’s protocols; the resultant QC data will enable assessment of the comparability and uncertainty of results generated by different laboratories and analytical procedures. It should be noted that the QC requirements specified in this plan represent the minimum requirements for any given analytical method; labs are free to perform additional QC in accordance with their standard practices.

In addition to performance on required QC measures and samples (i.e. MDLs, blanks, matrix spikes, CRM, replicates), data are also examined for internal and external consistency to ensure that reported values are realistic and representative for the locations and matrices of collected samples. This review may include but is not limited to:

1. Comparison of reported values to those from previous years for the same locations and matrices, where available – large differences from previously reported values may not necessarily indicate analytical issues and may simply reflect natural spatial and temporal variability of the ecosystem.
2. Comparison of reported values to those in the published literature, where available – differences from other regions and/or species may merely indicate differences in resident species and ecosystem structure, but very large (e.g. 2-3 orders of magnitude) differences may sometimes help identify errors in analysis or reporting (e.g. unit conversions).
3. Internal checks of relative analyte abundance – variations in concentrations of one compound or isomer in a class of chemical contaminants are often tightly linked to those of related compounds, such as a compound and its degradation products or manufacturing byproducts, or various congeners in a commercial mixture. Deviations in these relative abundances can sometimes indicate matrix interferences or other analytical problems, although care should be taken to not disregard results that might reveal atypical sources and/or ecosystem processes.

At the completion of the QA review by the QAO, results are assigned a compliance code on an individual record level. See Table 17.1 for compliance codes. Data are further assigned a batch verification code on a batch level. See Table. 17.2 batch verification codes. Results from the data review will be summarized in the annual QA Report.

Table 17.1. Compliance Codes.

DataCompliance Name	DataCompliance Code
Compliant	Com
Do Not Use	DNU
Estimated	Est
Historical	Hist
Not Applicable	NA
Not Recorded	NR
Pending QA review	Pend
Qualified	Qual
Qualified Historic	QualH
Rejected	Rej
Screening	Scr

Table 17.2. Batch Verification Codes.

BatchVerification Name	BatchVerification Code
Alternate Level Validation	VAP
Alternate Level Validation, Incomplete QC	VAP,VI
Alternate Level Validation, Incomplete QC, Flagged by QAO	VAP,VQI
Cursory Verification, Data Rejected - EPA Flag, Flagged by QAO	VAC,VR
Cursory Verification, Minor Deviations, Flagged by QAO	VAC,VMD
Cursory Verification, Minor Deviations, Incomplete QC, Flagged by QAO	VAC,VMD,VQI
Cursory Verificaton	VAC
Cursory Verificaton, Incomplete QC, Flagged by QAO	VAC,VQI
Cursory Verificaton/Validation	VLC
Cursory Verificaton/Validation, Incomplete QC, Flagged by QAO	VLC,VQI
Cursory Verificaton/Validation, Minor Deviations, Flagged by QAO	VLC,VMD
Cursory Verificaton/Validation, Minor Deviations, Incomplete QC, Flagged by QAO	VLC,VMD,VQI
Data Rejected - EPA Flag, Flagged by QAO	VR
Full Verification	VAF
Full Verification, Incomplete QC, Flagged by QAO	VAF,VQI
Full Verification, Minor Deviations, Flagged by QAO	VAF,VMD

Full Verification/Validation	VLF
Incomplete QC, Flagged by QAO	VQI
Incomplete QC, Temporary Verificaton, Flagged by QAO	VQI,VTC
Minor Deviations, Flagged by QAO	VMD
No QC, Flagged by QAO	VQN
Not Applicable	NA
Not Recorded	NR
Temporary Verification	VTC

18. Reconciliation with User Requirements

All data are reviewed by the QAO to determine if the results have met the Delta RMP MQOs of completeness, sensitivity, precision, and accuracy. Limitations of the data, including uncertainty of validated data, are reported to the data users by a QA code or qualifier. The Delta RMP has adopted the California Data Exchange Network's (CEDEN) standard list of codes to flag data at the result and analytical batch level; the Delta RMP uses a subset of the available codes to flag various QC issues as needed. The QA Report describes non-conformances with QAPP specifications. These findings should also be included in the data itself in QA codes, result qualifier codes, compliance codes, batch verification codes, and comment fields, so that all data users will be informed of the quality of the data.

The data will be stored and maintained in the Regional Data Center database structure and will follow CEDEN's business rules.

Measurement quality objectives listed previously (Section 4) establish targets to be routinely achieved by the analytical laboratory. However, it is uncertain whether obtained data, even when meeting all stated MQOs, will be sufficient to answer the Delta RMP management questions with sufficient certainty, as the relative contributions of environmental variability and analytical uncertainty to overall uncertainty (e.g. for use in modeling, comparisons to guidelines, or other functions) cannot be known *a priori* before sufficient data have been collected. However, as Delta RMP studies proceed, the ability of collected data to answer these management questions should be periodically re-evaluated for study design and budget planning in subsequent years.

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20. Appendices

20.1. Appendix A. Management Questions

Type	Management Questions
Status and Trends	Is there a problem or are there signs of a problem? a. Is water quality currently, or trending towards, adversely affecting beneficial uses of the Delta? b. Which constituents may be impairing beneficial uses in subregions of the Delta? c. Are trends similar or different across different subregions of the Delta?
Sources, Pathways, Loadings, and Processes	Which sources and processes are most important to understand and quantify? a. Which sources, pathways, loadings, and processes (e.g., transformations, bioaccumulation) contribute most to identified problems? b. What is the magnitude of each source and/or pathway (e.g., municipal wastewater, atmospheric deposition)? c. What are the magnitudes of internal sources and/or pathways (e.g. benthic flux) and sinks in the Delta?
Forecasting Water Quality Under Different Management Scenarios	a. How do ambient water quality conditions respond to different management scenarios b. What constituent loads can the Delta assimilate without impairment of beneficial uses? c. What is the likelihood that the Delta will be water quality-impaired in the future?
Effectiveness Tracking	a. Are water quality conditions improving as a result of management actions such that beneficial uses will be met? b. Are loadings changing as a result of management actions?

20.2. Appendix B. Assessment Questions

Delta RMP assessment questions for mercury, pesticides, and pathogens. Questions highlighted in yellow are the highest priority for initial studies.

Type	Core Management Questions	Mercury	Pesticides	Pathogens
Status & Trends	Is there a problem or are there signs of a problem? a. Is water quality currently, or trending towards, adversely affecting beneficial uses of the Delta? b. Which constituents may be impairing beneficial uses in subregions of the Delta? c. Are trends similar or different across different subregions of the Delta?	1. What are the status and trends in ambient concentrations of total mercury and methylmercury (MeHg) in fish, water, and sediment, particularly in subareas likely to be affected by major sources or new sources (e.g., large-scale restoration projects)? A. Are trends over time in MeHg in **sport fish** similar or different among Delta subareas? B. Are trends over time in MeHg in **water** similar or different among Delta subareas?	1. To what extent do pesticides contribute to observed toxicity in the Delta? 1.1. Which pesticides or degradates have the highest potential to be causing toxicity in the Delta and therefore should be the priority for monitoring and management? A. If samples are toxic, do detected pesticides explain the toxicity? B. If samples are not toxic, do detected pesticide concentrations exceed other thresholds of concern (e.g., water quality objectives or Office of Pesticide Programs aquatic toxicity benchmarks)? 1.2. What are the spatial and temporal extents of lethal and sublethal aquatic and sediment toxicity observed in the Delta? A. Do aquatic or sediment toxicity tests at targeted sites indicate a toxic response? B. If answer to A is yes, which other toxicity indicator(s) should guide monitoring and management of pesticides in Years 2+? 2. What are the spatial/temporal distributions of concentrations of currently used pesticides identified as likely causes of observed toxicity? 2.1. Which pesticides have the highest risk potential	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?

Type	Core Management Questions	Mercury	Pesticides	Pathogens
			(based on DPR's risk prioritization model[16]) and should be included in chemical analyses? A. Is the list of pesticides included in USGS pesticide scan sufficient for Delta RMP monitoring design? B. Are methods available to monitor pesticides with high-risk potential not included in USGS pesticide scan? 2.2. How do concentrations of the pesticides with the highest risk potential vary seasonally and spatially?	
Sources, Pathways, Loadings & Processes	Which sources and processes are most important to understand and quantify? a. Which sources, pathways, loadings, and processes (e.g., transformations, bioaccumulation) contribute most to identified problems? b. What is the magnitude of each source	1. Which sources, pathways and processes contribute most to observed levels of methylmercury in fish? A. What are the loads from tributaries to the Delta (measured at the point where tributaries cross the boundary of the legal Delta)? B. How do internal sources and processes influence methylmercury levels in fish in the Delta? C. How do currently uncontrollable sources (e.g., atmospheric deposition, both as direct deposition to Delta surface waters and as a contribution to nonpoint runoff) influence methylmercury levels in	1. What are the principal sources and pathways responsible for aquatic and sediment toxicity observed in the Delta? 2. What are the fates of prioritized pesticides and degradates in the environment? 2.1. Do physical/chemical properties of priority pesticides, application rates and processes, and ambient conditions influence the degree of toxicity observed? 3. What are the spatial/temporal use patterns of priority pesticides?	1. Can any changes in bin level[17] be attributed to an identifiable event, condition, or changes in a source? A. What is the influence of sources on pathogen levels at drinking water intakes? B. What is the viability and infectiousness of pathogens 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? 2. What are the factors affecting decay and growth rates and can they be quantified and

[16] http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis_memos/prioritization_report_2.pdf

[17] EPA has developed the Long Term 2 Enhanced Surface Water Treatment Rule (LT2 rule), which classifies filtered water systems into one of four treatment categories (bins) based on their monitoring results for *Cryptosporidium*. Most systems are expected to be classified in the lowest bin and will face no additional requirements. Systems classified in higher bins must provide additional water treatment to further reduce *Cryptosporidium* levels by 90 to 99.7 percent (1.0 to 2.5-log), depending on the bin. From: Rule Fact Sheet - Long Term 2 Enhanced Surface Water Treatment Rule (EPA 2005).

Type	Core Management Questions	Mercury	Pesticides	Pathogens
	and/or pathway (e.g., municipal wastewater, atmospheric deposition)? c. What are the magnitudes of internal sources and/or pathways (e.g. benthic flux) and sinks in the Delta?	fish in the Delta?		characterized for the purpose of modeling?
Forecasting Scenarios	a. How do ambient water quality conditions respond to different management scenarios b. What constituent loads can the Delta assimilate without impairment of beneficial uses? c. What is the likelihood that the Delta will be water quality-impaired in the future?	1. What will be the effects of in-progress and planned source controls, restoration projects, and water management changes on ambient methylmercury concentrations in fish in the Delta?	1. How do pesticide concentrations respond to different management scenarios? 2. What pesticide loads can the Delta assimilate without exceeding water quality criteria established to protect beneficial uses? 3. How will climate change affect concentrations and/or loadings of pesticides and impacts to aquatic species?	1. What is the effect of source controls on pathogen levels at drinking water intakes? 2. How will proposed restoration projects, water operations, and future urban growth affect municipal drinking water intake bin levels?
Effectiveness Tracking	a. Are water quality conditions improving as a result of management actions such that beneficial uses will be met?	[none]	1. Are pesticide-related toxicity impacts decreasing over time?	[none]

Type	Core Management Questions	Mercury	Pesticides	Pathogens
	b. Are loadings changing as a result of management actions?			

20.3. Appendix C. Delta RMP Monitoring Elements

Pesticides

Monthly sampling at five sites, which also capture targeted events. Targeted events (n = 5/year): Wet Weather: (1) 1st seasonal flush (Water Year), (2) Significant winter storm; Dry weather: (1) Early Spring, (2) Late spring/early summer irrigation season, (3) Late summer irrigation season. Chemical analyses and toxicity testing on all samples. Test species (endpoints): (1) *Selenastrum capricornutum* (growth) (2) *Ceriodaphnia dubia* (survival and reproduction), and (3) *Pimephales promelas* (larval survival and growth). Chemistry: pesticide scan (USGS), total suspended solids, dissolved organic carbon (DOC) and particulate organic carbon (POC), hardness, and dissolved copper analysis. Pesticide-focused Toxicity Identification Evaluations (TIEs) for a subset of samples with ≥ 50% of the measured endpoint; to be decided real-time by a TIE subcommittee.

Mercury

Sport Fish

Annual sampling at six fixed sites beginning in 2016. Indicator of primary interest is methylmercury in muscle fillet of 350-mm largemouth bass (or similar predator species). Sites are located to represent different subareas of the Delta and to link with water monitoring.

Water

Quarterly sampling at five sites that align with sport fish monitoring sites. Indicator of primary interest is total methylmercury in water.

Important ancillary parameters include total and dissolved total Hg, chlorophyll *a*, DOC, suspended sediment concentrations, and volatile suspended solids.

Pathogens

Monthly sampling for a two-year special study characterizing pathogen levels (*Cryptosporidium* and *Giardia lamblia*) to address the objectives of the Pathogen Special Study required by the Central Valley Drinking Water Policy Basin Plan Amendment. The study includes monitoring at ambient locations throughout the Delta. The sampling is added to the routine monthly sampling effort of the Department of Water Resources (DWR) Municipal Water Quality Investigations (MWQI). The Delta RMP contributes required additional laboratory analyses, data management, and reporting.

20.4. Appendix D. List of SOPs

The following SOPs, manuals, and method reference documents will be made available on CD by request or can be downloaded from the SFEI-ASC Google Drive.

Field
USGS – National Field Manual for the Collection of Water-Quality Data – Collection of Pyrethroids in Water and Sediment Matrices: Development and Validation of a Standard Operating Procedure *MPSL* – MPSL Field SOP v1.1 – MPSL-102a Sampling Marine and Freshwater Bivalves, Fish and Crabs for Trace Metal and Synthetic Organic Analysis – Low level mercury (USGS NFM A5.6.4.B) – Instructions for Constructing a Perforated Bucket Sampler to be Used as an Extended Holder for the Direct Filling of Sample Bottles (SWAMP SOP 2.1.1.4) *MWQI* – MWQI Program Field Manual – MWQI Program Field Manual, Appendix A – Delta RMP Pathogen Study Cryptosporidium and Giardia Sampling
Chemical Analysis
USGS – Determination of Elements in Natural-Water, Biota, Sediment, and Soil Samples Using Collision/Reaction Cell Inductively Coupled Plasma–Mass Spectrometry (USGS TM-5-B1) – Methods of Analysis—Determination of Pyrethroid Insecticides in Water and Sediment Using Gas Chromatography/Mass Spectrometry (USGS TM-5-C2) – Analysis of the herbicide diuron, three diuron degradates, and six neonicotinoid insecticides in water—Method details and application to two Georgia streams (USGS SIR 2012-5026) – A Multi-residue Method for the Analysis of Pesticides and Pesticide Degradates in Water Using HLB Solid-phase Extraction and Gas Chromatography–Ion Trap Mass Spectrometry – WATER EXTRACTION for GCMS analysis using HLB cartridges – Suspended sediment on Filter Paper EXTRACTION for GCMS analysis – WATER EXTRACTION for LCMSMS analysis using HLB cartridges – Procedures for Processing Samples for Analysis of Dissolved Organic Carbon and Organic Particulate Carbon – Determination of Carbon and Nitrogen in Sediments and Particulates of Estuarine/Coastal Waters Using Elemental Analysis (EPA 440.0) – Methods of Analysis by the U.S. Geological Survey National Water Quality Laboratory - Determination of Dissolved Organic Carbon by uv-promoted Persulfate Oxidation and Infrared Spectrometry (USGS Test Method O-1122-92) *MPSL* – Mercury in Solids and Solutions by Thermal Decomposition, Amalgamation, and Atomic Absorption Spectrophotometry (EPA 7473) – Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry (EPA 1631, Revision E)

- Methyl Mercury in Water by Distillation, Aqueous Ethylation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry (EPA 1630)
- MPSL-101 Sample Container Preparation for Organics and Trace Metals, Including Mercury and Methylmercury
- MPSL-104 Sample Receipt and Check-In
- SM 2540D Solids

CDFW-WPCL

- *In Vitro* Determination of Chlorophylls *a*, *b*, *c1* + *c2* and Pheopigments in Marine And Freshwater Algae by Visible Spectrophotometry (EPA 446.0)
- TOTAL ORGANIC CARBON in Water (EPA 415.1)
- WPCL-AB-001 Sample Custody, Receipt, and Storage
- WPCL-QA-050 Protocol for Corrective Action Procedures

Toxicity Testing

UCD-AHPL

- Initiation of *Selenastrum capricornutum* 96-Hour Chronic Toxicity Test (4th Edition) (SOP 1-1)
- Initiation of *Ceriodaphnia dubia* Chronic Toxicity Test (4th Edition) (SOP 1-2)
- Initiation of *Pimephales promelas* (Fathead Minnow) Chronic Toxicity Test (4th Edition) (SOP 1-3)
- Initiation of *Hyalella azteca* Acute 96-hour Water Column Toxicity Test (SOP 1-6)
- Protocol for Sample Receiving and Storage – Delta RMP Testing (SOP 12-7)

Toxicity Identification Evaluations (TIEs)

UCD-AHPL

- Protocol for Making a 5 ppm Solution of PBO and Spiking it into Sample Waters (SOP 7-1)
- C8 Solid Phase Extraction (SOP 7-2)
- C8 Column Elution for Phase I TIEs (SOP 7-3)
- C8 Column Elution for Phase II TIEs (SOP 7-4)
- Amendment of Water Samples with EDTA and Na_2S2O_3 (SOP 7-9)
- pH Adjustments to pH 3 and pH 11 (SOP 7-10)
- Aeration (Volatile/Surfactant Stripping) (SOP 7-11)

Toxicity Testing - Water Quality Measurements

UCD-AHPL

- Analysis for Total Water Hardness (SOP 6-1)
- Analysis for Ammonia Nitrogen (mg/L) (SOP 6-3)
- Analysis for Alkalinity (SOP 6-5)
- Use of YSI Model 33 Electrical Conductivity Meter (SOP 8-7)
- Operation of Beckman 12 pH/ISE Meter (SOP 8-8)
- Protocol for the YSI Model 58 Dissolved Oxygen Meter (SOP 8-9)

SWAMP Documentation

- SWAMP Toxicity Template Documentation
- SWAMP Toxicity Template
- SWAMP Sample Handling, Measurement Quality Objectives, and Corrective Action Tables

Pathogen Analysis

BioVir

- EPA Method 1622, 1623, 1623.1 Cryptosporidium and Giardia in Water by Filtration/IMS/FA:

Sample Filtration (SOP X.C.2.a)

- EPA Method 1622, 1623 and 1623.1 Cryptosporidium and Giardia in Water by Filtration/IMS/FA: Elution and Concentration (SOP X.C.2.b)
- EPA Method 1622, 1623 and 1623.1 Cryptosporidium and Giardia in Water by Filtration/IMS/FA: Immunomagnetic Separation (IMS) (SOP X.C.2.c)
- EPA Method 1622, 1623 and 1623.1 Cryptosporidium and Giardia in Water by Filtration/IMS/FA: Slide Staining Procedure (SOP X.C.2.d)
- EPA Method 1622, 1623 and 1623.1 Cryptosporidium and Giardia in Water by Filtration/IMS/FA: Slide Examination (SOP X.C.2.e)

Eurofins

- EPA Method 1622/1623 (Micro-SOP3404)

20.5. Appendix E. Example Field Sheets

Attach ASR and WatList

U. S. GEOLOGICAL SURVEY SURFACE-WATER QUALITY FIELD NOTES

USGS science for a changing world

Station No. ____________________

NWIS Record No. ____________________

Station No. ______________________ Station Name ____ Field ID ________________

Sample Date _____________ Mean Sample Time _______ Time Datum ______ (eg. EST, EDT, UTC) End Date _________ End Time _______

*Sample Medium: WS WSQ OAQ *Sample Type: 9 (regular) 7 (replicate) 2 (blank) 1 (spike) __________

*Sample Purpose (71999): 10 (routine) 15 (NAWQA) 20 (NASQAN) 25 (NMN) 30 (Benchmark) ____________________

* see last page for additional codes

*Purpose of Site Visit (50280): 1001 (fixed-frequency SW) 1003 (extreme high flow SW) 1004 (extreme low flow SW) 1098 (NAWQA QC) ______

QC Samples Collected? Y N Blank Replicate Spike Other______________________

Project No. ______________________________________ Project Name____

Sampling Team __________________________________ Team Lead Signature ______________________________ Date ___________

START TIME __________ GAGE HT _______ TIME __________ GHT ______ TIME __________ GHT ______ TIME __________ GHT ______ END TIME __________ GHT _______

FIELD MEASUREMENTS

Property	Parm Code	Method Code http://water.usgs.gov/usgs/owq/Forms/Fieldmeasure-ment_parametersmethods.doc	Result	Units	Remark Code	Value Qualifier	Null Value Qualifier	NWIS Result-Level Comments
Gage Height	00065			ft				
Discharge, instantaneous	00061			cfs				
Temperature, Air	00020	THM04 (Thermistor) THM05 (Thermometer)		˚C				
Temperature, Water	00010	THM01 (Thermistor)		˚C				
Specific Conductance	00095	SC001 (Contacting Sensor)		µS/cm				
Dissolved Oxygen	00300	LUMIN (Luminescent) MEMBR (Amperometric) SPC10 (Spectrophotometric)		mg/L				
Barometric Pressure	00025	BAROM (Barometer)		mm Hg				
pH	00400	PROBE (Electrode)		units				
Alkalinity, filtrd, incr. Alkalinity, filtrd, Gran	39086 29802	TT061 (Digital Titrator) TT062 (Buret) TT056 (Digital Titrator) TT057 (Buret)		mg/L				
Carbonate, filtrd, incr. Carbonate, filtrd, Gran	00452 63788	ASM01(Digital Titrator) ASM02(Buret) ASM03(Digital Titrator) ASM04(Buret)		mg/L				
Bicarbonate, filtrd, incr. Bicarbonate, filtrd, Gran	00453 63786	ASM01(Digital Titrator) ASM02(Buret) ASM03(Digital Titrator) ASM04(Buret)		mg/L				
Hydroxide, filtrd, incr. Hydroxide, filtrd, Gran	71834 29800	ASM01(Digital Titrator) ASM02(Buret) ASM03(Digital Titrator) ASM04(Buret)		mg/L				
Turbidity [see attachment for codes and units]								

SAMPLING INFORMATION

Parameter	Pcode	Value	Information
Sampler Type	84164	*see last page for proper codes— consider type of sampler and material*	Sampler ID:
Sampling Method	82398	10 EWI; 20 EDI; 30 single vertical; 40 multiple vertical; other ____________________	
Sampler bottle/bag material	84182	Plastic Bag (11) Teflon® Bag(12) Glass Bottle(20) Plastic Bottle (21) Teflon® Bottle (22) other (30)	
Sampler Nozzle material	72219	plastic (2) Teflon® (3) Brass (1)	
Sampler Nozzle Diameter	72220	3/16” (3) 1/4” (4) 5/16” (5)	
Sampler Transit Rate	50015	feet/second	
Velocity to Calculate Isokinetic transit rate	72196	feet/second	
Depth to Calculate Isokinetic transit rate	72195	feet	
Splitter Type	84171	*See last page for codes* ___________	Splitter ID:
Hydrologic Condition	N/A	A Not Determined; 4 Stable, low stage; 5 Falling stage; 6 Stable, high stage; 7 Peak stage; 8 Rising stage; 9 Stable, normal stage	
Observations [Codes: 0=none; 1=mild; 2=moderate; 3=serious; 4=extreme]		Oil-grease (01300) ___ Detergent suds (01305) ___ Floating garbage (01320) ___ Floating algae mats (01325) ___ Floating debris (01345) ___ Turbidity (01350) ___ Atm. Odor (01330) ___ Fish kill (01340) ___ Gas Bubbles (01310) ___ Sewage Solids (01335) ___ Floating Vegetation (84178) ___ Ice Cover(01355) ___	

BAG SAMPLER EFFICIENCY TEST

Test	Duration Sampler Collected Water (seconds)	Sample Volume Collected (milliliters)
1		
2		
3		
Mean	(72217)	(72218)

Bag Sampler Efficiency (*See last page*) %

COMPILED BY: ______________________ **CHECKED BY:** __________________________ **LOGGED INTO NWIS BY:** ________________________

November 2013 1 SW Form version 9.0

Field Data Entry Form

Submittal/Run Name: Banks RTM Grab

Submittal ID: C0615B0161

Instructions to Field Crew:

C0615B0648 Water, Natural **Depth: 1 Meter** **Collection Date:** 6/3/15 **Collection Time:** ___:___

Station No.: KA000331 **Sampler:** Brown & Del Cid Normal Sample of 0

Station Name: H.O. Banks Headworks **Add'l Note:** Canal Grab

Field Measure Name		Instrument	Property No.	Probe Number
Conductance (EC) (µS/cm)	________	EC Meter	________	________
Turbidity (N.T.U.)	________	Turbidimeter	________	________
Field Notes ()	________		________	________

Notes:

1 Glass, Amber, 40 ml Vial, H3PO4, pH <2, FiltDo Not Overfill. Vial Contains Acid.	1 Glass, Amber, 40 ml Vial, H3PO4, pH <2Do Not Overfill. Vial Contains Acid.
1 Polyethylene, 1/2 Pint, Filt	1 Polyethylene, 10 Liters

C0615B0649 Water, Purified **Depth: 1 Meter** **Collection Date:** 6/3/15 **Collection Time:** ___:___

Station No.: Blank; Equipment **Sampler:** Brown & Del Cid Blank; Field of 0

Station Name: Blank; Equipment **Add'l Note:** Filtered Blank

Field Measure Name		Instrument	Property No.	Probe Number
All ()	________		________	________

Notes:

1 Glass, Clear, 40 ml Vial, H3PO4, pH <2, FiltDo Not Overfill. Vial Contains Acid.

1 of 1

SWAMP Tissue Sampling - Non-Trawl (Event Type = TI) SWB_FishLk_LC_2014		Entered in d-base (initial/date)		Pg of Pgs
*StationCode: ___ ___ ___ ___ ___ ___ ___ ___ ___	*StationName:		*Purpose Failure Code:	Agency
*FundingCode: 1 3 S W B G 0 1	*Date (mm/dd/yyyy): / /			

Tissue Collection

Location	*Depth (m):		Distance from Bank (m):			Accuracy (ft / m)	Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line			Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA				Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,			End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA / WI	Other ________	Geoshape: Line Poly Point		Coord. 4				
Location	*Depth (m):		Distance from Bank (m):				Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line			Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA				Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,			End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA / WI	Other ________	Geoshape: Line Poly Point		Coord. 4				
Location	*Depth (m):		Distance from Bank (m):				Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line			Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA				Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,			End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA / WI	Other ________	Geoshape: Line Poly Point		Coord. 4				
Location	*Depth (m):		Distance from Bank (m):				Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line			Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA				Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,			End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA / WI	Other ________	Geoshape: Line Poly Point		Coord. 4				
Location	*Depth (m):		Distance from Bank (m):				Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line			Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA				Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,			End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA / WI	Other ________	Geoshape: Line Poly Point		Coord. 4				
Location	*Depth (m):		Distance from Bank (m):				Latitude (dd.ddddd)	Longitude (-ddd.ddddd)	Depth (m)
COLLECTION METHOD:	E-boat, Backpack shocker, Fyke net, gill net, seine, hook & line			Start Time	Coord. 1				
SAMPLE LOCATION:	Bank, Thalweg, Midchannel, Open Water, NA				Coord. 2				
HYDROMODIFICATION:	None, Bridge, Pipes, Concrete Channel, Grade Control, Culvert,			End Time	Coord. 3				
HYDROMODLOC(to sample):	US / DS / NA / WI	Other ________	Geoshape: Line Poly Point		Coord. 4				

Failure Codes: Dry (no water), Instrument Failure, No Access, Non-sampleable, Pre-abandoned, Other

Comments:

Modified 08/08/07

SWAMP Tissue Sampling - Non-Trawl (Event Type = TI) **SWB_FishLk_LC_2014**								Entered in d-base (initial/date)		Pg:	of	Pgs
*StationCode: ___ ___ ___ ___ ___ ___ ___ ___ ___				StationName:					Date (mm/dd/yyyy): / /			
Location #	**Organism ID**	**Tag #**	**Species Name/Code**	**FL (mm)**	**TL (mm)**	**StdL (mm)**	**Weight (g)**	**Count**	**Count Est.**	**Sex**	**Anomaly**	**Condition**
										M F U L		
										M F U L		
										M F U L		
										M F U L		
										M F U L		
										M F U L		
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										M F U L		
										M F U L		
										M F U L		

Location #: Match fish with Location # from Tissue Collection sheet | **Organism ID:** Combine composite # and fish # (e.g., fish 1 of composite WC01 is WC01-01) to be uni | **Tag #**: Use if applicable

Species Code: Largemouth Bass (**LMB**), Smallmouth Bass (**SMB**), Spotted Bass (**SPB**), Sacramento Pike Minnow (**SPM**), Rainbow Trout (**RT**), Brown Trout (**BT**), Brook Trout (**BKT**), White Catfish (**WC**), Carp (**CAR**), Channel Catfish (**CC**), Brown Bullhead (**BRB**), Sacramento Sucker (**SS**), Redear (**RES**), Black Crappie (**CRP**), Bluegill (**BG**), Tilapia (**TIL**), Green Sunfish (**GRS**), Kokanee (**KOK**)

Stage: Adult (A), Juvenile (J), Subadult (SA), Not Recorded (NR) | **Count Est**: If appropriate, add < or > if count is e

Anomalies: Ambicoloration (A), Albinism (B), Cloudiness (CL), Deformity-skeletal (D), Discoloration (DC), Depression (DS), Fin Erosion (F), Gill Erosion (T), Hemorrhage (H), Lesion (L), Parasite (P), Popeye (PE), Tumor (T), Ulceration (U), White Spots (W), and any combination | **Sex**: unk(**U**), taken at Lab(**L**) | **BodyLocation**: Branchial Chamber(BRC), Buccal Cavity(BC), Eyes(E), Musculoskeleton(M), Skin/Fins(SF)

Comments: Mark fish requiring further ID; **SEPARATE FISH BY LOCATION AND INDICATE LOCATION # ON LABEL**

Modified 06/19/07

20.6. Appendix F. Example for Chain of Custody Form

Results to: **CHAIN OF CUSTODY RECORD** Page of

San Francisco Estuary Institute
7770 Pardee Lane
Oakland, CA, 94621-1424
Phone: 510-746-7334 Fax: 510-746-7300

Bill to: | Shipped to:

Sampled by [Print Name(s)] / Affiliation

Sampler(s) Signature(s)

Preservatives (see codes)

Analyses Requested

Project Name:

Sample ID No.	Sampled Date	Sampled Time	Grab or Composite	Matrix (see codes)	Number/Size/Type of Containers										Remarks

← Total Number of Containers

Shipment Method

Out: / / Via:

Additional Comments:

Relinquished by / Affiliation	Date	Time	Accepted by / Affiliation	Date	Time

Cooler No.(s) / Temperature(s) (C)°

MATRIX CODES: F = Freshwater S = Saline SE = Sediment SW = Surface Water PW = Porewater B = Blanks T= Toxicity O = Other (specify)

PRESERVATIVE CODES: H = Hydrochloric acid + ice I = Ice only N = Nitric acid + ice S = Sulfuric acid + ice O = Other (specify)

21. Addenda

21.1. Addendum 1. Updates to: Collection of water samples for analysis of mercury and methylmercury

August 25, 2016

MPSL staff have prepared the SOP (Method # MPSL-111) Field Collection Procedures for Depth Integrated Water Via Bucket Sampler .

Pages 84 and 114 of the Delta RMP QAPP were updated accordingly.

21.2. Addendum 2. Updates to: Collection of water samples for analysis of pesticides and toxicity testing

September 19, 2016

The change was requested by participants in the Irrigated Lands Regulatory Program (ILRP). Per agreement with the Central Valley Regional Water Quality Control Board, ILRP participants use some of the pesticide data collected at San Joaquin R @ Vernalis/Airport Way and Ulatis Creek @ Brown Road for compliance reporting purposes. ILRP participants require the Cu, hardness, and alkalinity samples to come from the same bottle.

Pages 82 and 86 (Table 8.2) of the Delta RMP QAPP were updated accordingly.