

**Quality Assurance Program Plan
for
The Regional Monitoring Program for Water Quality
in San Francisco Bay**



Prepared by
Don Yee, Amy Franz, Thomas Jabusch, Adam Wong, Michelle Lent, Rachel Eastman, John Ross
and David Gluchowski
San Francisco Estuary Institute
September 30, 2014

San Francisco Estuary Institute
4911 Central Avenue
Richmond, CA 94804

A. PROJECT MANAGEMENT

Element 1 Title and Approval


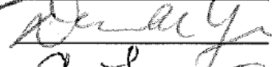
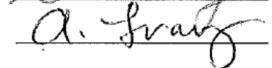
For

PROJECT NAME: Regional Monitoring Program for Water Quality in San Francisco Bay

Date:

NAME OF RESPONSIBLE ORGANIZATION : San Francisco Estuary Institute (SFEI)

APPROVAL SIGNATURES

Title:	Name:	Signature:	Signature Date:
SFEI Project Manager	Phil Trowbridge		<u>7/22/15</u>
SFEI QA Officer	Don Yee		<u>7/22/15</u>
SFEI Data Manager	Amy Franz		<u>7-15-15</u>

Element 2 Table of Contents

2.1 Table of Contents

A. PROJECT MANAGEMENT.....	2
Element 1 Title and Approval.....	2
Element 2 Table of Contents.....	4
2.1 Table of Contents.....	4
2.2 List of Tables.....	6
2.3 List of Figures.....	6
Element 3 Distribution List.....	7
Element 4 Project Task/Organization.....	10
4.2 Quality Assurance Officer Role.....	12
4.3 Persons Responsible for QAPP Update and Maintenance.....	12
4.4 Organizational Chart and Responsibilities.....	12
Element 5 Problem Definition/Background.....	13
5.1 Problem Statement.....	13
5.2 Decisions and Outcomes.....	14
5.3 Water Quality or Regulatory Criteria.....	14
Element 6 Project Tasks Description.....	17
6.1 Work Statement and Produced Products.....	17
6.2 Constituents to be Monitored and Reported.....	17
6.3 Project Schedule.....	32
6.4 Geographical Setting.....	33
6.5 Constraints.....	37
Element 7 Quality Objectives and Criteria for Measurement Data.....	42
7.1 Field Performance Measurements.....	42
7.2 Laboratory Performance Measurements.....	42
7.3 Laboratory Quality Control Procedures.....	45
7.4 Project specific action limits.....	77
Element 8 Special Training Needs and Certification.....	78
8.1 Specialized Training or Certifications.....	78
8.2 Training Certification and Documentation.....	78
8.3 Training Personnel.....	79
Element 9 Documents and Records.....	80
9.1 Report Package Information.....	81
9.2 Data Reporting Requirements.....	83
B. DATA GENERATION AND AQUISITION.....	102
Element 10 Sampling Process Design.....	102
10.1 Study Area and Period.....	102
10.2 Inaccessible Sampling Sites.....	103

10.3 Critical Versus Informational Project Data	103
Element 11 Sampling Methods	104
11.1 Sampling Guidelines	104
11.2 Field Equipment and Supplies	105
11.3 Field Sample Collection and Quality Assurance Procedures	106
11.4 Field Sampling SOPs for Sampling Procedures and Equipment.....	109
11.5 Corrective Action	109
Element 12 Sample Handling and Custody	122
12.1 Field Sample Handling and Shipping Procedures	122
12.2 Sample Disposal Procedures	122
Element 13 Analytical Methods	124
13.1 Field Analytical Methods.....	124
13.2 Laboratory Analytical Methods.....	124
13.2.1 Laboratory SOPs	125
13.2.2 Corrective Actions Procedures	125
13.3 Non-Standard Methods Used	125
Element 14 Quality Control	126
14.1 Field QC Procedures	126
14.2 Laboratory QC Procedures.....	127
Element 15 Instrument/Equipment Testing, Inspection, and Maintenance.....	157
Element 16 Instrument/Equipment and Calibration Frequency	159
Element 17 Inspection/Acceptance of Supplies and Consumables	166
Element 18 Non-direct Measurements (Existing Data)	167
Element 19 Data Management	168
19.1 Checklist Used for Data Management.....	169
<i>C. ASSESMENT AND OVERSIGHT.....</i>	<i>171</i>
Element 20 Assessment and Response Actions	171
Element 21 Reports to Management	172
<i>D. DATA VALIDATION AND USABILITY</i>	<i>173</i>
Element 22 Data Review, Verification, and Validation.....	173
Element 23 Verification and Validation Methods	174
Element 24 Reconciliation with User Requirements	177
Element 25 References	178

2.2 List of Tables

Table 3-1. Distribution List.....	7
Table 4-1. Analytical laboratories	10
Table 5-1 - Sources of Numeric Water Quality Objectives for San Francisco Bay (as of June 29, 2013).....	15
Table 5-2 - Objectives for Mercury and PCBs in fish (Basin Plan for the San Francisco Bay Basin 2010).....	16
Table 6-1. RMP Target Parameters and Reporting Units.....	18
Table 6-2. Proposed Project Schedule	32
Table 7-1 MDL averages for ancillary parameters in analyses of sediment and water.	47
Table 7-2 MDL averages for trace elements in analyses of sediment, waters and tissues	48
Table 7-3 MDL averages for alkylated polycyclic aromatic hydrocarbons (AlkPAHs) in analyses of sediment, waters and tissues.	50
Table 7-4 MDL averages for PAHs in analyses of sediment, waters and tissues.	51
Table 7-5 MDL averages for PBDEs in analyses of sediment, waters and tissues.....	53
Table 7-6 MDL averages for PCBs in analyses of sediment, waters and tissues	56
Table 7-7 MDL averages for dioxins and furans in analyses of sediment, waters and tissues.	62
Table 7-8 MDL averages for perfluorinated compounds in analyses of sediment, waters and tissues.....	63
Table 7-9 MDL averages for chlordane pesticides in analyses of sediment, waters and tissues.....	64
Table 7-10 MDL averages for cyclopentadiene pesticides in analyses of sediment, waters and tissues.....	64
Table 7-11 MDL averages for DDT pesticides in analyses of sediment, waters and tissues.....	64
Table 7-12 MDL averages for hexachlorobenzene pesticides (HCH) in analyses of sediment, waters and tissues.....	65
Table 7-13 MDL averages for pyrethroid pesticides in analyses of sediment, waters and tissues.....	66
Table 7-14 MDL averages for other pesticides in analyses of sediment, waters and tissues.	67
Table 9-1. List of required RMP data fields.....	83
Table 9-2. List of required data fields.....	86
Table 11-1. Field Sampling Methods, Sample Size, and Preservation.	110
Table 14-1. Laboratory Analytical QC	129
Table 15-1. Testing, inspection, maintenance of field equipment and laboratory instruments.....	158
Table 16-1. Calibration of equipment and analytical instruments	160
Table 21-1. Reporting Time Line.....	172

2.3 List of Figures

Figure 4-1. Organizational Chart and Responsibilities.....	12
Figure 6-1. 2011 Water Sampling Sites.....	35
Figure 6-2. 2011 Sediment Sampling Sites.....	36
Figure 6-3. 2010 Bivalve Sampling Sites.....	37
Figure 12-1. Chain of Custody Form	123

Element 3 Distribution List

Table 3-1. Distribution List

Name	Affiliation	Title	Phone	Email Address	No. of Copies
Ralph Poulsen	ALS-Arizona	Laboratory Director	520-623-8501	rpoulsen@caslab.com	1
Howard Boorse	ALS-Washington	Senior Chemist	360-577-7222	howard.boorse@alsglobal.com	1
Shar Samy	ALS-Washington	Project Manager		Shar.Samy@alsglobal.com	1
Lee Wolf	ALS-Washington	QA Manager		Lee.wolf@alsglobal.com	1
Jay Johnson	AMS-CA	Sr. Oceanographer, Principal	925-373-7142	johnson@amarine.com	1
Paul Salop	AMS-CA	Sr. Scientist, Principal	925-373-7142	salop@amarine.com	1
Dale Hoover	AXYS	QA Manager	250-655-5800	dhoover@axys.com	1
Cynthia Tomey	AXYS	Project Manager	250-655-5812	ctomey@axys.com	1
Tiffany Stillwater	BR	Project Manager	206-753-6129	tiffany@brooksrand.com	1
Frank McFarland	BR	QA Manager	206-632-6206	frank@brooksrand.com	1
Todd Albertson	CALTEST	Project Manager	(707) 258-4000 (main)	Todd_Albertson@CaltestLabs.com	1
Emily Volkmar	CALTEST	QA Officer	(707) 258-4000	Emily_Volkmar@CaltestLabs.com	1
Mary Lou Esparza	CCCSD	Project Manager	925-335-7751	mesparza@centralsan.org	1
Jackie Campos	CCCSD	QA Officer	925-240-7240	jcampos@centralsan.org	1
Anthony Ratttonetti	CCSF	Laboratory Project Manager	415-920-4967	trattonetti@sfwater.org	1

QAPP for the San Francisco Bay RMP

Ken Lee	CCSF	Laboratory Manager	415-920-4965	klee@sfwater.org	1
Mike Kellogg	CCSF-OBL	Supervising Biologist	415-242-2218	mkellogg@sfwater.org	1
Dorothy Norris	CCSF-OBL	Taxonomist	415.242.2208	dnorris@sfwater.org	1
Loc Nguyen	DFG-WPCL	QA Officer	916-358-2010	Lnguyen@ospr.dfg.ca.gov	1
Gail Cho	DFG-WPCL	Project Manager	916-358-2840	Gail.Cho@Wildlife.ca.gov	1
Mary Curry	DFG-WPCL	Project Manager	(916) 358-4398	mary.curry@wildlife.ca.gov	1
Nirmela Arsem	EBMUD	Laboratory Manager	510-287-1435	narsem@ebmud.com	1
Eva Agus	EBMUD	Organics Lab Supervisor	510-287-1796	eagus@ebmud.com	1
Kenneth Gerstman	EBMUD	Senior Chemist	510-287-1429	kgerstma@ebmud.com	1
Susan McCormick	McCormick	Taxonomist	530-333-2836	Mcwoods47@sbcglobal.net	1
Kamille Hammerston	MLML-BL	Research Associate	831-771-4424	khammerstrom@mlml.calstatel.edu	1
Ivano Aiello	MLML-GeoOc	Assistant Professor	831-771-4480	iaiello@mlml.calstate.edu	1
Autumn Bonnema	MLML-MPSL	QA Manager/Project Manager	831-771-4175	bonnema@mlml.calstate.edu	1
Russell Fairey	MLML-MPSL	Researcher	831-771-4161	fairey@mlml.calstate.edu	1
Marco Sigala	MLML-MPSL	Researcher	831-771-4173	msigala@mlml.calstate.edu	1
Scott Ogle	PERL	Principal Investigator	925-313-8080	scottogle@pacificcorisk.com	1
Bryn Phillips	UCD-GC	QA Officer/Project Manager	831-624-0947	bmphillips@ucdavis.edu	1
Josh Ackerman	USGS	Research Wildlife Biologist	(530) 752-0485	jackerman@usgs.gov	1
Colin Eagles-Smith	USGS	Research Wildlife Biologist	541-750-0949	ceagles-smith@usgs.gov	1
Phil Trowbridge	SFEI	RMP Program Manager	510-746-7345	philt@sfei.org	1

QAPP for the San Francisco Bay RMP

Don Yee	SFEI	QA Officer	510-746-7369	donald@sfei.org	1
Amy Franz	SFEI	Data Manager	510-746-7394	amy@sfei.org	1

Element 4 Program Task/Organization

4.1 Involved Parties and Roles

The Regional Monitoring Program for Water Quality in San Francisco Bay (RMP) is managed and operated by the San Francisco Estuary Institute (SFEI). SFEI was founded as a non-profit organization in 1986 to foster the development of the scientific understanding needed to protect and enhance the San Francisco Estuary. The governing body of SFEI is a Board of Directors composed of Bay Area scientists, environmentalists, regulators, local governments, and industries.

Phil Trowbridge is the RMP Project Manager. She will be responsible for all aspects of monitoring components of this project including the organization of field staff, scheduling of sampling days, management of the SFEI in-house analysis, and interactions with the contract laboratories.

Amy Franz is the SFEI Regional Data Center Manager. She will ensure that data submitted by subcontractor labs are timely, complete, and properly incorporated into the Regional Data Center database.

Don Yee is SFEI's Quality Assurance Officer (QAO). His 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 laboratory staff is listed above.

SFEI contracts with a number of laboratories that provide high quality analytical services. Qualifications for our labs generally include ISO (International Organization for Standardization) registration, National Environmental Laboratory Accreditation Program (NELAP) accreditation, and/or ELAP certification by the California Department of Public Health. Table 4.1 lists the laboratories currently used and will be updated as changes are made.

The analytical laboratories will act as a technical resource to SFEI staff and management. The responsible personnel and contact information are listed in Table 3-1.

Table 4-1. Analytical laboratories

Analytical laboratory	Lab abbrev.	Matrix	Analytical Services
ALS Environmental	ALS-Washington	Water	POC, DOC
	ALS-Washington	Sediment	particle size, CHN, total solids, organic matter
	ALS-Arizona	Sediment	TOC, TN, % Solids
Applied Marine Sciences, Inc.	AMS-CA	Water	Cruise logistics, field measurements
		Sediment	
		Tissue (bivalve)	
AXYS Analytical Services, LTD	AXYS	Water	Dioxins, PAHs, PBDEs, PCBs, Pesticides
		Sediment	Dioxins
		Tissue (bird egg, sport fish)	

Analytical laboratory	Lab abbrev.	Matrix	Analytical Services
		Tissue (bivalve)	PAHs, PBDEs, PCBs, Pesticides
		Tissue (bird egg, sport fish)	PFCs
Brooks Rand Labs, LLC	BR	Water	Trace elements
		Sediment	As, Se, Hg, MeHg, % solids
		Tissue (bivalve)	Selenium
CALTEST Analytical Laboratory	CALTEST	Water	Cu, hardness, Hg, MeHg, NH3, NO2, NO3, P, PO4, pyrethroids, SSC, Se, TKN, TOC
Central Contra Costa Sanitary District Laboratory	CCCSD	Water	Cyanide
City and County of San Francisco Laboratory	CCSF	Sediment	Trace elements
		Tissue (bivalve)	Trace elements
City and County of San Francisco Laboratory – Oceanside Biological Laboratory	CCSF-OBL	Benthos	Taxonomy
Department of Fish and Game – Water Pollution Control Laboratory	DFG-WPCL	Sediment	Pyrethroids
		Tissue (bird egg, sport fish)	PBDEs, PCBs, pesticides
East Bay Municipal Utility District	EBMUD	Water	Nutrients and water quality parameters
		Sediment	PAHs, PBDEs, PCBs, pesticides
Susan McCormick	McCormick	Benthos	Taxonomy
Moss Landing Marine Laboratories-Benthic Laboratory	MLML-BL	Benthos	Taxonomy
Moss Landing Marine Laboratories-Marine Pollution Studies Laboratory	MLML-MPSL	Tissue (bird egg and sport fish)	Mercury, selenium
Pacific Eco Risk	PER	Water	Toxicity
U.S. Geological Survey Western Ecological Research Center	USGS	Tissue (bird egg)	Mercury
University of California Davis-Granite Canyon Laboratory	UCD-GC	Sediment	Toxicity

4.2 Quality Assurance Officer Role

The SFEI QAO shall not be directly involved in generation of any laboratory or field data and will review and assess all data acquisition procedures against QAPP requirements, reporting all findings and requests for corrective action to the Project Manager. The QAO may stop all actions, including those conducted by field staff or contract laboratories, if there are significant deviations from required practices or if there is evidence of a systematic failure.

4.3 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's Project Manager and QAO, and with the concurrence of the RMP Technical Review Committee. SFEI's QAO will be responsible for making the changes, submitting drafts for review, preparing a final copy, and submitting the final for signature.

4.4 Organizational Chart and Responsibilities

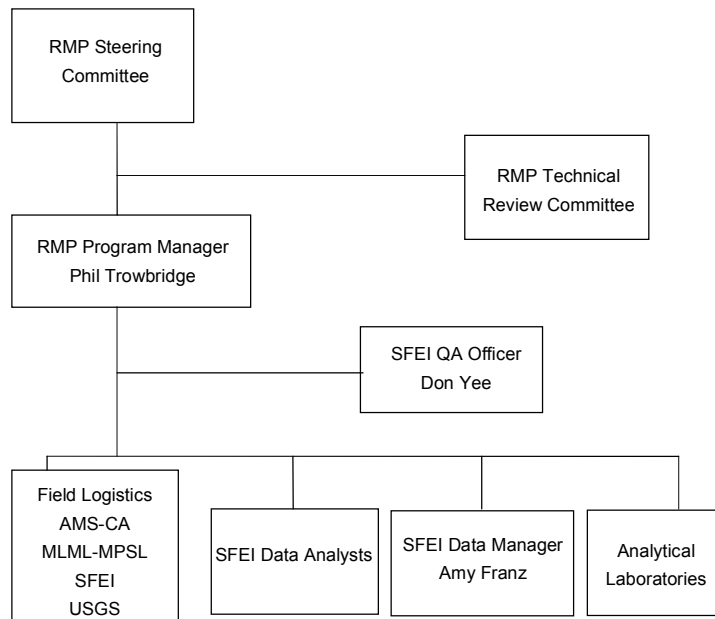


Figure 4-1. Organizational Chart and Responsibilities

Element 5 Problem Definition/Background

5.1 Problem Statement

The Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) was created to provide long-term monitoring information on ecosystem health in the Estuary. The impetus for the program development was a resolution by the San Francisco Bay Regional Water Board to require dischargers in the Bay Area regulated under the National Pollution Discharge Elimination System (NPDES) program to participate in regional monitoring. Contribution to the program constitutes compliance with the requirement to participate. Elimination of certain permit requirements for individual permits offset the requirement for continued participation.

The RMP began as a pilot study in 1989 and has been collecting water, sediment, and biological tissue data since 1993. The Status and Trends component of the RMP routinely collects monitoring data on these environmental matrices. The San Francisco Bay Regional Water Quality Control Board (Water Board) uses Status and Trends data to assist in regulatory decision-making, such as for determining impairment (303(d)) listing, NPDES permit conditions, and estimating Total Maximum Daily Loads (TMDL) of various pollutants needed to protect ecosystem and human health. The data are also useful for monitoring and modeling the effectiveness of past and planned management actions.

The overarching goal of the program is to collect data and communicate information about water quality in the San Francisco Estuary to support management decisions. The RMP, in consultation with its stakeholders, the Technical Review Committee, and the Steering Committee refined the management questions in May 2008.

1. Are chemical concentrations in the Estuary at levels of potential concern and are associated impacts likely?
 - a. Which chemicals have the potential to impact humans and aquatic life and should be monitored?
 - b. What potential for impacts on humans and aquatic life exists due to contaminants in the Estuary ecosystem?
 - c. What are appropriate guidelines for protection of beneficial uses?
 - d. What contaminants are responsible for observed toxic responses?
2. What are the concentrations and masses of contaminants in the Estuary and its segments?
 - a. Do spatial patterns and long-term trends indicate particular regions of concern?
3. What are the sources, pathways, loadings, and processes leading to contaminant-related impacts in the Estuary?
 - a. Which sources, pathways, and processes contribute most to impacts?
 - b. What are the best opportunities for management intervention for the most important contaminant sources, pathways, and processes?
 - c. What are the effects of management actions on loads from the most important sources, pathways, and processes?
4. Have the concentrations, masses, and associated impacts of contaminants in the Estuary increased or decreased?

- a. What are the effects of management actions on the concentrations and mass of contaminants in the Estuary?
 - b. What are the effects of management actions on the potential for adverse impacts on humans and aquatic life due to Bay contamination?
5. What are the projected concentrations, masses, and associated impacts of contaminants in the Estuary?
 - a. What patterns of exposure are forecast for major segments of the Estuary under various management scenarios?
 - b. Which contaminants are predicted to increase and potentially cause impacts in the Estuary?

5.2 Decisions and Outcomes

The primary focus of the RMP is to provide information to assist the San Francisco Bay Regional Water Quality Control Board (RWQCB) and other regional stakeholders in developing plans to address potential contaminant risks in the Bay, e.g., via a TMDL determination. An improved understanding of the status, trends, loadings, and fate of contaminants in the Bay allows regional stakeholders to develop appropriate, effective, and efficient management plans. Data from these studies are made publicly available for scientific research, environmental management purposes, and public awareness.

5.3 Water Quality or Regulatory Criteria

California's water quality standards are established in (regional) Basin Plans or statewide plans. The Basin Plan for San Francisco Bay was first completed in 1975 and has been revised at least once a decade since then, to reflect changing conditions as well as updated understanding of those conditions in the Bay. The water quality standards include both numeric and narrative water quality objectives (WQOs), which are usually based on federal water quality criteria. The most recent Basin Plan includes the most up-to-date WQOs.

Table 5-1 shows the sources of the WQOs in the San Francisco Bay Basin Plan for contaminants with numeric objectives as of June 29, 2013. The WQOs can differ in freshwater and marine water, defined in the Basin Plan as follows: freshwaters are those in which the salinity is equal to or less than 1 part per thousand 95% of the time, and marine waters are those in which the salinity is equal to or greater than 10 parts per thousand 95% of the time (San Francisco Bay RWQCB 2013). The stricter of the two WQOs applies for waters where the salinity falls between these definitions. The WQOs for contaminants listed in Table 5-1 apply throughout the region, except when site-specific objectives have been adopted. Site-specific objectives have been adopted for copper in all segments of San Francisco Bay, for nickel in South San Francisco Bay, and for cyanide in all San Francisco Bay segments.

Table 5-1 - Sources of Numeric Water Quality Objectives for San Francisco Bay (as of June 29, 2013).

Note: sources are subject to change as objectives are updated.

Compound	Marine Waters WQO Source	Fresh Waters WQO Source	Site-specific WQO in Bay?
Arsenic	CTR	CTR	No
Cadmium	CTR	CTR	No
Chromium III	-	NTR	No
Chromium VI	CTR	CTR	No
Copper	CTR	CTR	Yes
Cyanide	NTR	NTR	Yes
Lead	CTR	CTR	No
Mercury	U.S. EPA 1984	U.S. EPA 1986	No*
Nickel	CTR	CTR	Yes
Selenium	NTR	NTR	No**
Silver	CTR	CTR	No
Zinc	CTR	CTR	No
PAHs	Basin Plan	-	No

CTR - California Toxics Rule (40 CFR Part 131.38, May 18, 2000.)

NTR - National Toxics Rule (40 CFR Part 131, February 5, 1993.)

U.S. EPA 1984 - U.S. EPA Ambient Water Quality Criteria for Mercury (1984)

U.S. EPA 1986 - U.S. EPA Quality Criteria for Water 1986 (EPA 440/5-86-001)

Basin Plan - San Francisco Bay Basin Water Quality Control Plan (SFBRWQCB 2013).

*Site-specific WQO exist for tributaries to Bay, but not within the Bay itself

**TMDL development ongoing

Additionally, objectives for mercury and PCBs in fish apply to San Francisco Bay (Table 5-2). The mercury objective for fish tissue only applies to marine waters. Compliance with the human health quality objective for mercury in San Francisco Bay is evaluated in the five most commonly consumed fish species. The mercury concentration in the edible portion of these five species is averaged and compared to the human health water quality objective. The PCBs numeric target (also referred to as the TMDL target) in fish applies to all segments of San Francisco Bay. The PCBs numeric target, which is intended to protect both human health and wildlife, is an average fish tissue concentration of 10 micrograms total PCBs per kilogram of typically consumed fish (on a wet weight basis). Attainment of the total PCBs fish tissue numeric target will also protect human health and wildlife for dioxin-like PCBs.

Table 5-2 - Objectives for Mercury and PCBs in fish (Basin Plan for the San Francisco Bay Basin 2010)

Compound	Aim	Objectives	Tissue	Species	Size class (length)
Hg	Protection of human health	0.2 mg/kg wet weight	Edible portion	<ul style="list-style-type: none"> • Jacksmelt • White croaker • Striped bass • CA halibut • White sturgeon 	<ul style="list-style-type: none"> • 25 cm • 25 cm • 60 cm • 75 cm • 135 cm
Hg	Protection of aquatic organisms and wildlife	0.03 mg/kg wet weight	Whole fish	Not specified	3 to 5 cm
PCBs	Protection of human health and wildlife	10 ug/kg wet weight	Edible portion	White croaker	20 to 30 cm
PCBs	Protection of human health and wildlife	10 ug/kg wet weight	Edible portion	Surfperch	10 to 15 cm

Element 6 Program Tasks Description

6.1 Work Statement and Produced Products

To address the management questions posed, the RMP Status and Trends component regularly conducts sampling of various environmental matrices annually or less frequently. This work is planned and performed under the guidance of the RMP Steering and Technical Review Committees, which are composed of environmental regulators and representatives of local stakeholders.

Data from Status and Trends monitoring efforts are made available for download via the RMP website, incorporated into RMP reports for non-technical (e.g., Pulse of the Estuary) and technical audiences (e.g., Annual Monitoring Results report), and used for published manuscripts in the peer reviewed literature. These data are subsequently incorporated into statewide compilations or web portals of environmental data, such as the California Environmental Data Exchange Network (CEDEN) or the state's My Water Quality website (www.mywaterquality.ca.gov).

6.2 Constituents to be Monitored and Reported

RMP Status and Trends monitoring data will include collection, measurement, and reporting of different parameters and typically include the following information:

Station location (latitude and longitude)

Station sampling date and time

Matrix sampled (water, sediment, or biological tissue)

Parameter measurements (Table 6-1)

Collection and analytical methods

Qualifiers and comments (applied by analytical labs or by RMP staff in data review)

Table 6-1. RMP Target Parameters and Reporting Units

Field Measures – CTD¹ Meter (Water, Sediment and Bivalve Cruises)	Reporting Units
Backscatter	FTU ²
Electrical Conductivity	S ³ /m
Temperature	°C
Density	g/L
Oxygen, Dissolved	mg/L
Pressure	dbar
Salinity	PSU ⁴
Field Measures - Shipboard (Water Cruise)	Reporting Units
Oxygen, Dissolved	mg/L
pH	pH
Salinity	Ppt
Specific Conductivity	uS/cm
Temperature	°C
Field Measures - Shipboard (Sediment Cruise)	Reporting Units
*pH from interstitial water in undisturbed section of sediment grab	
pH*	pH
Eh	mV

¹ CTD = Conductivity, Temperature, Depth

² FTU = Formazin Turbidity Unit

³ S = Siemens

⁴ PSU = Practical Salinity Unit

[Basis codes: dw=dry weight, ww=wet weight]

Conventional Water Quality Parameters	Reporting Units
Ammonium as N	mg/L
Chlorophyll a	ug/L
Dissolved Organic Carbon	ug/L
Hardness as CaCO ₃	mg/L
Nitrate as N	mg/L
Nitrite as N	mg/L
Oxygen, Dissolved	mg/L
Particulate Organic Carbon	ug/L
pH	pH
Phaeophytin a	ug/L
Orthophosphate as P	mg/L
Salinity	PSU
Silica as SiO ₂	mg/L
Specific Conductivity	uS/cm
Suspended Sediment Concentration	mg/L
Temperature	°C
Conventional Sediment Quality Parameters	Reporting Units
[**Sum of Clay and Silt] [***Sum of all Sand fractions]	
% Solids	%
Collection Depth	m
Nitrogen, Total	% dw
Total Organic Carbon	% dw
Clay <0.0039 mm	% dw
Fine** <0.0625 mm	% dw
Granule + Pebble 2.0 to <64 mm	% dw
Sand, V. Fine 0.0625 to <0.125 mm	% dw
Sand, Fine 0.125 to <0.25 mm	% dw
Sand, Medium 0.25 to <0.5 mm	% dw
Sand, Coarse 0.5 to <1.0 mm	% dw
Sand, V. Coarse 1.0 to <2.0 mm	% dw

Sand*** 0.0625 to <2.0 mm	% dw
Silt 0.0039 to <0.0625 mm	% dw
Sediment Toxicity Parameters – Homogenate (RMP tests CHIR⁵, EOHA⁶ and HYAL⁷) SD = Standard Deviation, AF = Assessment Factor	Reporting Units
Mean % Survival	%
SD - Mean % Survival	%
Mean mg/Individual (AF Growth)	mg
Mean mg/Individual (Growth)	mg
Sediment Toxicity Parameters - Surface Water Interface (RMP tests MCAL⁸)	Reporting Units
SWI Mean % Normal Alive	%
SWI SD - Mean % Normal Alive	%
Water Toxicity Parameters – Sample Water (RMP tests <i>Americamysis bahia</i>)	Reporting Units
Biomass (wt/orig indiv)	mg/ind
Survival	%
Tissue Parameters 1. Reported with Trace Metals 2. Reported with Trace Organics 3. Reported for bivalves	Reporting Units
% Solids ¹	% dw
% Survival per Species ³	% dw
% Survival per Species (caged) ³	% dw
Dry Weight ³	g
Dry Weight Standard Error ³	g
Growth Mean ³	g
Growth Standard Error ³	g
Lipid	% dw
Moisture ²	% dw

⁵ *Chironomus*

⁶ *Eohaustoria*

⁷ *Hyalella*

⁸ *Mytilus californianus*

Trace Metals					
	Bird Eggs	Bivalve Tissue	Sediment	Sport Fish	Water
Aluminum	-	ug/g dw	mg/Kg dw	-	-
Arsenic	-	-	mg/Kg dw	-	ug/L
Cadmium	-	ug/g dw	mg/Kg dw	-	ug/L
Cobalt	-	-	-	-	ug/L
Copper	-	ug/g dw	mg/Kg dw	-	ug/L
Cyanide	-	-	-	-	ug/L
Iron	-	-	mg/Kg dw	-	ug/L
Lead	-	ug/g dw	mg/Kg dw	-	ug/L
Manganese	-	-	mg/Kg dw	-	ug/L
Mercury	ug/g dw	-	mg/Kg dw	ug/g ww	ug/L
Mercury, Methyl	-	-	ug/Kg dw	-	ng/L
Mercury, Acid Labile	-	-	-	-	ug/L
Mercury(II)	-	-	-	-	ug/L
Nickel	-	ug/g dw	mg/Kg dw	-	ug/L
Selenium	ug/g dw	ug/g dw	mg/Kg dw	ug/g ww	ug/L
Silver	-	ug/g dw	mg/Kg dw	-	ug/L
Zinc	-	ug/g dw	mg/Kg dw	-	ug/L

ORGANICS

Dioxins and Furans						
	Reporting Group	Bird Eggs	Bivalve Tissue	Sediment	Sport Fish	Water
HpCDD, 1,2,3,4,6,7,8-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
HxCDD, 1,2,3,4,7,8-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
HxCDD, 1,2,3,6,7,8-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
HxCDD, 1,2,3,7,8,9-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
OCDD, 1,2,3,4,6,7,8,9-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
PeCDD, 1,2,3,7,8-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
TCDD, 2,3,7,8-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
HpCDF, 1,2,3,4,6,7,8-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
HpCDF, 1,2,3,4,7,8,9-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
HxCDF, 1,2,3,4,7,8-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
HxCDF, 1,2,3,6,7,8-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L

Dioxins and Furans						
	Reporting Group	Bird Eggs	Bivalve Tissue	Sediment	Sport Fish	Water
HxCDF, 1,2,3,7,8,9-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
HxCDF, 2,3,4,6,7,8-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
OCDF, 1,2,3,4,6,7,8,9-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
PeCDF, 1,2,3,7,8-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
PeCDF, 2,3,4,7,8-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L
TCDF, 2,3,7,8-	PCDD/F	pg/g ww	-	ug/kg dw	pg/g ww	pg/L

Perfluorinated Compounds (PFC)						
	Reporting Group	Bird Eggs	Bivalve	Sediment	Sport Fish	Water
Perfluorobutanesulfonate	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L
Perfluorobutanoate	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L
Perfluorodecanoate	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L
Perfluorododecanoate	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L
Perfluoroheptanoate	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L
Perfluorohexanesulfonate	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L
Perfluorohexanoate	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L
Perfluorononanoate	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L
Perfluorooctanesulfonamide	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L
Perfluorooctanesulfonate	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L
Perfluorooctanoate	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L
Perfluoropentanoate	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L
Perfluoroundecanoate	Perfluorionate	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	ng/L

Pesticides						
	Reporting Group	Bird Eggs	Bivalve Tissue	Sediment	Sport Fish	Water
Aldrin	Cyclopentadienes	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Chlordane, cis-	Chlordanes	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Chlordane, trans-	Chlordanes	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Chlorpyrifos	Other	-	-	-	ng/g ww	pg/L
Dacthal	Other	ng/g ww	-	-	ng/g ww	pg/L
DDD(o,p')	DDTs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
DDD(p,p')	DDTs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
DDE(o,p')	DDTs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
DDE(p,p')	DDTs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
DDMU(p,p')	DDTs	ng/g ww	-	-	ng/g ww	-

Pesticides						
	Reporting Group	Bird Eggs	Bivalve Tissue	Sediment	Sport Fish	Water
DDT(o,p')	DDTs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
DDT(p,p')	DDTs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Diazinon	Other	-	-	-	ng/g ww	pg/L
Dieldrin	Cyclopentadienes	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Endosulfan I	Other	ng/g ww	-	-	ng/g ww	pg/L
Endosulfan II	Other	-	-	-	-	pg/L
Endosulfan sulfate	Other	-	-	-	-	pg/L
Endrin	Cyclopentadienes	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Fipronil desulfinyl	Other	-	-	ug/kg dw	-	-
Fipronil sulfide	Other	-	-	ug/kg dw	-	-
Fipronil sulfone	Other	-	-	ug/kg dw	-	-
Fipronil	Other	-	-	ug/kg dw	-	-
HCH, alpha	HCHs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
HCH, beta	HCHs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
HCH, delta	HCHs	-	ng/g dw	ug/kg dw	-	pg/L
HCH, gamma	HCHs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Heptachlor	Chlordanes	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Heptachlor Epoxide	Chlordanes	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Hexachlorobenzene	Other	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Mirex	Other	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Nonachlor, cis-	Chlordanes	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Nonachlor, trans-	Chlordanes	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
Oxadiazon	Other	ng/g ww	-	-	ng/g ww	-
Oxychlordane	Chlordanes	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L

Polybrominated Diphenyl Ethers (PBDEs)						
	Reporting Group	Bird Eggs	Bivalve Tissue	Sediment	Sport Fish	Water
PBDE 007	PBDEs	ng/g ww	ng/g dw	ug/kg dw	-	pg/L
PBDE 008	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 010	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 011	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 012	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 013	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L

Polybrominated Diphenyl Ethers (PBDEs)						
	Reporting Group	Bird Eggs	Bivalve Tissue	Sediment	Sport Fish	Water
PBDE 015	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 017	PBDEs	-	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 025	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 028	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 030	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 032	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 033	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 035	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 037	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 047	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 049	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 051	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 066	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 071	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 075	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 077	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 079	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 085	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 099	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 100	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 105	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 116	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 119	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 120	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 126	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 128	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 138	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 140	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 153	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 154	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 155	PBDEs	-	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 166	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 179	PBDEs	ng/g ww			ng/g ww	
PBDE 181	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 183	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 184	PBDEs	ng/g ww			ng/g ww	
PBDE 188	PBDEs	ng/g ww			ng/g ww	
PBDE 190	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 196	PBDEs	-	-	ug/kg dw	-	-

Polybrominated Diphenyl Ethers (PBDEs)						
	Reporting Group	Bird Eggs	Bivalve Tissue	Sediment	Sport Fish	Water
PBDE 197	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 200	PBDEs	ng/g ww	-	-	ng/g ww	-
PBDE 201	PBDEs	ng/g ww	-	-	ng/g ww	-
PBDE 202	PBDEs	ng/g ww	-	-	ng/g ww	-
PBDE 203	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 204	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 205	PBDEs	-	ng/g dw	ug/kg dw	-	pg/L
PBDE 206	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 207	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 208	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PBDE 209	PBDEs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L

Polychlorinated Biphenyls (PCBs)						
	Reporting Group	Bird Egg	Bivalve Tissue	Sediment	Sport Fish	Water
PCB 001	PCBs	-	-	ug/kg dw	-	pg/L
PCB 002	PCBs	-	-	ug/kg dw	-	pg/L
PCB 003	PCBs	-	-	ug/kg dw	-	pg/L
PCB 004	PCBs	-	-	ug/kg dw	-	pg/L
PCB 005	PCBs	-	-	ug/kg dw	-	pg/L
PCB 006	PCBs	-	-	ug/kg dw	-	pg/L
PCB 007	PCBs	-	-	ug/kg dw	-	pg/L
PCB 008	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 009	PCBs	-	-	ug/kg dw	-	pg/L
PCB 010	PCBs	-	-	ug/kg dw	-	pg/L
PCB 011	PCBs	-	-	-	ng/g ww	-
PCB 012	PCBs	-	-	ug/kg dw	-	pg/L
PCB 013	PCBs	-	-	ug/kg dw	-	pg/L
PCB 014	PCBs	-	-	ug/kg dw	-	pg/L
PCB 015	PCBs	-	-	ug/kg dw	-	pg/L
PCB 016	PCBs	-	-	ug/kg dw	-	pg/L
PCB 017	PCBs	-	-	ug/kg dw	-	pg/L
PCB 018	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 019	PCBs	-	-	ug/kg dw	-	pg/L
PCB 020	PCBs	-	-	ug/kg dw	-	pg/L
PCB 021	PCBs	-	-	ug/kg dw	-	pg/L
PCB 022	PCBs	-	-	ug/kg dw	-	pg/L
PCB 023	PCBs	-	-	ug/kg dw	-	pg/L
PCB 024	PCBs	-	-	ug/kg dw	-	pg/L

Polychlorinated Biphenyls (PCBs)						
	Reporting Group	Bird Egg	Bivalve Tissue	Sediment	Sport Fish	Water
PCB 025	PCBs	-	-	ug/kg dw	-	pg/L
PCB 026	PCBs	-	-	ug/kg dw	-	pg/L
PCB 027	PCBs	ng/g ww	-	ug/kg dw		pg/L
PCB 028	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 029	PCBs	ng/g ww	-	ug/kg dw		pg/L
PCB 030	PCBs	-	-	ug/kg dw	-	pg/L
PCB 031	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 032	PCBs	-	-	ug/kg dw	-	pg/L
PCB 033	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 034	PCBs	-	-	ug/kg dw	-	pg/L
PCB 035	PCBs	-	-	ug/kg dw	-	pg/L
PCB 036	PCBs	-	-	ug/kg dw	-	pg/L
PCB 037	PCBs	-	-	ug/kg dw	-	pg/L
PCB 038	PCBs	-	-	ug/kg dw	-	pg/L
PCB 039	PCBs	-	-	ug/kg dw	-	pg/L
PCB 040	PCBs	-	-	ug/kg dw	-	pg/L
PCB 041	PCBs	-	-	ug/kg dw	-	pg/L
PCB 042	PCBs	-	-	ug/kg dw	-	pg/L
PCB 043	PCBs	-	-	ug/kg dw	-	pg/L
PCB 044	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 045	PCBs	-	-	ug/kg dw	-	pg/L
PCB 046	PCBs	-	-	ug/kg dw	-	pg/L
PCB 047	PCBs	-	-	ug/kg dw	-	pg/L
PCB 048	PCBs	ng/g ww	-	ug/kg dw	-	pg/L
PCB 049	PCBs	-	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 050	PCBs	-	-	ug/kg dw	-	pg/L
PCB 051	PCBs	-	-	ug/kg dw	-	pg/L
PCB 052	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 053	PCBs	-	-	ug/kg dw	-	pg/L
PCB 054	PCBs	-	-	ug/kg dw	-	pg/L
PCB 055	PCBs	-	-	ug/kg dw	-	pg/L
PCB 056	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 057	PCBs	-	-	ug/kg dw	-	pg/L
PCB 058	PCBs	-	-	ug/kg dw	-	pg/L
PCB 059	PCBs	-	-	ug/kg dw	-	pg/L
PCB 060	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 061	PCBs	-	-	ug/kg dw	-	pg/L
PCB 062	PCBs	-	-	ug/kg dw	-	pg/L
PCB 063	PCBs	-	-	ug/kg dw	-	pg/L

Polychlorinated Biphenyls (PCBs)						
	Reporting Group	Bird Egg	Bivalve Tissue	Sediment	Sport Fish	Water
PCB 064	PCBs	ng/g ww	-	ug/kg dw		pg/L
PCB 065	PCBs	-	-	ug/kg dw	-	pg/L
PCB 066	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 067	PCBs	-	-	ug/kg dw	-	pg/L
PCB 068	PCBs	-	-	ug/kg dw	-	pg/L
PCB 069	PCBs	-	-	ug/kg dw	-	pg/L
PCB 070	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 071	PCBs	-	-	ug/kg dw	-	pg/L
PCB 072	PCBs	-	-	ug/kg dw	-	pg/L
PCB 073	PCBs	-	-	ug/kg dw	-	pg/L
PCB 074	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 075	PCBs	-	-	ug/kg dw	-	pg/L
PCB 076	PCBs	-	-	ug/kg dw	-	pg/L
PCB 077	PCBs	ng/g ww	-	ug/kg dw	-	pg/L
PCB 078	PCBs	-	-	ug/kg dw	-	pg/L
PCB 079	PCBs	-	-	ug/kg dw	-	pg/L
PCB 080	PCBs	-	-	ug/kg dw	-	pg/L
PCB 081	PCBs	-	-	ug/kg dw	-	pg/L
PCB 082	PCBs	-	-	ug/kg dw	-	pg/L
PCB 083	PCBs	-	-	ug/kg dw	-	pg/L
PCB 084	PCBs	-	-	ug/kg dw	-	pg/L
PCB 085	PCBs	-	-	ug/kg dw	-	pg/L
PCB 086	PCBs	-	-	ug/kg dw	-	pg/L
PCB 087	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 088	PCBs	-	-	ug/kg dw	-	pg/L
PCB 089	PCBs	-	-	ug/kg dw	-	pg/L
PCB 090	PCBs	-	-	ug/kg dw	-	pg/L
PCB 091	PCBs	-	-	ug/kg dw	-	pg/L
PCB 092	PCBs	-	-	ug/kg dw	-	pg/L
PCB 093	PCBs	-	-	ug/kg dw	-	pg/L
PCB 094	PCBs	-	-	ug/kg dw	-	pg/L
PCB 095	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 096	PCBs	-	-	ug/kg dw	-	pg/L
PCB 097	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 098	PCBs	-	-	ug/kg dw	-	pg/L
PCB 099	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 100	PCBs	-	-	ug/kg dw	-	pg/L
PCB 101	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 102	PCBs	-	-	ug/kg dw	-	pg/L

Polychlorinated Biphenyls (PCBs)						
	Reporting Group	Bird Egg	Bivalve Tissue	Sediment	Sport Fish	Water
PCB 103	PCBs	-	-	ug/kg dw	-	pg/L
PCB 104	PCBs	-	-	ug/kg dw	-	pg/L
PCB 105	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 106	PCBs	-	-	ug/kg dw	-	pg/L
PCB 107	PCBs	-	-	ug/kg dw	-	pg/L
PCB 108	PCBs	-	-	ug/kg dw	-	pg/L
PCB 109	PCBs	-	-	ug/kg dw	-	pg/L
PCB 110	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 111	PCBs	-	-	ug/kg dw	-	pg/L
PCB 112	PCBs	-	-	ug/kg dw	-	pg/L
PCB 113	PCBs	-	-	ug/kg dw	-	pg/L
PCB 114	PCBs	ng/g ww	-	ug/kg dw	ng/g ww	pg/L
PCB 115	PCBs	-	-	ug/kg dw	-	pg/L
PCB 116	PCBs	-	-	ug/kg dw	-	pg/L
PCB 117	PCBs	-	-	ug/kg dw	-	pg/L
PCB 118	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 119	PCBs	-	-	ug/kg dw	-	pg/L
PCB 120	PCBs	-	-	ug/kg dw	-	pg/L
PCB 121	PCBs	-	-	ug/kg dw	-	pg/L
PCB 122	PCBs	-	-	ug/kg dw	-	pg/L
PCB 123	PCBs	-	-	ug/kg dw	-	pg/L
PCB 124	PCBs	-	-	ug/kg dw	-	pg/L
PCB 125	PCBs	-	-	ug/kg dw	-	pg/L
PCB 126	PCBs	ng/g ww	-	ug/kg dw	-	pg/L
PCB 127	PCBs	-	-	ug/kg dw	-	pg/L
PCB 128	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 129	PCBs	-	-	ug/kg dw	-	pg/L
PCB 130	PCBs	-	-	ug/kg dw	-	pg/L
PCB 131	PCBs	-	-	ug/kg dw	-	pg/L
PCB 132	PCBs	-	ng/g dw	ug/kg dw	-	pg/L
PCB 133	PCBs	-	-	ug/kg dw	-	pg/L
PCB 134	PCBs	-	-	ug/kg dw	-	pg/L
PCB 135	PCBs	-	-	ug/kg dw	-	pg/L
PCB 136	PCBs	-	-	ug/kg dw	-	pg/L
PCB 137	PCBs	ng/g ww	-	ug/kg dw	ng/g ww	pg/L
PCB 138	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 139	PCBs	-	-	ug/kg dw	-	pg/L
PCB 140	PCBs	-	-	ug/kg dw	-	pg/L
PCB 141	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L

Polychlorinated Biphenyls (PCBs)						
	Reporting Group	Bird Egg	Bivalve Tissue	Sediment	Sport Fish	Water
PCB 142	PCBs	-	-	ug/kg dw	-	pg/L
PCB 143	PCBs	-	-	ug/kg dw	-	pg/L
PCB 144	PCBs	-	-	ug/kg dw	-	pg/L
PCB 145	PCBs	-	-	ug/kg dw	-	pg/L
PCB 146	PCBs	ng/g ww	-	ug/kg dw		pg/L
PCB 147	PCBs	-	-	ug/kg dw	-	pg/L
PCB 148	PCBs	-	-	ug/kg dw	-	pg/L
PCB 149	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 150	PCBs	-	-	ug/kg dw	-	pg/L
PCB 151	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 152	PCBs	-	-	ug/kg dw	-	pg/L
PCB 153	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 154	PCBs	-	-	ug/kg dw	-	pg/L
PCB 155	PCBs	-	-	ug/kg dw	-	pg/L
PCB 156	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 157	PCBs	ng/g ww	-	ug/kg dw	ng/g ww	pg/L
PCB 158	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 159	PCBs	-	-	ug/kg dw	-	pg/L
PCB 160	PCBs	-	-	ug/kg dw	-	pg/L
PCB 161	PCBs	-	-	ug/kg dw	-	pg/L
PCB 162	PCBs	-	-	ug/kg dw	-	pg/L
PCB 163	PCBs	-	-	ug/kg dw	-	pg/L
PCB 164	PCBs	-	-	ug/kg dw	-	pg/L
PCB 165	PCBs	-	-	ug/kg dw	-	pg/L
PCB 166	PCBs	-	-	ug/kg dw	-	pg/L
PCB 167	PCBs	-	-	ug/kg dw	-	pg/L
PCB 168	PCBs	-	-	ug/kg dw	-	pg/L
PCB 169	PCBs	ng/g ww	-	ug/kg dw	-	pg/L
PCB 170	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 171	PCBs	-	-	ug/kg dw	-	pg/L
PCB 172	PCBs	-	-	ug/kg dw	-	pg/L
PCB 173	PCBs	-	-	ug/kg dw	-	pg/L
PCB 174	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 175	PCBs	-	-	ug/kg dw	-	pg/L
PCB 176	PCBs	-	-	ug/kg dw	-	pg/L
PCB 177	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 178	PCBs	-	-	ug/kg dw	-	pg/L
PCB 179	PCBs	-	-	ug/kg dw	-	pg/L
PCB 180	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L

Polychlorinated Biphenyls (PCBs)						
	Reporting Group	Bird Egg	Bivalve Tissue	Sediment	Sport Fish	Water
PCB 181	PCBs	-	-	ug/kg dw	-	pg/L
PCB 182	PCBs	-	-	ug/kg dw	-	pg/L
PCB 183	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 184	PCBs	-	-	ug/kg dw	-	pg/L
PCB 185	PCBs	-	-	ug/kg dw	-	pg/L
PCB 186	PCBs	-	-	ug/kg dw	-	pg/L
PCB 187	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 188	PCBs	-	-	ug/kg dw	-	pg/L
PCB 189	PCBs	ng/g ww	-	ug/kg dw	-	pg/L
PCB 190	PCBs	-	-	ug/kg dw	-	pg/L
PCB 191	PCBs	-	-	ug/kg dw	-	pg/L
PCB 192	PCBs	-	-	ug/kg dw	-	pg/L
PCB 193	PCBs	-	-	ug/kg dw	-	pg/L
PCB 194	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 195	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 196	PCBs	-	-	ug/kg dw	-	pg/L
PCB 197	PCBs	-	-	ug/kg dw	-	pg/L
PCB 198	PCBs	ng/g ww	-	ug/kg dw	-	pg/L
PCB 199	PCBs	ng/g ww	-	ug/kg dw	-	pg/L
PCB 200	PCBs	ng/g ww	-	ug/kg dw	-	pg/L
PCB 201	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 202	PCBs	-	-	ug/kg dw	-	pg/L
PCB 203	PCBs	ng/g ww	ng/g dw	ug/kg dw	ng/g ww	pg/L
PCB 204	PCBs	-	-	ug/kg dw	-	pg/L
PCB 205	PCBs	-	-	ug/kg dw	-	pg/L
PCB 206	PCBs	ng/g ww	-	ug/kg dw	ng/g ww	pg/L
PCB 207	PCBs	-	-	ug/kg dw	-	pg/L
PCB 208	PCBs	ng/g ww	-	ug/kg dw	-	pg/L
PCB 209	PCBs	-	-	ug/kg dw	ng/g ww	pg/L

Polycyclic Aromatic Hydrocarbons (PAHs)						
	Reporting Group	Bird Eggs	Bivalve Tissue	Sediment	Sport Fish	Water
Acenaphthene	LPAH	-	ng/g dw	ug/kg dw	-	pg/L
Acenaphthylene	LPAH	-	ng/g dw	ug/kg dw	-	pg/L
Anthracene	LPAH	-	ng/g dw	ug/kg dw	-	pg/L
Benz(a)anthracene	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Benz(a)anthracenes/Chrysenes, C1-	ALK PAHs	-	ng/g dw	-	-	pg/L

Polycyclic Aromatic Hydrocarbons (PAHs)						
	Reporting Group	Bird Eggs	Bivalve Tissue	Sediment	Sport Fish	Water
Benz(a)anthracenes/Chrysenes, C2-	ALK PAHs	-	ng/g dw	-	-	pg/L
Benz(a)anthracenes/Chrysenes, C3-	ALK PAHs	-	ng/g dw	-	-	pg/L
Benz(a)anthracenes/Chrysenes, C4-	ALK PAHs	-	ng/g dw	-	-	pg/L
Benzo(a)pyrene	HPAH	-	ng/g dw	ug/kg dw	-	pg/L
Benzo(b)fluoranthene	HPAH	-	ng/g dw	ug/kg dw	-	pg/L
Benzo(e)pyrene	HPAH	-	ng/g dw	ug/kg dw	-	pg/L
Benzo(g,h,i)perylene	HPAH	-	ng/g dw	ug/kg dw	-	pg/L
Benzo(k)fluoranthene	HPAH	-	ng/g dw	ug/kg dw	-	pg/L
Biphenyl	LPAH	-	ng/g dw	ug/kg dw	-	pg/L
Chrysene	HPAHs	-	ng/g dw	ug/kg dw	-	pg/L
Chrysenes, C1-	ALK PAHs	-	-	ug/kg dw	-	-
Chrysenes, C2-	ALK PAHs	-	-	ug/kg dw	-	-
Chrysenes, C3-	ALK PAHs	-	-	ug/kg dw	-	-
Chrysenes, C4-	ALK PAHs	-	-	ug/kg dw	-	-
Dibenz(a,h)anthracene	HPAHs	-	ng/g dw	ug/kg dw	-	pg/L
Dibenzothiophene	LPAH	-	ng/g dw	ug/kg dw	-	pg/L
Dibenzothiophenes, C1-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Dibenzothiophenes, C2-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Dibenzothiophenes, C3-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Dimethylnaphthalene, 2,6-	LPAH	-	ng/g dw	ug/kg dw	-	pg/L
Fluoranthene	HPAHs	-	ng/g dw	ug/kg dw	-	pg/L
Fluoranthene/Pyrenes, C1-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Fluorene	LPAHs	-	ng/g dw	ug/kg dw	-	pg/L
Fluorenes, C1-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Fluorenes, C2-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Fluorenes, C3-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Indeno(1,2,3-c,d)pyrene	HPAHs	-	ng/g dw	ug/kg dw	-	pg/L
Methylnaphthalene, 1-	LPAHs	-	ng/g dw	ug/kg dw	-	pg/L
Methylnaphthalene, 2-	LPAHs	-	ng/g dw	ug/kg dw	-	pg/L
Methylphenanthrene, 1-	LPAHs	-	ng/g dw	ug/kg dw	-	pg/L
Naphthalene	LPAHs	-	ng/g dw	ug/kg dw	-	pg/L
Naphthalenes, C1-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Naphthalenes, C2-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Naphthalenes, C3-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Naphthalenes, C4-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Perylene	HPAHs	-	ng/g dw	ug/kg dw	-	pg/L
Phenanthrene	LPAHs	-	ng/g dw	ug/kg dw	-	pg/L
Phenanthrene/Anthracene, C1-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Phenanthrene/Anthracene, C2-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Phenanthrene/Anthracene, C3-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L

Polycyclic Aromatic Hydrocarbons (PAHs)						
	Reporting Group	Bird Eggs	Bivalve Tissue	Sediment	Sport Fish	Water
Phenanthrene/Anthracene, C4-	ALK PAHs	-	ng/g dw	ug/kg dw	-	pg/L
Pyrene	HPAHs	-	ng/g dw	ug/kg dw	-	pg/L
Trimethylnaphthalene, 2,3,5-	LPAHs	-	ng/g dw	ug/kg dw	-	pg/L

Pyrethroids						
	Reporting Group	Bird Eggs	Bivalve Tissue	Sediment	Sport Fish	Water
Allethrin	Pyrethroids	-	-	ug/kg dw	-	-
Bifenthrin	Pyrethroids	-	-	ug/kg dw	-	-
Cyfluthrin, total*	Pyrethroids	-	-	ug/kg dw	-	-
Cyhalothrin, lambda, total*	Pyrethroids	-	-	ug/kg dw	-	-
Cypermethrin, total*	Pyrethroids	-	-	ug/kg dw	-	-
Delta/Tralomethrin	Pyrethroids	-	-	ug/kg dw	-	-
Esfenvalerate/Fenvalerate, total*	Pyrethroids	-	-	ug/kg dw	-	-
Fenpropathrin	Pyrethroids	-	-	ug/kg dw	-	-
Permethrin, cis-	Pyrethroids	-	-	ug/kg dw	-	-
Permethrin, trans-	Pyrethroids	-	-	ug/kg dw	-	-
Phenothrin	Pyrethroids	-	-	ug/kg dw	-	-
Prallethrin	Pyrethroids	-	-	ug/kg dw	-	-
Resmethrin	Pyrethroids	-	-	ug/kg dw	-	-
Tetramethrin	Pyrethroids	-	-	ug/kg dw	-	-
*Sum of individual isomers						

6.3 Project Schedule

Table 6-2 shows the planned schedule for RMP Status & Trends monitoring efforts for the next 5 years.

Table 6-2. Proposed Project Schedule

Element	2013	2014	2015	2016	2017	2018
Benthic Community Assessment		On-hold until further notice				
In-Bay Surface Water	x		x		x	
Surface Sediment		x				x
Bivalves – Organics		x		x		x

Analysis						
Bivalves – Trace Metals Analysis		x				
Bird Egg Analysis			x			x
Sport Fish Analysis		x				
Tributary Loading	x	x	x	x	x	x

6.4 Geographical Scope

Status & Trends: Water and Sediment Sampling

The surface sediment and in-bay surface water samples are collected from probabilistically distributed stations throughout the Bay, with the majority of stations changing each sampling year, and a few fixed historical and probabilistically selected stations repeated in subsequent years. These locations have been selected from a sampling frame of open water areas of the Bay (e.g., not including local rivers and streams, harbors and marinas) with a minimum water depth of 1 foot at Mean Lower Low Water (MLLW). Probabilistically assigned stations planned in any given year may be skipped due to access limitations or safety reasons, e.g., militarily sensitive areas, shallow water access difficulties or underwater hazards, treacherous waves, or currents. Sediment samples are collected during the middle of either the wet season (January through March) or dry season (July through September) in alternate years.

As an example, Figures 6-1 and 6-2 show the sampling location distributions for one recent year for each matrix. Locations of past sampled stations can be obtained in queries of historical data from the RMP on the SFEI website. Planned locations for future sampling can be obtained on request.

Status & Trends: Biota

Transplanted and resident bivalves are collected biennially from 9 fixed locations during the dry season (Figure 6-3). Sport fish are collected quinquennially from five popular fishing locations in the Bay (Figure 6-4). Cormorant and tern eggs are collected triennially from colonies around the Bay (Figures 6-5 and 6-6) to assess piscivorous wildlife risk integrated over large areas of the Bay.

Loadings: Tributaries (Stormwater)

The RMP Small Tributaries Loading Strategy workgroup monitors watershed stations as part of the implementation of the Municipal Regional Permit (MRP)(Figure 6-7). Sites were selected based on information from a reconnaissance study of potential locations. The criteria used for site selection include:

1. Watersheds are representative,
2. Management opportunity to implement POC load reduction actions,
3. Existing permit requirements, and
4. Feasibility of sampling

6.5 Constraints

In addition to the logistical constraints to sampling some areas of the Bay as noted previously, 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 contract laboratories. Target detection limits in this document represent those achieved by laboratories contracted by the RMP in the past and/or levels needed to obtain quantitative measurements of ambient concentrations in a majority of samples.

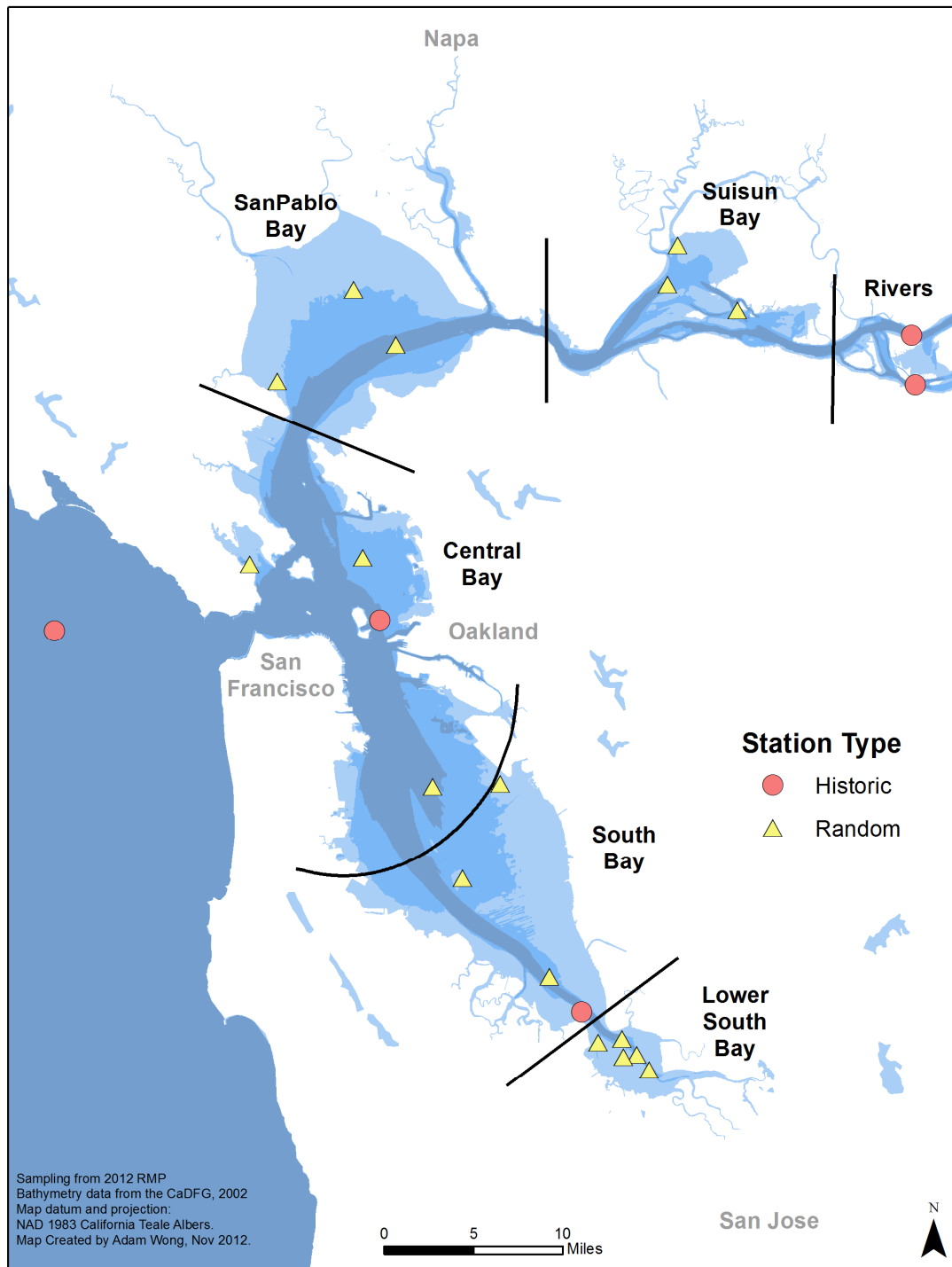


Figure 6-1. 2011 Water Sampling Sites

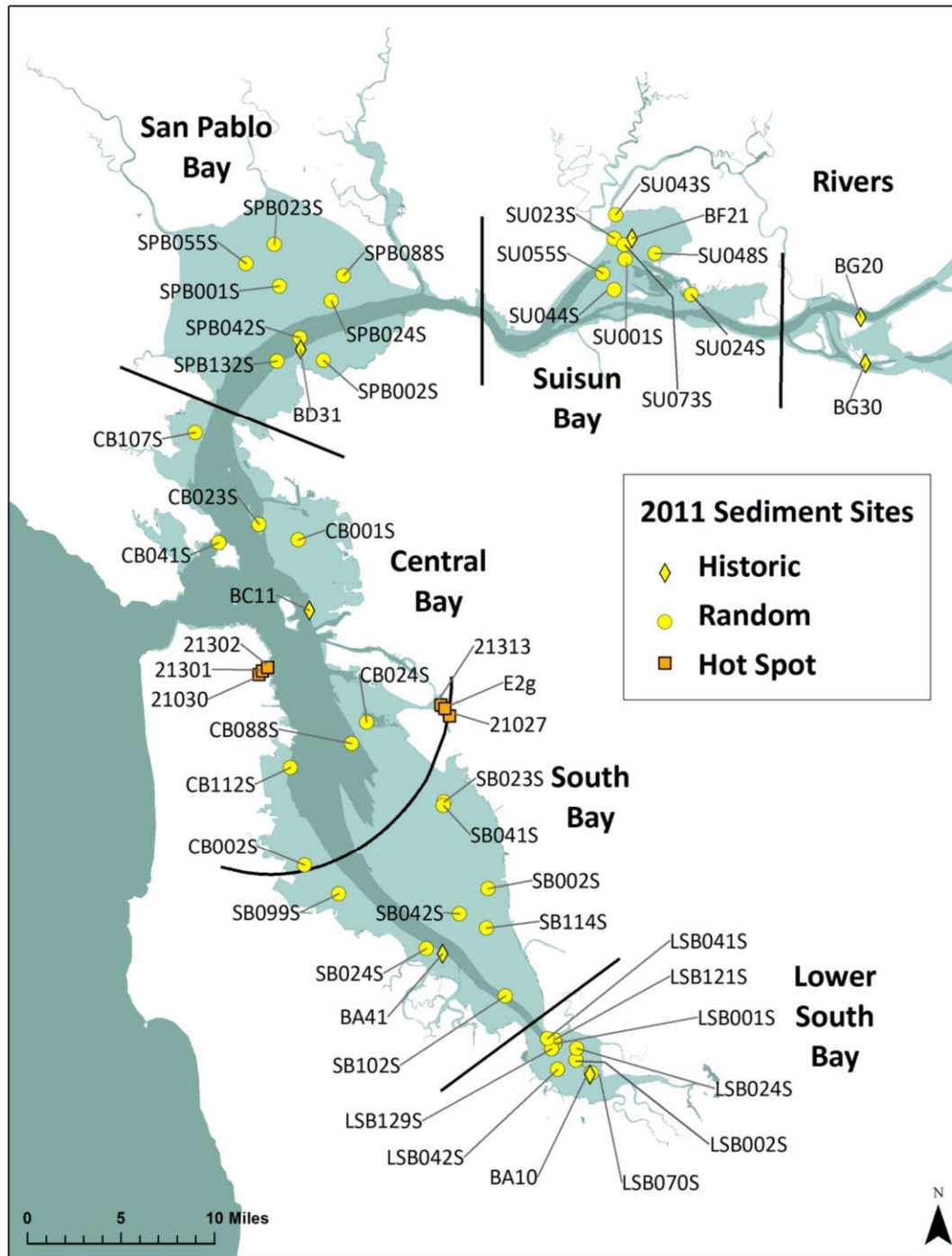


Figure 6-2. 2011 Sediment Sampling Sites

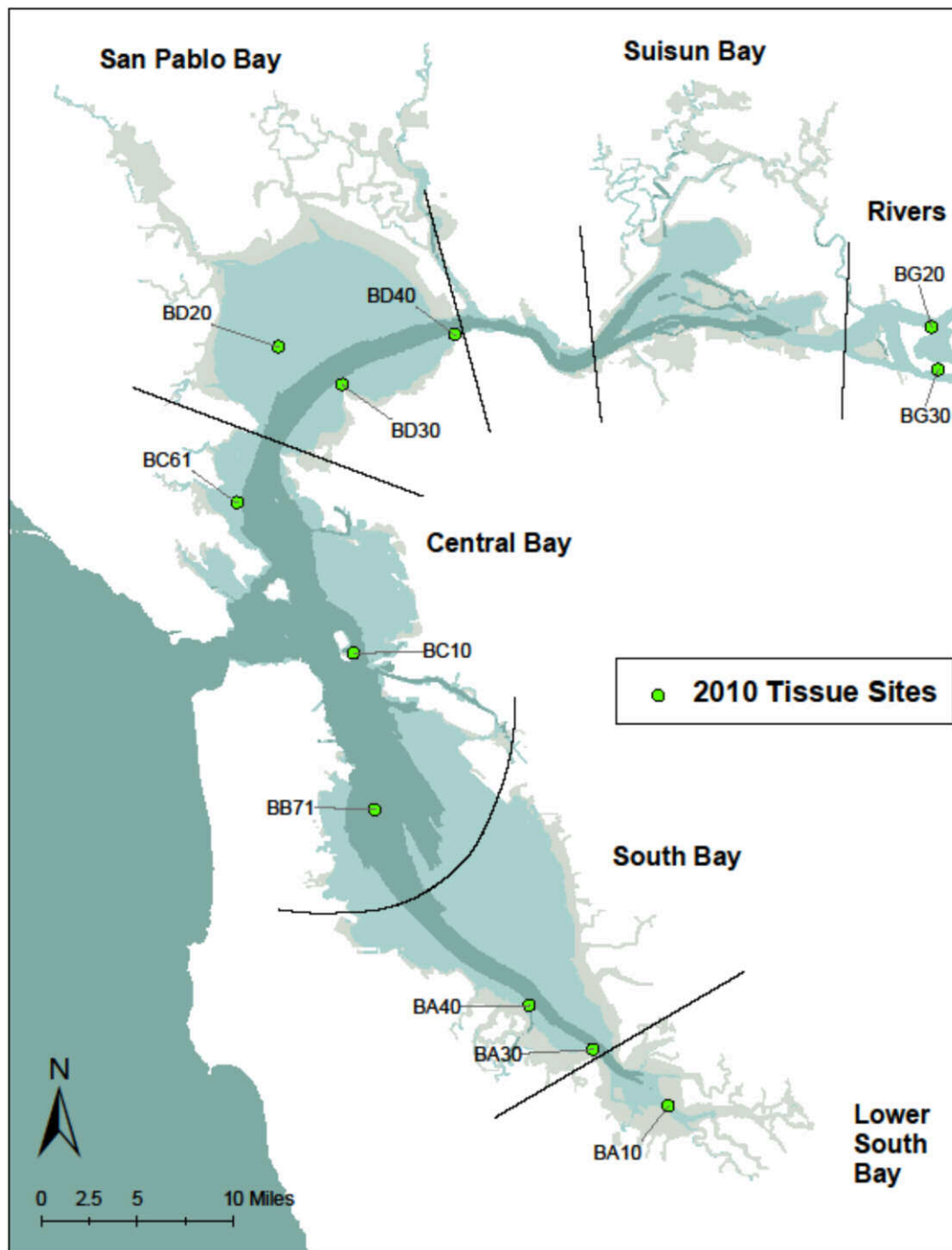


Figure 6-3. 2010 Bivalve Sampling Sites

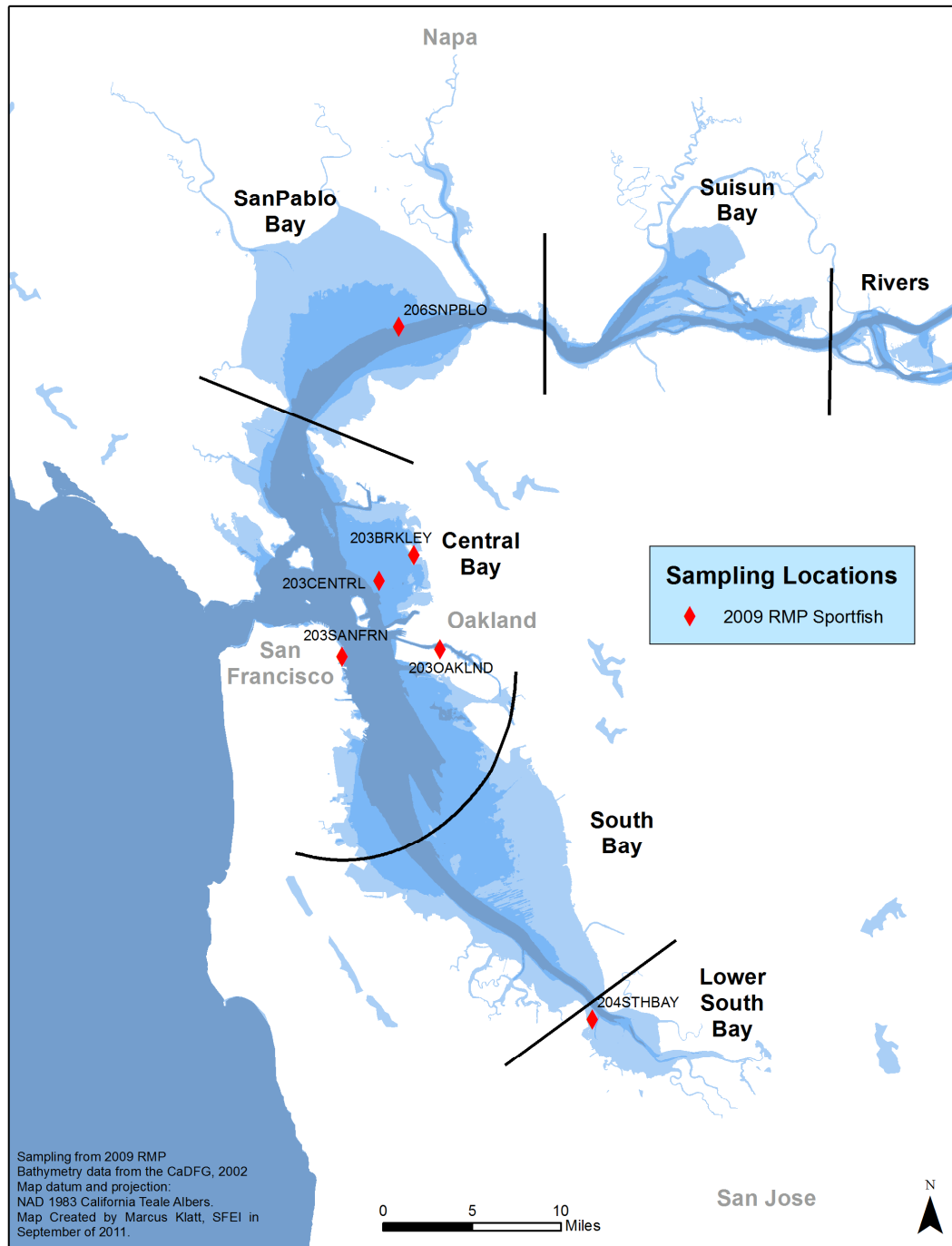


Figure 6-4. 2009 Sportfish Sampling Sites

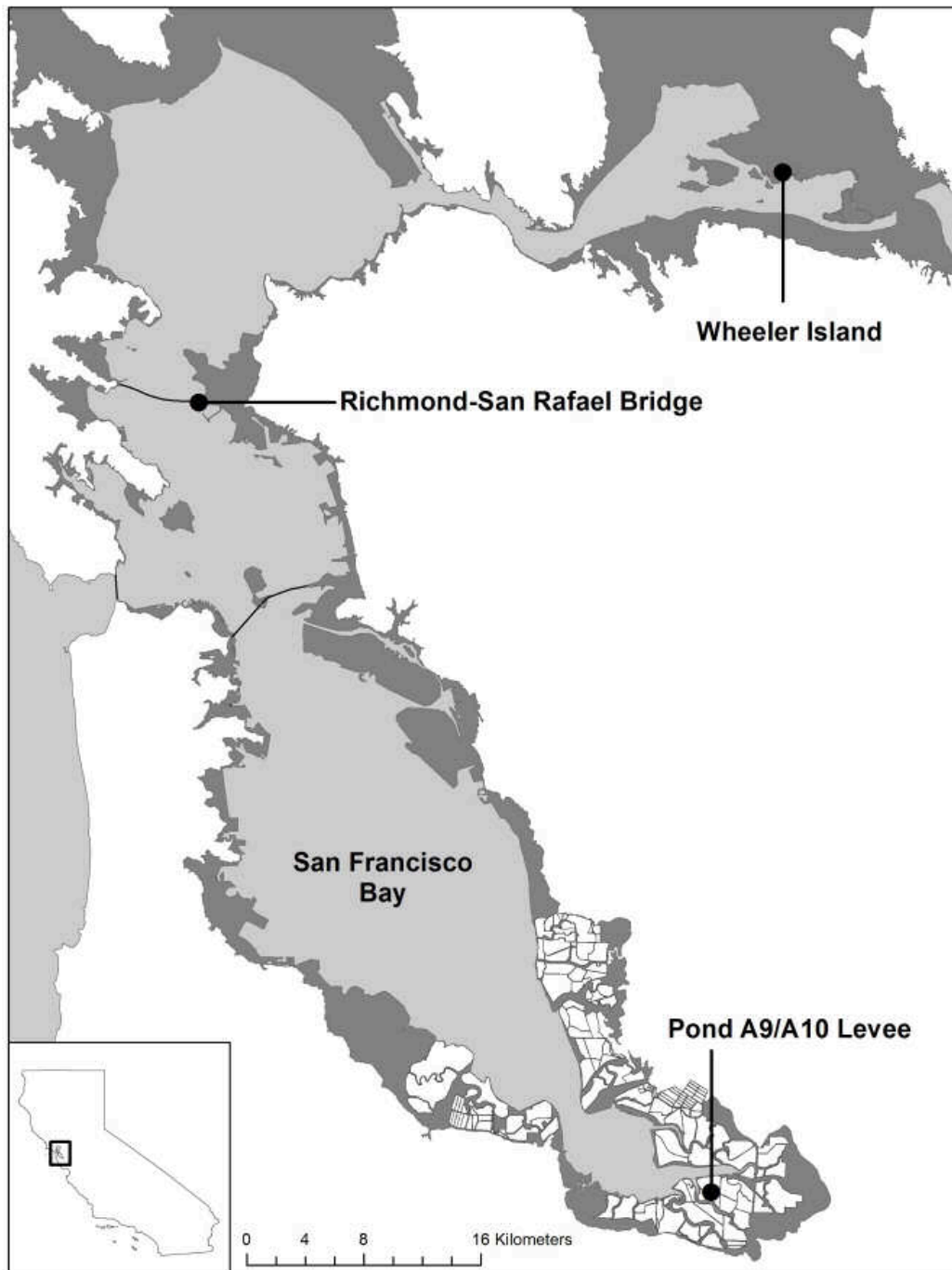


Figure 6-5. 2012 Cormorant Egg Sampling Sites (from *San Francisco Bay Triennial Bird Egg Monitoring Program for Contaminants – 2012 Data Summary*, USGS)

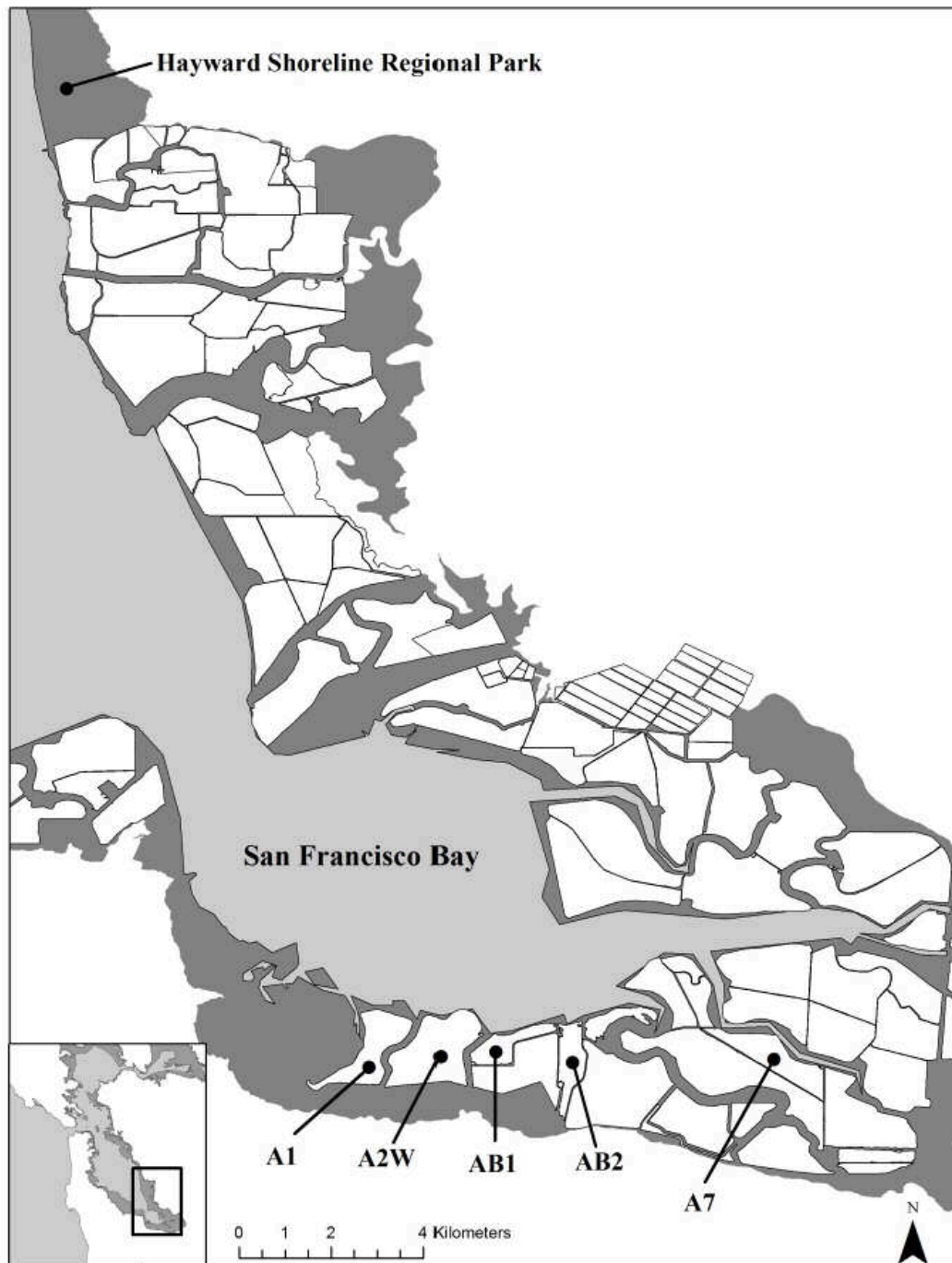


Figure 6-6. 2012 Tern Egg Sampling Sites (from *San Francisco Bay Triennial Bird Egg Monitoring Program for Contaminants – 2012 Data Summary*, USGS)

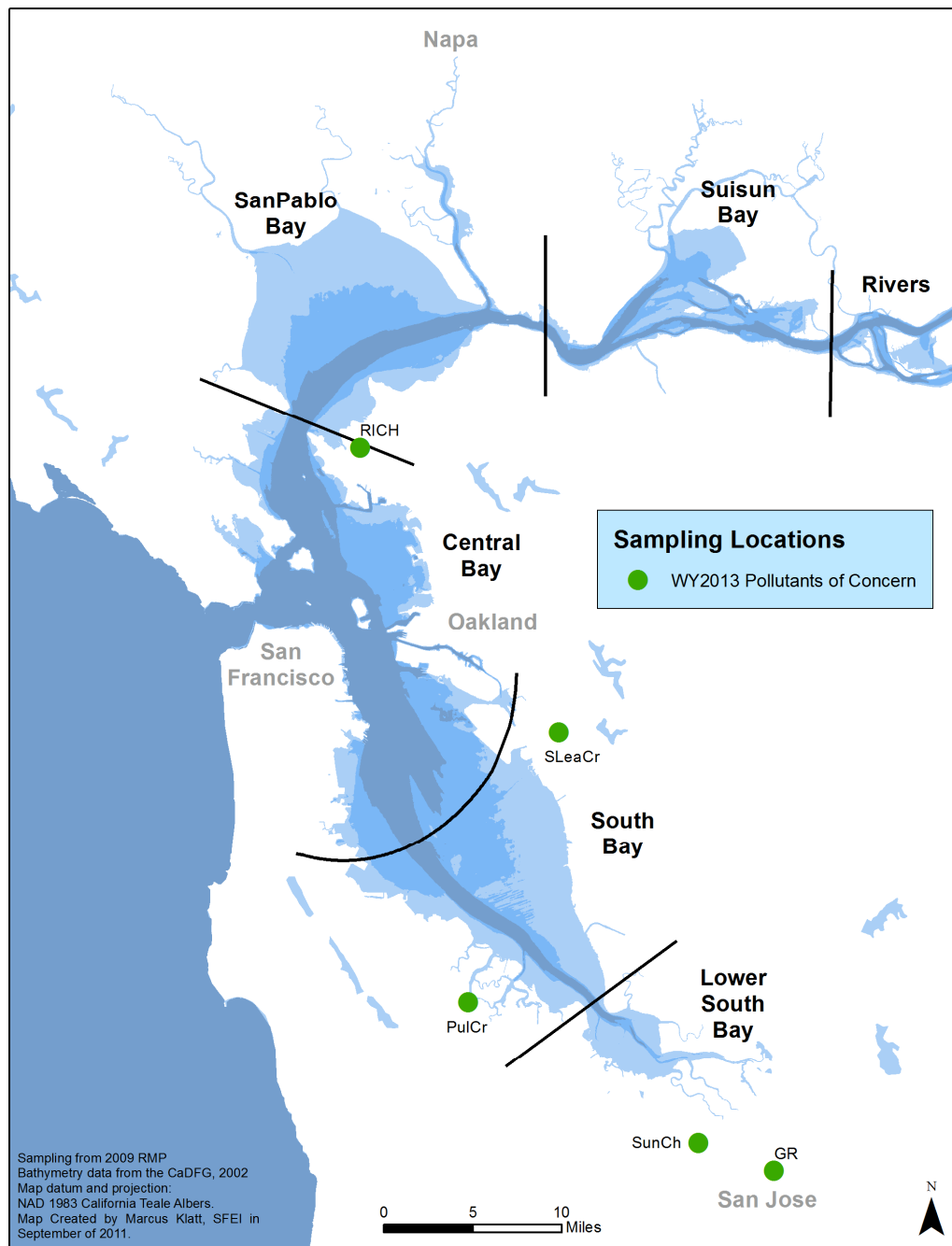


Figure 6-7. Water Year 2013 Pollutants of Concern Stormwater Monitoring Sites: Guadalupe River (GR), North Richmond Pump Station (RICH), Pulgas Creek Pump Station (PulCr), San Leandro Creek (SLeaCr), Sunnyvale East Channel (SunCh).

Element 7 Quality Objectives and Criteria for Measurement Data

Data quality objectives for field and laboratory measurements evaluate the following:

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

The discussion in this section reviews the measurements and procedures expected to demonstrate the quality of reported data.

7.1 Field Performance Measurements

Sensitivity of field measurements is generally fixed 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 to be 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 (pH, conductivity, DO, etc.)), 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.

7.2 Laboratory Performance Measurements

Laboratory performance measurements are included in the analysis stream to check if measurement quality objectives are met. These performance measurements are briefly defined below. 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 Tables in Section 14.

QC measures typically used for evaluation of lab 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 (or internal) Standards: analytes (often isotopes or other substituted analogues of target compounds) introduced to samples to measure and correct for losses and errors introduced during analysis, with recoveries and corrections to reported values generally reported for each sample individually.
4. 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.
5. 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.
6. 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.
7. (Instrument) Replicates: replicate analyses of extracted material or standards that measure the instrumental precision.
8. 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.

These types of QC samples serve to evaluate and diagnose errors introduced during analysis. The remainder of this chapter will provide guidance for general laboratory requirements and protocols for checking and tracking possible sources of errors (outlined above) in the analytical process. Results of both field and lab QC samples will be reviewed by the SFEI QA Officer or designees for conformance with the reporting and data quality requirements.

Sensitivity of lab measurements, expressed as detection or reporting limits, are determined by a combination of factors, often including sample size, extraction efficiency, background contamination, matrix interferences, and instrument sensitivity. Appropriate methods should be chosen that generally allow significant differences between sites or within a site at different times to be reported. For chemical analyses, the ability to detect an analyte at concentrations at least 10 times below any applicable criterion or toxicity threshold, and preferably detected in at least half of all collected samples is generally desired. Such low detection limits are sometimes not achievable due to limitations on currently available instrumentation as well as other practical constraints such as maximum extractable sample size, ubiquitous background contamination, and other factors. In such cases, analyses may proceed with the best currently available methodology, so long as the analyses provide information usable by the RMP (e.g., non-detects or semi-quantitative results providing estimates for upper bounds of possible concentrations), with attention to advances in instruments or methods that can overcome some of these obstacles.

Contamination of samples during field collection and/or during lab preparation and analytical procedures often provides a challenge to detection and quantitation of pollutants in environmental samples. Method blank samples taken through the entire analytical procedure, including containers and glassware, preservatives, reagents, and extraction, concentration, cleanup, and analysis steps and equipment, can determine contamination introduced by some of the steps. Follow-up work investigating these steps individually can be used to isolate and correct or manage the contamination source. Field blanks, collecting a clean matrix (e.g., ultra-pure water) using sampling equipment in the field, or exposing sampling containers and equipment to ambient field conditions, can identify sources of contamination in field collections that may affect collected samples but have not been seen in lab method blanks. If field contamination is found, individual elements of the sample collection process similarly can be isolated to identify and fix causes of sample contamination.

Accuracy of lab measurements is evaluated by measurement of known standards or samples containing the appropriate analytes. Calibration standards and calibration-check samples establish the adequacy of instrument performance, but measurements of accuracy incorporating all preparation, extraction, and cleanup steps are required for evaluating the entire analytical process. When available, certified reference materials in an appropriate similar matrix and concentration range are most preferred, as the certified or reference values provide an external confirmation of the expected concentrations for those samples. However, in some cases, particularly for low level measurements (e.g., hydrophobic organics in water samples) or for newer contaminants of interest reported by relatively few labs, such materials are not available in many or any matrices, so recoveries for other sample types with expected or known values (e.g., LRMs, MSs, LCSs) may be used, but their use as exclusive indicators of measurement accuracy should be discussed with and agreed to by the Project Manager and QAO. In other cases, reference material may be available, but concentrations are much higher than those typically seen locally, so good accuracy on such reference materials provides less assurance of accuracy at lower concentrations. For such instances, other recovery sample types (i.e., LRMs, MSs, LCSs) may supplement to provide a better indication of ongoing measurement accuracy than high concentration certified reference materials alone.

Precision of lab measurements is determined by repeated measurement of an analyte within a single sample (e.g. via lab replicates sub-sampling a homogenous collected sample), or by measurement of field replicates collected simultaneously, in rapid succession, and/or close proximity in a homogenous location. For evaluation of lab performance, lab replicates are preferable, as uncertainty introduced by heterogeneity in the environment by field replicates is minimized. However, for some matrices (e.g., hydrophobic organic compounds in water), low ambient concentrations and consequent large sample size requirements do not allow sub-sampling for lab replicates without loss of measurement sensitivity, requiring use of separately collected field replicates for precision evaluation instead. In other cases where sample size and available material may be limited, other sample types may be used in place of locally field-collected samples as replicates. Such samples can include matrix or blank (LCS) spike replicates (at low levels within ~10x of those typically seen in field samples), larger field samples collected from other locations for other projects, and/or CRMs and LRMs for similar matrices. General constraints for other sample types used for replicate analyses are that 1) the samples be taken through all the same analytical procedures (reagent additions, extractions, drying, etc.) and 2) that concentrations be similar in magnitude (at maximum 100x, preferably 10x or lower) to average project samples.

Completeness of laboratory measurement is evaluated as a percentage of usable measurements out of the total number of measurements desired. At least 90% of measurements should be usable. If a

lower percentage is achieved for any sampling event or time period, the cause(s) shall be investigated and fixed where possible, through instrument maintenance, recalibration, repair, or replacement, and reanalysis of samples as needed. If completeness targets are not achieved, instrumentation and/or laboratory procedures and analytical methods shall be adjusted or changed to improve measurement reliability before the next sampling event or measurement period.

7.3 Laboratory Quality Control Procedures

Performance-based measures for chemical analyses consist of two basic elements: initial demonstration of laboratory capability (e.g., documentation that samples analyses can be performed within the measurement quality objectives) and on-going demonstration of capability during analysis of project samples. Prior to the initial analyses of samples for the project, each laboratory will demonstrate capability and proficiency.

7.3.1 Initial Demonstration of Capability

Initial documentation of method detection limits

Analytical chemists have coined a variety of terms to define “limits” of detection. Keith et al. (1983) and Keith (1991) provide definitions for some of the more commonly used terms. The method detection limit (MDL) represents a quantitative estimate of lowest-level response detectable at the maximum sensitivity of a method. The Code of Federal Regulations (40 CFR Part 136) gives the following definition:

The MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.

The American Society of Testing and Materials (ASTM) defines the limit of detection as:

A concentration of twice the criterion of detection...when it has been decided that the risk of making a Type II error is to be equal to a Type I error.

In order to compare MDLs in quantitative terms by different laboratories participating in analyses, MDLs will initially be determined according to 40 CFR 136.2 (f) and Appendix B of 40 CFR 136 or by a similar exercise of repeated analyses of blank or low-level samples taken through the full analytical process (all steps using all equipment and reagents). Determining the MDL with this procedure is elaborate and need not be determined annually provided that confirmation of MDLs occurs on an annual basis as per revised ISO 17025/NELAP guidance.

Exceptions may be made to this general approach for determination of detection limits, particularly for analytes found at ultra-trace levels (e.g., organic contaminants in ambient water), where MDLs derived by standard procedures above would typically show no detects in ambient samples, if sensitivity and high specificity of the method (e.g., HRMS detection) provide high confidence in the identification of analytes. Use of alternative methods for detection limit determination shall be discussed with the Project Manager and QAO for approval beforehand on a case-by-case basis.

The matrix and the amount of sample (e.g., dry weight of sediment or volume of water) used in calculating the MDL will match as closely as possible the matrix and typical sample amount of the actual field samples. In order to ensure the utility of results, MDL average values are provided (see Tables 7-1 through 7-14). These MDL averages have been derived empirically from previously

reported literature or local monitoring and research efforts (e.g., previous RMP results), with the aim of obtaining semi-quantitative or quantitative results for most samples in the monitored matrices.

The laboratory shall confirm the ability to analyze low-level samples. This shall be accomplished by analyzing a method blank spiked at about 10 times the method detection limit or a reference material in the appropriate range. Recoveries for analyses shall be within $\pm 50\%$ of the target value for 70% or more of the analytes.

Table 7-1 MDL averages for ancillary parameters in analyses of sediment and water.

Matrix - Units	Sediment - % dw	
	Average MDL	Lab – Method
Total Organic Carbon	1.00E-02	CAS - EPA 440
Nitrogen, Total	4.26E+00	CAS - EPA 440

Matrix - Units	Water - mg/L	
	Average MDL	Lab – Method
Ammonium as N	6.00E-03	EBMUD - Solorzano, L., 1969
Dissolved Organic Carbon	1.00E+02	CAS - EPA 9060 / 9060M
Particulate Organic Carbon	5.02E+01	CAS - EPA 9060 / 9060M
Chlorophyll a	3.50E-02	EBMUD - SM 10200 H-2bM

Matrix - Units	Water - mg/L	
	Average MDL	Lab – Method
Suspended Sediment Concentration	9.95E-01	EBMUD - ASTM D3977
Silica as SiO ₂	5.04E-02	EBMUD - SM 4500-SiO ₂ C, EPA 370.1
Pheophytin a	5.82E-02	EBMUD - SM 10200 H-2aM
Hardness as CaCO ₃	1.17E+01	EBMUD - SM 2340 C
Nitrate as N	7.00E-03	EBMUD - EPA 353.2
Nitrite as N	5.00E-03	EBMUD - EPA 353.2
Salinity	7.04E-01	EBMUD - 2520B

Matrix	Water - assorted units
Method	AMS-CA - YSI 556 Water Quality Meter
	Average MDL
Oxygen, Dissolved	0.3 mg/L
pH	1.00E-02
Specific Conductivity	1000 uS/cm
Temperature	0.1 Deg C

Table 7-2 MDL averages for trace elements in analyses of sediment, waters and tissues

Matrix	Sediment - mg/kg dw	
Analyte Name	Average MDL	Lab - Method
Aluminum	1.45E+01	CCSF - EPA 6020AM
Cadmium	3.42E-02	CCSF - EPA 6020AM
Copper	1.20E-01	CCSF - EPA 6020AM
Iron	4.10E+01	CCSF - EPA 6020AM
Lead	2.64E-02	CCSF - EPA 6020AM
Manganese	1.84E-01	CCSF - EPA 6020AM
Nickel	1.37E-01	CCSF - EPA 6020AM
Silver	7.18E-03	CCSF - EPA 6020AM
Zinc	4.95E-01	CCSF - EPA 6020AM
Arsenic	6.58E-01	BR - EPA 1638M
Mercury, Methyl	2.20E-02	BR - EPA 1630M
Mercury	4.55E-03	BR - BR-0002 Rev 010
Selenium	6.49E-02	BR - BR-0020 Rev 007

Matrix	Surface Water - µg/L	
Analyte Name	Average MDL	Lab - Method
Arsenic	3.00E-02	BR - EPA 1640
Cadmium	3.00E-03	BR - EPA 1640
Cobalt	1.64E-02	BR - EPA 1640
Copper	3.00E-02	BR - EPA 1640
Lead	2.53E-02	BR - EPA 1640
Nickel	3.00E-02	BR - EPA 1640
Selenium	4.00E-02	BR - EPA 1640
Silver	2.43E-03	BR - EPA 1640
Zinc	8.51E-02	BR - EPA 1640
Mercury, Methyl	1.01E-02	BR - EPA 1630M
Mercury	1.91E-04	BR - EPA 1631EM
Iron	5.46E+00	BR - EPA 1638M
Manganese	5.09E-01	BR - EPA 1638M
Cyanide	9.10E-01	CCCSD - SM 4500-CN C

Matrix	Stormwater - µg/L	
Analyte Name	Average MDL	Lab - Method
Mercury, Methyl	2.00E-02	CALTEST - EPA 1630
Mercury	2.50E-04	CALTEST - EPA 1631E
Copper	7.00E-02	CALTEST - EPA 1638

Selenium	6.00E-02	CALTEST - EPA 1638
----------	----------	--------------------

Matrix	Bivalves - µg/g dw	
Analyte Name	Average MDL	Lab - Method
Aluminum	1.02E+00	CCSF - EPA 6020AM
Arsenic	8.00E-02	CCSF - EPA 6020AM
Cadmium	2.32E-02	CCSF - EPA 6020AM
Copper	6.23E-02	CCSF - EPA 6020AM
Iron	5.12E+00	CCSF - EPA 6020AM
Lead	1.14E-02	CCSF - EPA 6020AM
Manganese	2.70E-02	CCSF - EPA 6020AM
Nickel	1.21E-01	CCSF - EPA 6020AM
Selenium	4.43E-02	CCSF - EPA 6020AM
Silver	6.75E-03	CCSF - EPA 6020AM
Zinc	3.10E-01	CCSF - EPA 6020AM
Selenium	3.24E-01	BR - EPA 1638M

Matrix	Bird Eggs - µg/g ww	
Analyte Name	Average MDL	Lab - Method
Mercury	3.75E-03	MPSL-DFG - EPA 7473
Selenium	9.60E-01	MPSL-DFG - EPA 200.8
Mercury	4.00E-03	USGS-WERC - EPA 7473

Matrix	Sportfish - µg/g ww	
Analyte Name	Average MDL	Lab - Method
Mercury	1.20E-02	MPSL-DFG - EPA 7473
Selenium	1.50E-01	MPSL-DFG - 200.8

Table 7-3 MDL averages for alkylated polycyclic aromatic hydrocarbons (AlkPAHs) in analyses of sediment, waters and tissues.

Matrix	Sediment - ug/kg dw	Water -pg/L	Stormwater - pg/L	Bivalves - ng/g dw	Bird Eggs - ng/g ww	Sportfish - ng/g ww
Method	EBMUD - EPA 8270M	AXYS - MLA- 021 Rev 07-08	AXYS MLA-021 Rev 10	AXYS - MLA- 021 Rev 08	None (Not Analyzed)	None (Not Analyzed)
	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
Benz(a)anthracenes/Chrysenes, C1-		3.84E+01	5.26E+03	9.46E-02		
Benz(a)anthracenes/Chrysenes, C2-		5.80E+01	3.16E+03	9.13E-02		
Benz(a)anthracenes/Chrysenes, C3-		2.31E+01	8.77E+02	7.48E-02		
Benz(a)anthracenes/Chrysenes, C4-		2.45E+01	5.81E+02	8.11E-02		
Chrysenes, C1-	1.45E+00					
Chrysenes, C2-	1.45E+00					
Chrysenes, C3-	1.45E+00					
Chrysenes, C4-	1.45E+00					
Dibenzothiophenes, C1-	1.45E+00	4.05E+01	5.63E+02	4.37E-01		
Dibenzothiophenes, C2-	1.45E+00	5.42E+01	6.71E+02	6.84E-01		
Dibenzothiophenes, C3-	1.45E+00	5.39E+01	5.19E+02	6.89E-01		
Fluoranthene/Pyrenes, C1-	1.45E+00	5.42E+01	2.74E+03	1.11E-01		
Fluorenes, C1-	1.45E+00	1.86E+02	1.34E+03	2.93E-01		
Fluorenes, C2-	1.45E+00	1.22E+02	1.55E+03	1.73E-01		
Fluorenes, C3-	1.45E+00	1.64E+02	1.22E+03	1.73E-01		
Naphthalenes, C1-	1.45E+00	5.38E+01	3.77E+02	1.23E-01		
Naphthalenes, C2-	1.45E+00	1.03E+02	6.34E+02	4.22E-01		
Naphthalenes, C3-	1.45E+00	7.39E+01	2.97E+02	1.41E-01		
Naphthalenes, C4-	1.45E+00	1.10E+02	7.52E+02	3.09E-01		
Nonachlor, cis-	6.02E-04	6.01E+00		3.18E-02		
Phenanthrene/Anthracene, C1-	1.45E+00	4.03E+01	3.35E+02	8.13E-02		
Phenanthrene/Anthracene, C2-	1.45E+00	5.95E+01	5.33E+02	2.13E-01		
Phenanthrene/Anthracene, C3-	1.45E+00	7.22E+01	5.70E+02	3.68E-01		
Phenanthrene/Anthracene, C4-	1.45E+00	1.64E+02	1.64E+03	1.30E+00		

Table 7-4 MDL averages for PAHs in analyses of sediment, waters and tissues.

Matrix	Sediment - ug/kg dw	Water -pg/L	Bivalves - ng/g dw	Stormwater - pg/L	Bird Eggs - ng/g ww	Sportfish - ng/g ww
Method	EBMUD - EPA 8270M	AXYS - MLA-021 Rev 07-08	AXYS - MLA-021 Rev 08	AXYS MLA-021 Rev 10	None (Not Analyzed)	None (Not Analyzed)
	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
Acenaphthene	1.73E+00	5.50E+01	8.82E-02	1.56E+03		
Acenaphthylene	1.59E+00	3.48E+01	6.74E-02	1.02E+03		
Anthracene	1.20E+00	4.00E+01	9.09E-02	1.04E+03		
Benz(a)anthracene	5.49E-01	2.34E+01	2.07E-01	9.99E+03		
Benzo(a)pyrene	2.17E+00	5.31E+01	1.79E-01	1.51E+03		
Benzo(b)fluoranthene	3.04E+00	3.35E+01	1.20E-01	6.80E+02		
Benzo(e)pyrene	2.46E+00	4.68E+01	1.51E-01	1.14E+03		
Benzo(g,h,i)perylene	1.10E+00	5.80E+01	1.77E-01	1.14E+03		
Benzo(k)fluoranthene	3.32E+00	4.17E+01	1.51E-01			
Benzo(j/k)fluoranthene				7.87E+02		
Biphenyl	7.66E-01	3.93E+01	7.50E-02	2.96E+02		
Chrysene	1.33E+00	2.83E+01	9.00E-02	4.34E+02		
Chrysenes, C1-	1.45E+00					
Chrysenes, C2-	1.45E+00					
Chrysenes, C3-	1.45E+00					
Dibenz(a,h)anthracene	1.39E+00	5.94E+01	1.66E-01	2.49E+03		
Dibenzothiophene	1.30E+00	3.66E+01	6.37E-02	9.12E+02		
Dibenzothiophenes, C1-	1.45E+00	4.05E+01	4.37E-01	5.63E+02		
Dibenzothiophenes, C2-	1.45E+00	5.42E+01	6.84E-01	6.71E+02		
Dibenzothiophenes, C3-	1.45E+00	5.39E+01	6.89E-01	5.19E+02		
Dimethylnaphthalene, 2,6-	2.89E+00	8.34E+01	1.53E-01	5.40E+02		
Fluoranthene	1.45E+00	3.35E+01	6.10E-02	3.92E+02		
Fluoranthene/Pyrenes, C1-	1.45E+00	5.42E+01	1.11E-01	2.74E+03		
Fluorene	1.88E+00	4.48E+01	5.91E-02	1.00E+03		

Matrix	Sediment - ug/kg dw	Water -pg/L	Bivalves - ng/g dw	Stormwater - pg/L	Bird Eggs - ng/g ww	Sportfish - ng/g ww
Method	EBMUD - EPA 8270M	AXYS - MLA-021 Rev 07-08	AXYS - MLA-021 Rev 08	AXYS MLA-021 Rev 10	None (Not Analyzed)	None (Not Analyzed)
Fluorenes, C1-	1.45E+00	1.86E+02	2.93E-01	1.34E+03		
Fluorenes, C2-	1.45E+00	1.22E+02	1.73E-01	1.55E+03		
Fluorenes, C3-	1.45E+00	1.64E+02	1.73E-01	1.22E+03		
Indeno(1,2,3-c,d)pyrene	1.33E+00	5.95E+01	1.48E-01	1.24E+03		
Methylnaphthalene, 1-	1.42E+00	5.70E+01	3.16E-01	4.07E+02		
Methylnaphthalene, 2-	7.37E-01	5.39E+01	1.23E-01	3.77E+02		
Methylphenanthrene, 1-	1.43E+00	4.05E+01	8.13E-02	3.35E+02		
Naphthalene	2.31E+00	1.01E+02	2.10E-01	4.38E+02		
Naphthalenes, C1-	1.45E+00	5.38E+01	1.23E-01	3.77E+02		
Naphthalenes, C2-	1.45E+00	1.03E+02	4.22E-01	6.34E+02		
Naphthalenes, C3-	1.45E+00	7.39E+01	1.41E-01	2.97E+02		
Naphthalenes, C4-	1.45E+00	1.10E+02	3.09E-01	7.52E+02		
Perylene	2.02E+00	5.65E+01	1.76E-01	3.08E+03		
Phenanthrene	7.23E-01	3.99E+01	6.98E-02	2.70E+02		
Phenanthrene/Anthracene, C1-	1.45E+00	4.03E+01	8.13E-02	3.35E+02		
Phenanthrene/Anthracene, C2-	1.45E+00	5.95E+01	2.13E-01	5.33E+02		
Phenanthrene/Anthracene, C3-	1.45E+00	7.22E+01	3.68E-01	5.70E+02		
Phenanthrene/Anthracene, C4-	1.45E+00	1.64E+02	1.30E+00	1.64E+03		
Pyrene	2.31E+00	3.32E+01	1.80E-01	3.87E+02		
Trimethylnaphthalene, 2,3,5-	2.17E+00	7.14E+01	1.12E-01	2.66E+02		

Table 7-5 MDL averages for PBDEs in analyses of sediment, waters and tissues.

Matrix	Sediment - ug/kg dw	Water - pg/L	Stormwater - pg/L	Bivalves - ng/g dw	Bird Eggs - ng/g ww	Sportfish - ng/g ww
Method	EBMUD - EPA 1614M	AXYS - MLA-033 Rev 03-05	AXYS - MLA-033 Rev 06	AXYS - MLA-033 Rev 04	DFG-WPCL - EPA 8081BM	DFG-WPCL - EPA 8081BM
	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
PBDE 007	9.80E-04	9.20E-02	4.62E-01	4.82E-03		
PBDE 008	7.83E-04	7.16E-02	4.91E-01	3.67E-03		
PBDE 010	3.23E-03	1.02E-01	4.87E-01	5.30E-03		
PBDE 012	5.38E-04	6.40E-02	5.10E-01	3.25E-03		
PBDE 015	3.61E-04	5.68E-02	4.00E-01	2.66E-03		
PBDE 017	4.39E-04	8.98E-02	3.40E+00	6.48E-03	4.84E-02	1.22E-01
PBDE 025					4.84E-02	1.47E-01
PBDE 028	4.28E-04	7.81E-02	1.29E+00	5.54E-03	4.84E-02	1.46E-01
PBDE 030	1.71E-03	9.32E-02	1.56E+00	6.91E-03	4.84E-02	1.20E-01
PBDE 032	1.21E-03	7.84E-02	1.63E+00	5.36E-03		
PBDE 033					4.84E-02	9.62E-02
PBDE 035	2.71E-04	6.65E-02	2.23E+01	4.43E-03		
PBDE 037	3.67E-04	6.39E-02	1.33E+00	4.29E-03		
PBDE 047	2.94E-04	3.83E-02	4.06E-01	9.81E-04	4.84E-02	2.23E-01
PBDE 049	3.34E-04	4.64E-02	4.22E-01	1.28E-03	4.84E-02	1.33E-01
PBDE 051	2.29E-04	3.73E-02	1.35E+00	9.52E-04		
PBDE 066	4.08E-04	5.11E-02	4.41E-01	1.39E-03	4.84E-02	1.69E-01
PBDE 071	5.16E-04	4.45E-02	1.79E+00	1.19E-03		
PBDE 075	2.06E-04	4.19E-02	3.47E+00	1.08E-03		
PBDE 077	2.53E-04	4.04E-02	1.79E+00	1.00E-03		
PBDE 079	2.81E-04	4.63E-02	1.04E+00	1.00E-03		
PBDE 085	1.18E-03	1.49E-01	4.98E+00	1.48E-02	9.69E-02	2.59E-01
PBDE 099	3.55E-03	1.05E-01	3.15E+00	1.06E-02	9.69E-02	
PBDE 100	3.51E-04	7.21E-02	2.26E+00	7.04E-03	9.69E-02	1.22E-01

Matrix	Sediment - ug/kg dw	Water - pg/L	Stormwater - pg/L	Bivalves - ng/g dw	Bird Eggs - ng/g ww	Sportfish - ng/g ww
Method	EBMUD - EPA 1614M	AXYS - MLA-033 Rev 03-05	AXYS - MLA-033 Rev 06	AXYS - MLA-033 Rev 04	DFG-WPCL - EPA 8081BM	DFG-WPCL - EPA 8081BM
PBDE 105	1.22E-03	2.00E-01	7.27E+00	1.85E-02		
PBDE 116	1.06E-03	2.64E-01	9.64E+00	2.55E-02		
PBDE 119	6.49E-04	1.61E-01	8.16E+00	1.68E-02		
PBDE 126	5.98E-04	9.93E-02	3.17E+00	1.02E-02		
PBDE 128	2.12E-03	3.65E-01	5.99E+01	1.84E-02		
PBDE 138	2.44E-03	1.36E-01	4.34E+00	4.90E-03	9.69E-02	1.33E-01
PBDE 140	7.94E-04	7.88E-02	3.10E+00	3.06E-03		
PBDE 153	8.57E-04	9.31E-02	2.60E+00	3.32E-03	9.69E-02	1.23E-01
PBDE 154	6.31E-04	5.33E-02	1.76E+00	2.20E-03	9.69E-02	1.50E-01
PBDE 155	7.28E-04	5.32E-02	1.72E+00	2.23E-03		
PBDE 179					1.94E-01	2.10E-01
PBDE 181	7.33E-04	2.25E-01	2.20E+01	1.12E-02		
PBDE 183	4.22E-03	1.26E-01	1.21E+01	6.05E-03	1.94E-01	3.42E-01
PBDE 184					1.94E-01	1.12E-01
PBDE 188					1.94E-01	1.51E-01
PBDE 190	1.89E-03	4.04E-01	4.12E+01	1.99E-02	1.94E-01	2.59E-01
PBDE 196	9.26E-03					
PBDE 197	2.31E-03	4.69E-01	2.01E+01	9.91E-03		
PBDE 200					1.94E-01	1.56E-01
PBDE 201					1.94E-01	1.36E-01
PBDE 202					1.94E-01	2.46E-01
PBDE 203	3.25E-03	6.22E-01	6.00E+01	1.31E-02	1.94E-01	2.93E-01
PBDE 204	4.52E-03					
PBDE 205	4.86E-03	1.08E+00	1.03E+02	2.58E-02		
PBDE 206	1.21E-02	5.11E-01	8.46E+01	1.46E-02	4.84E-01	5.99E-01
PBDE 207	2.62E-03	5.16E-01	9.81E+01	1.48E-02	4.84E-01	1.06E+00

Matrix	Sediment - ug/kg dw	Water - pg/L	Stormwater - pg/L	Bivalves - ng/g dw	Bird Eggs - ng/g ww	Sportfish - ng/g ww
Method	EBMUD - EPA 1614M	AXYS - MLA-033 Rev 03-05	AXYS - MLA-033 Rev 06	AXYS - MLA-033 Rev 04	DFG-WPCL - EPA 8081BM	DFG-WPCL - EPA 8081BM
PBDE 208	2.54E-03	6.00E-01	1.06E+02	1.83E-02	4.84E-01	8.35E-01
PBDE 209	1.34E-02	5.73E+00	3.99E+01	2.43E-01	1.94E+00	2.64E+00

Table 7-6 MDL averages for PCBs in analyses of sediment, waters and tissues

Matrix	Sediment - ug/kg dw	Water -pg/L	Stormwater - pg/L	Bivalves - ng/g dw	Bird Eggs - ng/g ww	Sportfish - ng/g ww
Method	EBMUD - EPA 1668A	AXYS - MLA-010 Rev 08-10	AXYS MLA-010 Rev 11	AXYS - MLA-010 Rev 9	DFG-WPCL - EPA 8082M	DFG-WPCL - EPA 8082M
	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
PCB 001	6.96E-04	3.44E-02				
PCB 002	6.18E-04	3.56E-02				
PCB 003	5.52E-04	3.71E-02				
PCB 004	1.81E-03	1.16E-01				
PCB 005	1.02E-03	7.54E-02				
PCB 006	1.00E-03	6.60E-02				
PCB 007	9.52E-04	6.73E-02				
PCB 008	9.69E-04	1.68E-01	1.38E+00	2.08E-03	1.94E-01	1.98E-01
PCB 009	1.07E-03	6.59E-02				
PCB 010	9.79E-04	6.20E-02				
PCB 011	1.00E-03	9.09E-02	0.00E+00		0.00E+00	1.98E-01
PCB 013	1.01E-03	9.05E-02				
PCB 014	8.73E-04	6.92E-02				
PCB 015	8.43E-04	7.56E-02				
PCB 016	3.68E-04	3.51E-02				
PCB 017	2.82E-04	3.21E-02				
PCB 018	1.95E-04	3.42E-02	4.82E-01	4.18E-04	1.94E-01	1.98E-01
PCB 019	3.69E-04	3.72E-02				
PCB 022	3.03E-04	4.00E-02				
PCB 023	3.03E-04	3.76E-02				
PCB 024	2.25E-04	3.38E-02				
PCB 025	3.01E-04	3.39E-02				
PCB 026	3.01E-04	4.76E-02				

Matrix	Sediment - ug/kg dw	Water -pg/L	Stormwater - pg/L	Bivalves - ng/g dw	Bird Eggs - ng/g ww	Sportfish - ng/g ww
PCB 027	2.09E-04	3.34E-02	0.00E+00		1.94E-01	1.98E-01
PCB 028	1.85E-04	3.85E-02	6.02E-01	6.94E-04	1.94E-01	1.98E-01
PCB 031	1.70E-04	3.68E-02	5.65E-01	6.40E-04	1.94E-01	1.98E-01
PCB 032	2.03E-04	3.61E-02				
PCB 033	1.86E-04	3.75E-02	5.72E-01	6.57E-04	1.94E-01	1.98E-01
PCB 034	3.05E-04	3.83E-02				
PCB 035	5.76E-04	4.18E-02				
PCB 036	5.39E-04	3.74E-02				
PCB 037	4.90E-04	4.09E-02				
PCB 038	5.43E-04	3.79E-02				
PCB 039	4.88E-04	3.81E-02				
PCB 040	6.58E-04	3.12E-02				
PCB 041	8.50E-04					
PCB 042	7.44E-04	3.13E-02				
PCB 043	6.48E-04	3.38E-02				
PCB 044	3.63E-04	3.63E-02	5.53E-01	5.56E-04	1.94E-01	1.98E-01
PCB 045	3.89E-04	3.11E-02				
PCB 046	4.49E-04	3.37E-02				
PCB 048	6.77E-04	3.12E-02				
PCB 049	3.18E-04	3.49E-02	5.32E-01	5.17E-04	1.94E-01	1.98E-01
PCB 052	3.59E-04	3.73E-02	5.71E-01	5.90E-04	1.94E-01	1.98E-01
PCB 053	3.72E-04	3.06E-02				
PCB 054	2.46E-04	2.82E-02				
PCB 055	7.50E-04	5.56E-02				
PCB 056	4.53E-04	8.35E-02	1.05E+00	6.61E-03	1.94E-01	1.98E-01
PCB 057	6.87E-04	5.38E-02				
PCB 058	6.89E-04	5.47E-02				
PCB 059	5.04E-04	2.71E-02				

Matrix	Sediment - ug/kg dw	Water -pg/L	Stormwater - pg/L	Bivalves - ng/g dw	Bird Eggs - ng/g ww	Sportfish - ng/g ww
PCB 060	4.50E-04	8.42E-02	1.02E+00	6.33E-03	1.94E-01	1.98E-01
PCB 063	6.41E-04	5.20E-02				
PCB 064	4.89E-04	2.64E-02	0.00E+00		1.94E-01	1.98E-01
PCB 066	4.44E-04	7.77E-02	9.64E-01	6.27E-03	6.19E-01	1.98E-01
PCB 067	6.71E-04	4.82E-02				
PCB 068	5.98E-04	5.34E-02				
PCB 070	4.30E-04	7.93E-02	9.48E-01	5.97E-03	2.91E-01	2.98E-01
PCB 072	6.60E-04	5.18E-02				
PCB 077	5.14E-04	5.63E-02	0.00E+00		1.94E-01	1.98E-01
PCB 078	7.58E-04	5.65E-02				
PCB 079	6.02E-04	4.77E-02				
PCB 080	6.15E-04	5.04E-02				
PCB 081	5.13E-04	5.94E-02				
PCB 082	8.30E-04	4.84E-02				
PCB 083	5.64E-04		0.00E+00		0.00E+00	0.00E+00
PCB 084	5.62E-04	4.81E-02				
PCB 085	6.05E-04	3.90E-02				
PCB 087	3.81E-04	4.65E-02	9.43E-01	2.45E-03	2.91E-01	2.98E-01
PCB 089	5.15E-04	4.55E-02				
PCB 091	4.68E-04	4.37E-02				
PCB 092	4.99E-04	4.45E-02				
PCB 093	4.75E-04		0.00E+00		0.00E+00	0.00E+00
PCB 094	4.97E-04	4.67E-02				
PCB 095	3.76E-04	5.06E-02	1.08E+00	2.65E-03	2.91E-01	2.98E-01
PCB 096	3.26E-04	2.89E-02				
PCB 099	3.51E-04	5.29E-02	1.11E+00	2.95E-03	1.90E+00	1.98E-01
PCB 101	3.64E-04	4.72E-02	9.50E-01	2.46E-03	2.52E+00	5.01E-01
PCB 102	4.66E-04		0.00E+00		0.00E+00	0.00E+00

Matrix	Sediment - ug/kg dw	Water -pg/L	Stormwater - pg/L	Bivalves - ng/g dw	Bird Eggs - ng/g ww	Sportfish - ng/g ww
PCB 103	4.49E-04	4.02E-02				
PCB 104	3.05E-04	3.03E-02				
PCB 105	4.86E-04	9.27E-02	1.63E+00	7.58E-03	1.27E+00	0.00E+00
PCB 106	5.88E-04	6.53E-02				
PCB 109	5.97E-04	6.54E-02				
PCB 110	3.63E-04	4.20E-02	7.92E-01	2.06E-03	2.91E-01	2.98E-01
PCB 111	5.13E-04	3.65E-02				
PCB 112	3.75E-04	3.55E-02				
PCB 114	5.48E-04	7.29E-02	0.00E+00		1.94E-01	1.98E-01
PCB 118	4.53E-04	9.50E-02	1.55E+00	7.33E-03	4.71E+00	3.66E-01
PCB 120	5.37E-04	3.57E-02				
PCB 121	3.53E-04	3.66E-02				
PCB 122	6.10E-04	7.31E-02				
PCB 123	5.37E-04	7.39E-02				
PCB 124	5.90E-04	6.88E-02				
PCB 126	6.29E-04	8.54E-02	0.00E+00		1.94E-01	1.98E-01
PCB 127	5.68E-04	6.99E-02				
PCB 128	4.36E-04	9.32E-02	2.52E+00	1.96E-02	1.90E+00	1.98E-01
PCB 130	5.42E-04	1.03E-01				
PCB 131	4.97E-04	9.61E-02				
PCB 132	3.76E-04	1.16E-01	3.12E+00	2.64E-02	0.00E+00	1.98E-01
PCB 133	4.80E-04	9.27E-02				
PCB 134	5.03E-04	9.57E-02				
PCB 136	2.44E-04	3.04E-02				
PCB 137	3.95E-04	9.55E-02	0.00E+00		1.94E-01	1.98E-01
PCB 138	3.33E-04	9.35E-02	2.49E+00	1.97E-02	7.74E+00	3.29E-01
PCB 139	4.42E-04	8.72E-02				
PCB 141	3.77E-04	1.01E-01	2.77E+00	2.15E-02	1.94E-01	1.98E-01

Matrix	Sediment - ug/kg dw	Water -pg/L	Stormwater - pg/L	Bivalves - ng/g dw	Bird Eggs - ng/g ww	Sportfish - ng/g ww
PCB 142	4.99E-04	9.52E-02				
PCB 144	4.49E-04	3.69E-02				
PCB 145	2.40E-04	3.13E-02				
PCB 146	4.28E-04	8.13E-02	0.00E+00		1.68E+00	1.98E-01
PCB 148	4.40E-04	3.77E-02				
PCB 149	3.01E-04	1.01E-01	2.67E+00	2.13E-02	1.94E-01	1.98E-01
PCB 150	2.36E-04	3.05E-02				
PCB 151	2.28E-04	3.68E-02	8.48E-01	5.66E-04	1.94E-01	1.98E-01
PCB 152	2.27E-04	2.99E-02				
PCB 153	2.94E-04	8.39E-02	2.23E+00	1.77E-02	1.73E+01	1.12E+00
PCB 154	4.09E-04		0.00E+00		0.00E+00	0.00E+00
PCB 155	1.68E-04	2.84E-02				
PCB 156	4.51E-04	1.09E-01	2.49E+00	1.89E-02	0.00E+00	1.98E-01
PCB 158	2.69E-04	7.47E-02	1.94E+00	1.55E-02	4.14E-01	1.98E-01
PCB 159	6.52E-04	7.24E-02				
PCB 160	3.89E-04		0.00E+00		0.00E+00	0.00E+00
PCB 161	3.66E-04	7.01E-02				
PCB 162	6.06E-04	7.39E-02				
PCB 165	4.09E-04	7.84E-02				
PCB 167	4.49E-04	7.25E-02				
PCB 169	4.39E-04	9.09E-02	0.00E+00		1.94E-01	1.98E-01
PCB 170	3.77E-04	4.06E-02	1.00E+00	7.10E-04	2.13E+00	1.98E-01
PCB 171	5.44E-04	4.43E-02				
PCB 172	5.43E-04	4.53E-02				
PCB 174	3.32E-04	3.74E-02	8.18E-01	6.67E-04	0.00E+00	1.98E-01
PCB 175	5.70E-04	4.02E-02				
PCB 176	2.00E-04	3.18E-02				
PCB 177	2.97E-04	3.78E-02	9.01E-01	7.67E-04	1.90E+00	1.98E-01

Matrix	Sediment - ug/kg dw	Water -pg/L	Stormwater - pg/L	Bivalves - ng/g dw	Bird Eggs - ng/g ww	Sportfish - ng/g ww
PCB 178	2.78E-04	4.15E-02				
PCB 179	2.09E-04	3.14E-02				
PCB 180	2.93E-04	3.37E-02	8.01E-01	5.65E-04	9.44E+00	1.98E-01
PCB 181	4.88E-04	4.30E-02				
PCB 182	5.29E-04	3.91E-02				
PCB 183	2.90E-04	3.73E-02	8.21E-01	6.64E-04	2.13E+00	1.98E-01
PCB 184	2.17E-04	3.14E-02				
PCB 186	2.13E-04	3.31E-02				
PCB 187	2.92E-04	3.57E-02	7.92E-01	6.41E-04	5.70E+00	1.98E-01
PCB 188	1.84E-04	3.09E-02				
PCB 189	4.85E-04	4.38E-02	0.00E+00		1.94E-01	1.98E-01
PCB 190	4.34E-04	3.56E-02				
PCB 191	4.21E-04	3.46E-02				
PCB 192	4.37E-04	3.80E-02				
PCB 194	4.56E-04	4.00E-02	9.70E-01	9.78E-04	1.91E+00	1.98E-01
PCB 195	4.88E-04	4.25E-02	1.06E+00	9.89E-04	3.98E-01	1.98E-01
PCB 196	4.42E-04	5.16E-02				
PCB 199	4.65E-04	5.24E-02	0.00E+00		1.94E-01	1.98E-01
PCB 200	3.18E-04	3.77E-02	0.00E+00		1.94E-01	1.98E-01
PCB 201	1.96E-04	3.06E-02	7.04E-01	3.91E-04	2.13E+00	1.98E-01
PCB 202	4.24E-04	4.33E-02				
PCB 203	2.77E-04	3.81E-02	9.55E-01	4.40E-04	1.90E+00	1.98E-01
PCB 204	3.31E-04	3.78E-02				
PCB 205	6.39E-04	4.13E-02				
PCB 206	8.21E-04	6.68E-02	0.00E+00		1.94E-01	1.98E-01
PCB 207	6.04E-04	4.93E-02				
PCB 208	6.23E-04	4.92E-02				
PCB 209	4.71E-04	5.28E-02	0.00E+00		1.94E-01	1.98E-01

Table 7-7 MDL averages for dioxins and furans in analyses of sediment, waters and tissues.

Matrix	Sediment - ug/kg dw	Water -pg/L	Bivalves - ng/g dw	Stormwater - pg/L	Bird Eggs - pg/g ww	Sportfish - pg/g ww
Method	AXYS - MLA-017 Rev 16	AXYS - MLA-017 Rev 16	None (Not Analyzed)	AXYS MLA-017 Rev 20	AXYS MLA-017 Rev 20	AXYS MLA-017 Rev 17
	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
TCDD, 2,3,7,8-	2.94E-05	1.89E-02		1.54E-01	5.74E-02	4.97E-02
PeCDD, 1,2,3,7,8-	3.22E-05	2.25E-02		2.96E-01	5.74E-02	5.05E-02
HxCDD, 1,2,3,4,7,8-	3.09E-05	2.08E-02		1.32E-01	5.74E-02	5.17E-02
HxCDD, 1,2,3,6,7,8-	3.09E-05	2.08E-02		1.32E-01	5.74E-02	5.17E-02
HxCDD, 1,2,3,7,8,9-	3.09E-05	2.08E-02		1.32E-01	5.74E-02	5.17E-02
HpCDD, 1,2,3,4,6,7,8-	4.05E-05	1.46E-02		2.45E-01	5.74E-02	4.95E-02
OCDD, 1,2,3,4,6,7,8,9-	4.34E-05	1.80E-02		1.90E-01	1.89E-01	4.96E-02
TCDF, 2,3,7,8-	6.17E-05	8.28E-03		1.48E-01	6.75E-02	5.98E-02
PeCDF, 1,2,3,7,8-	3.62E-05	1.44E-02		3.17E-01	7.85E-02	5.27E-02
PeCDF, 2,3,4,7,8-	3.62E-05	1.44E-02		1.72E-01	5.74E-02	5.27E-02
HxCDF, 1,2,3,4,7,8-	2.79E-05	1.15E-02		1.24E-01	1.95E-01	5.02E-02
HxCDF, 1,2,3,6,7,8-	2.79E-05	1.15E-02		1.24E-01	5.74E-02	5.02E-02
HxCDF, 1,2,3,7,8,9-	2.79E-05	1.15E-02		1.40E-01	5.74E-02	5.02E-02
HxCDF, 2,3,4,6,7,8-	2.79E-05	1.15E-02		1.24E-01	8.16E-02	5.02E-02
HpCDF, 1,2,3,4,6,7,8-	3.11E-05	1.47E-02		1.54E-01	1.08E-01	4.95E-02
HpCDF, 1,2,3,4,7,8,9-	3.11E-05	1.47E-02		1.54E-01	6.35E-02	4.95E-02
OCDF, 1,2,3,4,6,7,8,9-	2.89E-05	1.71E-02		1.33E-01	8.48E-02	5.09E-02

Table 7-8 MDL averages for perfluorinated compounds in analyses of sediment, waters and tissues.

Matrix	Sediment - ug/Kg dw	Water -pg/L	Bivalves - ng/g dw	Stormwater - pg/L	Bird Eggs - ng/g ww	Sportfish - ng/g ww
Method	None	None	None	None	AXYS – MLA-043 Rev 06	AXYS – MLA0943 Rev 07
	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
Perfluorobutanesulfonate					4.87E+00	4.93E+00
Perfluorobutanoate					2.43E+00	2.46E+00
Perfluorodecanoate					2.43E+00	2.46E+00
Perfluorododecanoate					2.43E+00	2.46E+00
Perfluoroheptanoate					2.43E+00	2.46E+00
Perfluorohexanesulfonate					4.87E+00	4.93E+00
Perfluorohexanoate					2.43E+00	2.46E+00
Perfluorononanoate					2.43E+00	2.46E+00
Perfluorooctanesulfonamide					2.43E+00	2.46E+00
Perfluorooctanesulfonate					4.87E+00	4.93E+00
Perfluorooctanoate					2.43E+00	2.46E+00
Perfluoropentanoate					2.43E+00	2.46E+00
Perfluoroundecanoate					2.43E+00	2.46E+00

Table 7-9 MDL averages for chlordane pesticides in analyses of sediment, waters and tissues.

Matrix	Sediment - ug/Kg dw	Water -pg/L	Water -pg/L	Bivalves - ng/g dw	Stormwater - pg/L	Bird Eggs - ng/g ww	Sportfish - ng/g ww
Method	EBMUD - EPA 1668AM	AXYS - MLA-028 Rev 03	AXYS - MLA-035 Rev 05	AXYS - MLA-028 Rev 05	None (Not Analyzed)	DFG-WPCL - EPA 8081BM	DFG-WPCL - EPA 8081BM
	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
Chlordane, cis-	3.85E-04	2.80E-01	1.55E+01	2.70E-02		3.87E-01	3.97E-01
Chlordane, trans-	3.07E-04	2.49E-01	1.50E+01	2.30E-02		4.36E-01	4.46E-01
Heptachlor	4.65E-04	2.24E-01	2.00E+00	1.66E-02		3.45E-01	3.53E-01
Heptachlor epoxide	3.51E-04	1.13E+00	1.20E+01	1.81E-02		2.38E-01	2.44E-01
Nonachlor, cis-	6.02E-04	5.10E-01	9.64E+00	3.18E-02		2.98E-01	3.06E-01
Nonachlor, trans-	2.43E-04	2.91E-01	1.52E+01	2.95E-02		1.88E-01	1.93E-01
Oxychlordane	5.29E-04	8.82E-01	1.91E+01	4.39E-02		4.59E-01	4.70E-01

Table 7-10 MDL averages for cyclopentadiene pesticides in analyses of sediment, waters and tissues.

Matrix	Sediment - ug/Kg dw	Water -pg/L	Water -pg/L	Bivalves - ng/g dw	Stormwater - pg/L	Bird Eggs - ng/g ww	Sportfish - ng/g ww
Method	EBMUD - EPA 1668AM	AXYS - MLA-028 Rev 03	AXYS - MLA-035 Rev 05	AXYS - MLA-028 Rev 05	None (Not Analyzed)	DFG-WPCL - EPA 8081BM	DFG-WPCL - EPA 8081BM
	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
Aldrin	1.02E-03	2.47E-01	3.35E+00	1.02E-02		4.01E-01	4.11E-01
Dieldrin	1.24E-03	1.23E+00	1.05E+01	1.56E-02		4.18E-01	4.28E-01
Endrin	1.51E-03	2.03E+00	7.75E+00	2.89E-02		1.74E-01	1.79E-01

Table 7-11 MDL averages for DDT pesticides in analyses of sediment, waters and tissues.

Matrix	Sediment - ug/Kg dw	Water -pg/L	Water -pg/L	Bivalves - ng/g dw	Stormwater	Bird Eggs - ng/g ww	Sportfish - ng/g ww
---------------	----------------------------	--------------------	--------------------	---------------------------	-------------------	----------------------------	----------------------------

Method	EBMUD - EPA 1668AM	AXYS - MLA-028 Rev 03	AXYS - MLA-035 Rev 05	AXYS - MLA-028 Rev 05	None (Not Analyzed)	DFG-WPCL - 8081BM	DFG-WPCL - 8081BM
	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
DDD(o,p')	1.39E-03	1.63E+00	1.35E+01	6.09E-02		9.28E-02	9.53E-02
DDD(p,p')	3.40E-04	1.63E+00	1.04E+01	6.96E-02			1.23E-01
DDE(o,p')	8.06E-04	5.91E-01	2.52E+01	1.58E-02		1.72E-01	1.77E-01
DDE(p,p')	1.41E-03	6.71E-01	3.04E+01	1.88E-02		4.65E+01	4.76E-01
DDT(o,p')	2.33E-03	2.23E+00	1.75E+01	1.00E-01		2.09E-01	2.14E-01
DDT(p,p')	2.16E-03	2.33E+00	1.45E+01	1.05E-01		1.51E-01	1.55E-01
DDMU(p,p')						1.05E-01	1.07E-01

Table 7-12 MDL averages for hexachlorohexane pesticides (HCH) in analyses of sediment, waters and tissues.

Matrix	Sediment - ug/Kg dw	Water -pg/L	Water -pg/L	Bivalves - ng/g dw	Stormwater	Bird Eggs - ng/g ww	Sportfish
Method	EBMUD - EPA 1668AM	AXYS - MLA-028 Rev 03	AXYS - MLA-035 Rev 05	AXYS - MLA-028 Rev 05	None (Not Analyzed)	DFG-WPCL - EPA 8081BM	None (Not Analyzed)
	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
HCH, alpha	5.54E-04	6.03E-01	3.56E+00	2.23E-02		0.254	
HCH, beta	7.67E-04	8.08E-01	4.57E+00	3.27E-02		0.203	
HCH, delta	7.90E-04	1.01E+00	3.99E+00	2.09E-02			
HCH, gamma	6.30E-04	6.01E-01	3.62E+00	2.51E-02		0.139	

Table 7-13 MDL averages for pyrethroid pesticides in analyses of sediment, waters and tissues.

Matrix	Sediment - ug/kg dw	Water -pg/L	Bivalves - ng/g dw	Stormwater - pg/L	Stormwater - pg/L	Bird Eggs - ng/g ww	Sportfish - ng/g ww
Method	DFG-WPCL - EPA 8081BM	AXYS - MLA- 035 Rev 05	None (Not Analyzed)	CALTEST - EPA 8270M_NCI	AXYS - AXYS MLA-046 Rev 04	None (Not Analyzed)	None (Not Analyzed)
	Average MDL	Average MDL		Average MDL	Average MDL	Average MDL	Average MDL
Allethrin	1.49E+00			1.34E+02	4.32E+04		
Bifenthrin	2.19E-01			1.42E+02	1.31E+03		
Cyfluthrin, total	2.55E-01			2.75E+02	2.56E+03		
Cyhalothrin, lambda, total	1.66E-01			2.84E+02	7.63E+02		
Cypermethrin, total	3.59E-01	2.88E+01		2.75E+02	8.29E+02		
Deltamethrin/Tralomethrin	1.00E-01			2.75E+02	2.86E+02		
Deltamethrin	3.58E-01						
Esfenvalerate/Fenvalerate, total	2.09E-01			2.75E+02	6.87E+02		
Fenpropathrin	8.27E-01			2.75E+02	2.32E+03		
Permethrin, cis-	7.33E-01						
Permethrin, trans-	1.19E+00						
Permethrin, total		1.93E+02		2.91E+03	4.10E+02		
Phenothrin	1.60E-01				9.44E+02		
Prallethrin	4.30E-01				7.55E+04		
Resmethrin	4.25E-01				4.72E+03		
Tetramethrin	3.05E-01			2.75E+02			
T-Fluvalinate				2.75E+02			

Table 7-14 MDL averages for other pesticides in analyses of sediment, waters and tissues.

Matrix	Sediment - ug/Kg dw	Water -pg/L	Bivalves - ng/g dw	Stormwater - ug/L	Bird Eggs - ng/g ww	Sportfish - ng/g ww
Method	EBMUD - EPA 1668A	None (Not Analyzed)	None (Not Analyzed)	DFG-WPCL - EPA 619M	None (Not Analyzed)	None (Not Analyzed)
Pesticides of Concern	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
Fipronil	4.42E-03			5.00E-04		
Firpnil Desulfinyl	4.29E-03			5.00E-04		
Firpnil Sulfide	4.42E-03			5.00E-04		
Fipronil Sulfone	4.55E-03			5.00E-04		
Method	None (Not Analyzed)	None (Not Analyzed)	None (Not Analyzed)	DFG-WPCL - EPA 632M	None (Not Analyzed)	None (Not Analyzed)
Carbamates	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
Carbaryl				1.00E-02		
Methiocarb				2.00E-03		
Oxamyl				2.00E-03		
Method	EBMUD - EPA 1668A	AXYS - MLA-035 Rev 06	AXYS - MLA-028 Rev 06	None (Not Analyzed)	DFG-WPCL - EPA 8081BM	DFG-WPCL - EPA 8081BM
Organochlorines	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
Methoxychlor					9.69E-01	
Endosulfan I		1.38E+02			5.42E-01	5.55E-01
Hexachlorobenzene		1.63E-02	3.04E-02		3.35E-01	3.43E-01
Mirex	2.15E-02	8.07E+00	3.89E-02		2.91E-01	2.98E-01

Method	DFG-WPCL - EPA 8081BM	AXYS - MLA-035 Rev 06	None (Not Analyzed)	CALTEST - EPA 8270M_NCI	None (Not Analyzed)	DFG-WPCL - EPA 8081BM
Organophosphates	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
Chlorpyrifos		6.20E+01		1.48E+02		2.02E-01
Diazinon		1.42E+02		7.41E+01		4.76E+00
Method	None (Not Analyzed)	AXYS - MLA-035 Rev 06	None (Not Analyzed)	DFG-WPCL - EPA 632M	DFG-WPCL - EPA 8081BM	DFG-WPCL - EPA 8081BM
Herbicides	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL	Average MDL
Diuron				2.00E-03		
Dacthal		2.64E+01			9.36E-02	9.60E-02
Oxadiazon					5.27E-01	5.40E-01

Limits of Quantitation

Taylor (1987) states “a measured value becomes believable when it is larger than the uncertainty associated with it”. The uncertainty associated with a measurement is calculated from the standard deviation of replicate measurements of a low concentration standard or a blank. Normally, the MDL is set at three times the standard deviation of replicate measurements, where the uncertainty of a measurement is approximately $\pm 100\%$ at the 95% level of confidence. Values at the MDL may not reflect a signal much above zero, and therefore are quantitatively not very robust. The limit of quantitation (LOQ), as established by the American Chemical Society, is normally ten times the standard deviation of replicate measurements (about 3 times the MDL), which corresponds to a measurement uncertainty of $\pm 30\%$ (Taylor 1987). By these standard definitions, measurements below the MDL are not believable, measurements between the MDL and the LOQ are only semi-quantitative, and confidence in measurements above the LOQ is high. Average or expected values on QC samples below 3 times the MDL therefore shall not be used in evaluation of laboratory measurement accuracy or precision.

Initial Analysis of Representative Samples

As appropriate, representative sample matrices that are uncompromised, homogeneous, and contain target analytes at relevant (e.g., near typical ambient) concentrations may be used to evaluate performance of analytical laboratories prior to routine analysis of field samples for the RMP. The samples used for this initial demonstration of laboratory capability can be splits used in laboratory inter-comparison exercises, or splits of samples previously or simultaneously analyzed by laboratories with known acceptable performance, or of CRMs with known values. A new laboratory’s performance generally will be considered acceptable if its submitted values are within accuracy and precision MQOs (Table 14-1) for target analytes at concentrations at least three times the project target MDL (\sim LOQ). If the results for the initial analysis fail to meet these criteria, the laboratory may be required to perform corrective actions to meet the performance criteria.

Laboratory inter-comparisons or split sample analyses may not be practical or feasible for some analytes and matrices (e.g., few capable labs, no consensus on expected concentrations). Another option would be a more limited evaluation of selected samples that represent the expected range of values. Results would be compared to an expected range of values obtained from the literature or from similar local/regional studies of comparable sample matrices and locations.

7.2.2 On-going Demonstration of Capability

Participation in Laboratory Inter-comparison Exercises

Laboratories analyzing applicable contaminants are required to participate in inter-comparison exercises conducted jointly by the U.S. National Institute of Standards and Technology (NIST) and the National Research Council Canada (NRCC) or similar parties where available. These exercises provide a tool for validation and improvement of laboratory measurements by helping analysts identify and resolve problems in methodology and/or QA/QC. The results of these exercises are

also used to evaluate both the individual and collective performance of the participating analytical laboratories on a continuing basis and to insure that ongoing measurements are meeting MQOs. Laboratories are required to initiate corrective actions, if their performance in these comparison exercises falls outside pre-determined minimal standards, described in later sections.

In a typical exercise, conducted on an annual or less frequent basis, the coordinating agency will distribute performance evaluation samples of an “unknown” sample and an existing CRM to each laboratory, along with detailed instructions for analysis. Laboratories are required to analyze the sample(s) and submit their results in a timely manner to the agency (as instructed). At the end of each exercise, coordinating personnel at the agency present and discuss the comparison exercise results, with participating laboratories strongly encouraged to participate in subsequent discussions of analytical problems and challenges identified in the inter-comparison exercises.

Routine Analysis of Certified or Laboratory Reference Materials

Certified reference materials generally are considered the most useful QC samples for assessing the accuracy (i.e., measurement relative to a “true” value) of a given analysis. CRMs are desirable because they have “certified” concentrations of the analytes of interest, as determined through replicate analyses by a reputable certifying agency, and/or multiple labs, using two or more independent measurement techniques for verification. In addition, the certifying agency may provide “reference” or “informational” values for other analytes of interest. Such values are determined using a single measurement technique, or a limited number of labs, which may have unrecognized bias and/or large uncertainty. Therefore, non-certified reference values must be used with caution as measures of laboratory performance. A second caution is that “certified” values in some cases is premised on a complete extraction the sample matrix (e.g., HF extraction of a sediment mineral phase), and a partial or less aggressive extraction is unlikely to produce the certified result. In such cases, a CRM may be more equivalent to a laboratory internal reference material described below.

A laboratory reference material (LRM) is similar to a certified reference material in that it is a homogeneous matrix that closely matches the samples being analyzed but is typically only used in-house by a single laboratory or small group of laboratories. Unlike CRMs, concentrations of the analytes of interest in LRMs are not certified, and may be analyzed only by a single method over time. In practice, this material is best used to assess the precision (i.e., consistency) of a single laboratory’s performance over time but may be useful for evaluating accuracy, if the previous result has been shown to be accurate (e.g., in batches with CRMs reported accurately). Thus, if available, LRMs may be preferred for routine (i.e., day to day) analysis because CRMs are relatively expensive.

Routine analyses of CRMs (when available) or LRMs represent a valuable aspect of “performance-based” QC. Where available, certified and reference concentrations of target analytes known to the analyst(s) can be used to provide quick checks of batch performance before proceeding with analyses of subsequent batches. If the laboratory fails to meet precision and/or accuracy MQOs for a CRM or LRM, results for the sample batch may be suspect. Calculations and instruments should be checked; selected samples and the CRM or LRM may have to be reanalyzed to confirm the results. Some minor deviations outside MQOs may be expected, particularly at concentrations near the MDL and for analytes with wide confidence intervals in certified values. However, if MQOs are not achieved in consecutive samples, the laboratory should consult with the SFEI QAO and other parties to identify and correct possible source(s) of the problem. The results of the CRM or LRM analysis should never be used by the laboratory to “correct” the data for a given sample batch.

CRM (or LRM) samples should be analyzed at a minimum frequency of 1 per batch (or one per 20 samples for larger batches) when samples in an appropriate matrix (similar to samples) are available. Multiple CRM sources and/or replicate CRM analyses may help diagnose problems if deviations from desired MQOs or control limits are found. CRM or LRM recovery is calculated as:

$$\text{Recovery} = \frac{\text{Laboratory measurement}}{\text{Certified or Consensus Value}} \times 100\%$$

Accuracy control limits for individual compounds are listed in Table 14-1. The IUPAC Harmonized Protocol for proficiency testing defines “z-scores” for normalizing performance relative to objectives, converting a result to a z-score:

$$z = |\text{result} - \text{expected value}| / \text{acceptable deviation}$$

which is converted into recovery percentages (normalizing everything to the expected value):

$$z = |\text{recovery} - 100\%| / \text{MQO}\%$$

where the MQO% is the accepted deviation (as %) from the expected value (e.g., $\pm 35\%$ of expected value for most organics, $\pm 25\%$ for most trace elements). For each class of analytes (i.e., a group of analytes reported by a single method), at least 70% of the individual analytes should be within the MQO (i.e., a z-score ≤ 1); no individual analyte value should be grossly outside the MQO (z-score > 2 , e.g., $\pm 70\%$ for organics) more than once in consecutive analyses without appropriate documentation and consultation with the SFEI QAO. Due to the inherent variability in analyses near the method detection limit, these limits only apply to analytes with expected values > 3 times the target MDL.

Concentrations of some analytes are provided only as (uncertified) reference values in some commonly used CRMs, and in some cases the acceptance range (e.g., 95% confidence interval) even for certified values of specific analytes may include z-scores > 2 . In such cases, results may still be flagged for large deviations from expected values and uncertainty in quantitation, but should not be censored due to substantial uncertainty in what the underlying “true” expected values are.

Each laboratory is expected to maintain control charts for use by analysts in monitoring the overall accuracy and precision of the CRM or LRM. The relative standard deviation (RSD) will be calculated for each analyte of interest in the CRM based on the last seven or more CRM analyses. Upper and lower control chart limits (e.g., warning limits and control limits) should be based on 7 or more recent results (or initially, the confidence interval/acceptance limits of the CRM issuer) and will be continually updated; control limits for individual measurements based on 99% confidence intervals around the mean are recommended.

Laboratory Replicates for Precision

Precision is the reproducibility of an analytical method and can be evaluated for any sample that is analyzed in replicate. Replicates of field samples are most representative of local concentrations and conditions and thus are preferred indicators of analytical precision. However, analyte concentrations in local ambient samples are often non-detect or near MDLs. If all results are non-detect, precision is clearly not calculable, and if true values are near the MDL, a mix of non-detects and results slightly above MDL may be expected. However, if the average value (substituting a value of zero for any

non-detects) for a set of replicates falls into a quantitative range at least 3 times the MDL (e.g., a non-detect and a value 100 times MDL, with an average value 50 times the MDL), the disparity in results represents a lack of precision and should be considered an indication of either poor precision or an underestimate of the MDL.

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

A minimum of one field sample (or alternative sample type, e.g. MS or CRM/LRM, 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) or relative standard deviation (RSD) among replicate samples will be less than the MQO listed in Table 14-1 for each analyte of interest. RSD and RPD are calculated as:

$$\text{RSD} = \frac{\text{Standard Deviation (all replicatesamples)}}{\text{Average(all replicatesamples)}} \times 100\%$$

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

Similar to z-scores for accuracy, precision may be expressed relative to an MQO as a p-score:

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

If results for any analytes do not meet the MQO for precision ($p\text{-score} > 1$), 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 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 ($p\text{-score} > 1$) or censored if extremely poor ($p\text{-score} > 2$).

Field Replicates and Field Split Samples

As part of the regular quality assurance program of the Project, field replicate samples may be collected, homogenized, and placed in separate sample containers for subsequent chemical analysis as funds allow. Some of the sample containers may be submitted as blind field replicates to the primary analytical laboratory. Others, considered field splits, may be sent to additional laboratories to conduct inter-laboratory comparisons, or for development and testing of laboratory methods. The analysis of field replicates and field splits will provide an assessment of both inter- and intra-laboratory precision and variability in the sample matrix and collection and homogenization methods. In many cases, variability in field replicates represents spatial and/or temporal variability in the environmental matrix being sampled, so field replicates should not be used in place of lab replicates to assess laboratory measurement performance unless the laboratory is in agreement that past results are sufficiently consistent for such use.

Calibration Checks

Initial calibration check samples that are traceable to a recognized organization must be inserted as part of the sample stream. As an indicator of calibration accuracy, the source of the initial calibration check sample shall be independent from the standards used for the calibration and contain all the analytes of interest, and should be at a concentration in the middle of the calibration range.

Continuing calibration checks should also be included as an indication of measurement stability. The source of the continuing checks can be that used in the initial calibration check or the same standards as used for the calibration, as required or recommended by the analytical method. Either may be suitable for demonstrating continued stability of measurement so long as the result is consistent (for either check sample source). The frequency of these checks is dependent on the type of instrumentation used and, therefore, requires considerable professional judgment. All analyses shall be bracketed by acceptable calibration checks. A continuing calibration check shall be run every 12 hours at a minimum.

If the calibration check control limits (set by the laboratory) are not met, the initial calibration will have to be repeated. If possible, any samples analyzed since the last successful calibration check will be reanalyzed following recalibration. If reanalyses of all potentially impacted samples is not planned, reanalyses of samples should progress in reverse order until it is determined that the precision between initial and reanalysis results is within MQOs (Table 14-1). The laboratory will begin by reanalyzing the last sample (or subset of samples) analyzed before the failed calibration check. If the RPD or RSD between the results of this reanalysis and the original analysis exceeds precision MQOs (Tables 14-1), the analytical process is likely to have been out of control during the original analysis. The laboratory will report only results from analyses while the process is in control (i.e., within calibration, or in agreement with other subsequent results obtained while within calibration). If it is not possible to perform reanalysis of samples, all earlier data (i.e., since the last successful calibration control check) are suspect. In this case, the laboratory will flag the data and prepare a narrative explanation to accompany the submitted data.

Laboratory Method Blank

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 or 30% of the lowest reported sample concentration. A method blank concentration $> 2 \times$ the MDL or $> 30\%$ of the lowest reported sample concentration 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, except where $3 \times \text{STDEV}$ of the mean blank measurement can be demonstrated to be less than or equal to the MDL.

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 is to achieve $>95\%$ completeness for all analyses.

Surrogates

The usage of the terms “surrogate”, “injection internal standard”, and “internal standard” varies considerably among laboratories and is clarified here.

Surrogates are non-target analytes chosen to simulate the analytes of interest for estimating analyte losses during the extraction and cleanup process and must be added to each sample, including QA/QC samples, prior to extraction. The reported concentrations of corresponding analytes are adjusted to correct for the recoveries of surrogate compounds, as done in the National Status & Trends (NS&T) Program of the National Oceanic and Atmospheric Administration (NOAA). The surrogate recovery data will be carefully monitored and each laboratory must report the percent recovery of surrogates along with the target analyte data for each sample. If possible, isotopically labeled analogs of the analytes will be used as surrogates.

Each laboratory will set its own warning limit criteria based on the experience and best professional judgment of the analyst(s). It is the responsibility of the analyst(s) to demonstrate that the analytical process is always “in control” (i.e., highly variable surrogate recoveries are not acceptable for repeat analyses of the same certified reference material and for the matrix spike/matrix spike duplicate). The target analytes to which specific surrogates correspond and the warning limit criteria used by the laboratory will be provided in the standard operating procedures submitted.

Internal Standards

Internal standards (also referred to as “injection internal standards” by some analysts) are added to each sample extract just prior to injection to enable optimal quantitation, particularly of complex extracts subject to retention time shifts or instrument interferences relative to the analysis of standards. They are essential, if the actual recovery of the surrogates added prior to extraction is to be calculated. Internal standards can also be used to detect and correct for problems in the injection

port or other parts of the instrument. Internal standard analytes must be different from surrogate analytes. The analyst(s) will monitor internal standard retention times and recoveries to determine if instrument maintenance or repair or changes in analytical procedures are needed. Corrective action will be initiated based on the judgment of the analyst(s). Instrument problems that may have affected the data or resulted in the reanalysis of samples will be documented properly in logbooks and internal data reports and used by the laboratory personnel to take appropriate corrective action. For some inorganic analysis methods, “internal standards” are added at points in the sample preparation process not immediately preceding instrument quantitation; for purposes of this QAPP these are considered similar to surrogate standards and should be used in conjunction with (not in place of) injection internal standards to distinguish whether quantitation errors occur in the instrument measurement or in prior steps (e.g., sample extraction or dilution).

Confirmatory Analysis

For analyses in which important specific analytes may not be positively isolated or quantified (e.g., for 2,3,7,8-TCDF in dioxin analysis), confirmatory analyses (using a different detector, or different analytical separations) are often employed to minimize erroneous identification and quantitation. In analytical methods for which confirmatory analysis is prescribed, confirmatory results should agree within the limits specified in the method. If the method does not include limits for confirmation results, the MQO for replicate precision for the analyte may be used as a control limit indicating agreement. If results are not in agreement, the cause of the discrepancy should be investigated and corrected, with samples reanalyzed if needed. When both primary and confirmatory results are in agreement, the result that most positively identifies and quantifies the analyte without interference should be reported as the final measurement. Generally, if neither of the methods is specified as being more reliable for quantitation, lower values suggest less interference, unless the analyst has experience or evidence of negative interferences that are likely to bias the signal low (e.g., matrix constituents causing signal quenching).

Matrix Spike and Matrix Spike Duplicate

A laboratory-fortified matrix sample (commonly called a matrix spike, or MS) and a laboratory-fortified sample matrix duplicate (commonly called a matrix spike duplicate, or MSD) will be used for both evaluating the effect of the sample matrix on the recovery of the compound(s) of interest and providing an estimate of analytical precision. For matrices without appropriate CRMs or LRMs, MSs become the preferred measure of accuracy. Even when CRMs or LRMs are available, MSs should be run as secondary confirmation of accuracy where possible. Around 5% of the total number of samples (and at least one per analytical batch) will be included for analysis as MS/MSDs. To create an MS and MSD, a field sample is first homogenized and then split into three subsamples. Two of these subsamples are fortified with the matrix spike solution, and the third subsample is analyzed to provide a background concentration for each analyte of interest. If there is sufficient material, a split into four subsamples may be preferred (with the unfortified sample also analyzed in duplicate). The matrix spike solution should contain as many analytes from the target list as is feasible and appropriate for the analysis. The final spiked concentration of each analyte in the sample should be at least 3x the MDL for the analyte and at least double (but preferably also within 10x) the expected concentrations in unspiked samples. Choosing an appropriate spiking level may be

difficult when field sample concentrations are highly variable, because the initial concentration of the sample to be spiked is generally not known. However, spiking around 10x the 75th to 90th percentile of previous or nearby results for a site provides a reasonable likelihood of MS/MSD results being sufficiently above the unspiked result to calculate recovery. Recovery (in percent) is calculated as follows:

$$\text{Recovery} = \frac{[(\text{Matrix plus spike result}) - (\text{Matrix result})]}{\text{Spike amount}} \times 100\%$$

The spike amount is the expected final concentration minus the (unspiked) matrix result. If the percent recovery for any analyte in a usable quantitative range (i.e., at least 3x the MDL and at least 3x the concentration in the unspiked sample; MQO deviations below this range are disregarded) in the MS or MSD is not within target MQOs (Table 14-1), the chromatograms or other raw data quantitation reports will be reviewed to identify possible errors in quantitation (e.g., calculation errors, poor peak separation, etc.). If an explanation for low recovery value is not discovered, the instrument response should be rechecked with calibration standards. If the poor recovery occurs in both the MS and MSD, and the other QC samples in the batch (e.g., CRMs) indicate that the analysis was “in control”, further instrument response checks may not be warranted. An explanation for poor recovery values in MS/MSD results and investigations or corrective actions taken will be discussed in the narrative accompanying the data package. If causes of poor recovery cannot be identified and fixed, results for affected analytes may need to be qualified (z-score > 1), or even censored if extremely poor (z-score > 2)

As mentioned previously in the section on precision, analysis of the MS/MSD can also be useful for assessing laboratory precision, particularly when unspiked field samples are near or below the MDL. When final expected values in the MS and MSD are exactly equal, the precision calculation can be made on their concentration results directly. However, in many cases, the MS and MSD will have slightly different expected values (e.g., due to variations in sample size; for example, addition of 10 ng of spike will result in different final expected concentrations if the subsample used for the MS is 9.5 g and the MSD 10 g). In cases where the MS/MSDs have slightly different values, precision should be calculated as the RPD or RSD of their respective recoveries. The RPD or RSD between MS/MSD results should be less than the target criterion listed in Table 14-1 for each analyte of interest, although replicate measurements for unspiked sample types are generally preferred as an indicator of precision at the lower concentration of ambient field samples.

Representativeness

Sampling locations, times, frequencies, and matrices are selected to capture and describe spatial and temporal variations of interest to the RMP. The sampling and analytical methods were chosen in accordance with approved and well-documented procedures that best meet the RMP’s objectives. Through selection of relevant media (water, sediment, and biota) with sampling distributed over time throughout the estuary, a representative characterization of the sampling site and the parameters investigated will be achieved. Representativeness will be assessed through post hoc analysis of the temporal and spatial distribution and variability in the collected data.

7.4 Project-specific action limits

As this is a research project rather than a compliance monitoring effort (i.e., individually results do not trigger enforcement actions, but collectively the data may guide management actions by other parties through planning), there are no project-specific actions limits required for the data.

Element 8 Special Training Needs and Certification

8.1 Specialized Training or Certifications

Because the RMP uses performance-based methods for lab evaluation, laboratory certifications (e.g. by NELAP/ELAP⁹) for the analyses planned are preferred but not required. The laboratory providing analytical support to the 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 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 staff. The purpose of the orientation session is to familiarize key laboratory personnel with this QAPP and the 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. Meetings shall be held with participating laboratories at regular intervals to continually review QA/QC procedures and to revise/update the QAPP as needed.

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.

SFEI personnel using field collection equipment must be trained in its use and care. Initial training needs to be conducted for eight hours, and retraining or frequent use of the equipment for various projects is necessary to stay eligible for fieldwork assignments. All staff involved in field sampling must also undergo safety training prior to working in the field.

8.2 Training Certification and Documentation

No special training certification is necessary for operating the sampling equipment for water quality and sediment samples, but staff collecting biological samples should be trained and/or accompanied by trained personnel (who may be from organizations other than SFEI). In all cases, personnel involved in any kind of sample collection should have appropriate documentation (access and collection permits, where needed). The SFEI Field Operations Manager or designee is responsible for providing field equipment operation and safety instruction to all staff that attend field trips. SFEI

⁹Environmental 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

field staff training is documented and filed at SFEI. Documentation consists of a record of the training date, instructor, and material covered.

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.

8.3 Training Personnel

The SFEI Field Operations Manager and the QAO are responsible for providing training to staff that collect samples in the field or who process and ship samples to analytical laboratories.

Each contract laboratory's QA Officer and Safety Officer shall provide and/or designate staff to provide training to their respective personnel.

Element 9 Documents and Records

SFEI will collect records for sample collection, field analyses, and laboratory chemical analyses. Samples sent to analytical laboratories will include a Chain of Custody form. The analytical laboratories will maintain records of sample receipt and storage, analyses, and reported results.

SFEI maintains hardcopy or scanned files of field notes and measurements, as well as laboratory submitted documentation and results at the SFEI main office. The SFEI Data Manager is 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.

Quality Assurance Documentation

All laboratories will have the latest revision of the 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 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.
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 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 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 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 RMP Project Manager and QAO or their designees.

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

All participants listed in Element 3 will receive the most current version of the RMP QAPP, with signed copies only to the Approval Sheet (Element 1) signatories, and electronic copies provided to the remainder.

9.1 Report Package Information

Analytical results, including associated quality control samples, will be provided to SFEI by the analytical laboratory and submitted to the Regional Board within the final project report. Laboratory standard turn around time is 90 days. Exceedances should be discussed with and approved by the RMP Program Manager and QAO.

The digital data generated from sample analyses arrive at SFEI in various formats that are then converted to a standard CEDEN/SWAMP database format. SFEI personnel check data for conformance to Project MQOs. Verification of all individual quantitative results submitted by analytical laboratories will generally not be undertaken due to the high level of effort that would be required. However, analytical results will be spot checked for consistency and validity between laboratory hardcopy/electronic reports and the RMP database via verification of sums, range checking, and other aggregating methods. Anomalies in data sets received will be identified and reported to the lab as needed for correction.

Laboratory personnel will verify, screen, validate, and prepare all data, including QA/QC results, in accordance with the 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 cover letter and tabulated analytical data (including associated QA/QC information outlined below) in a format agreed upon with the RMP Project/Data Manager or designee.

Each Electronic Data Deliverable (EDD) report will consist of the following: Analytical and QA data results, Case Narrative, and SOPs.

9.1.1 Analytical and QA data results

Results will be submitted in the electronic data deliverable (EDD) template supplied by SFEI. Tabulated data will include the following information for each sample (when applicable):

1. Sample identification: Unique sample ID, site code, site name, collection date, analysis date, sample type (field or QC types), and matrix (water, sediment, tissue (include species code)).
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, 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:

- % Solids or % moisture (for sediment and tissue samples, respectively)
- Control results (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.

9.1.2 Case Narrative

The following topics will be addressed in the narrative:

A. Overview of Work Performed, Analytical Methodology and Reporting

Number of samples received and analyzed.

Describe handling/storage/preparation of samples.

Summarize extraction method.

Summarize analysis method.

Include concentration range(s) used to generate calibration curves.

Reporting units and basis (See Table 9-1 – all results should be in the same units and basis)

Define qualifiers used to qualify the results.

Are results for corrective actions (e.g. reanalysis results, contamination study, etc.)?

B. Completeness

Were all sample results reported?

Describe reason for any missing results.

C. Detection Limits

Provide detection and reporting limits and how estimated.

Estimate proportion of unquantified results, given detection limits for target analytes

D. Batch Specific Discussion of Results

Provide a brief summary of results for each analytical batch.

Describe number and type of samples analyzed in each laboratory batch.

Indicate if results were blank or surrogate recovery corrected.

Discuss analytical problems and any corrective actions.

1. Laboratory Blanks - describe type(s) of blanks analyzed, summarize method blank results.

2. Accuracy - summarize accuracy achieved by parameter and how measured (matrix spikes, certified reference materials, etc.). Include a copy of the certification values for all certified reference materials used in the analysis. For matrix and blank spikes, note where expected values (native + spike concentration) and percent recovery calculations are included in the data tables.

3. Precision - summarize precision achieved from replicates and how measured (replicates of field samples, MS/MSDs, etc.). Note RPD (or RSD) calculations in data tables.

Tables 9-1 and 9-2 provide detailed lists of required and not required data fields for reporting water, sediment and tissue results using EDD templates. These tables are based on guidelines and definitions provided by the California Environmental Data Exchange Network (CEDEN) (CEDEN, 2014). Lookup list values can be obtained by visiting the [CEDEN Controlled Vocabulary website](#).

Table 9-1. List of required RMP data fields for chemistry results in water and sediment data templates. These templates are used to upload data to SFEI using the on-line [Data Checker](#).

Lab Result Table			
Field Name	Data Type	Required Field?	Description
LabSampleID	Text	Y	Unique sample identifier supplied by lab.
SFEIContractID	Text	N	SFEI contract number
StationCode	Text	Y	Station identifier. Use "LABQA" for lab generated QA samples and For other client samples use "000NONPJ_A", "000NONPJ_B", etc. to group parent samples with replicates and matrix spikes.
SampleDate	Date	Y	Date of station visit (expressed as dd/mm/yyyy). For lab generated QA samples where StationCode = "LABQA" use the analysis date. When not available or not recorded use 1/Jan/1950.
CollectionTime	Time	Y	Time sample was collected (based on a 24-hour clock; hh:mm). For LABQA samples use 00:00.
EventCode	Text	Y	Grouping for sample collections from Event Lookup table (e.g., WQ, TI, BA).
ProtocolCode	Text	Y	Unique code referencing the Protocol which is a set of methods, methodology and/or specifications used (e.g., RMP).
SampleTypeCode	Text	Y	Sample type code from SampleTypeLookup table (e.g., Grab, Integrated, LabBlank. For toxicity controls, use CNEG or RFST).
Replicate	Number	Y	Used to identify the replicate number for a replicate created in the field (default=1 for native sample).
LabReplicate	Number	Y	Used to distinguish between splits created in the laboratory (default=1 for original sample) (e.g., lab duplicates, matrix spike duplicates).
CollectionDepth	Number	Y	Depth at which analytical sample was collected. For lab generated QA samples (StationCode=LABQA), use "-88".
UnitCollectionDepth	Text	Y	Unit at which depth of analytical sample was collected. Default is "m" for water and tissue samples and "cm" for sediment samples.
ProjectCode	Text	Y	Project code that by default relates to the sampling year, program, regional board number, and study type (e.g., 07RMP2ST = 2007 RMP Status and Trends).
AgencyCode	Text	Y	Organization collecting samples (e.g., AMS-CA). For lab generated QA samples, use the code of the lab conducting analyses.
CollectionComments	Text	N	Additional comments related to sample.

SampleID	Text	Y	Unique sample container identifier generated during sample collection. For QA samples, provide a sample description in this field (e.g., CRM name, method blank).
PreparationPreservation	Text	Y	Sample preparation or preservation done on the sample prior to digestion and analysis from PrepPreservationLookup table. If not applicable, use "None".
PreparationPreservation Date	Date	Y	The date the preparation was started (expressed as dd/mmm/yyyy). If not applicable or none, use "01/Jan/1950".
DigestExtractMethod	Text	Y	Digestion or extraction method. If none of the existing methods apply, please contact the QA Officer. If the digest/extraction is part of the analytical method, use the MethodName. If not applicable, use "None". Major changes in methods from previous years should be approved by the QA Officer.
DigestExtractDate	Date	Y	The date the digestion or extraction was initiated (expressed as dd/mmm/yyyy). If not applicable or none, use "01/Jan/1950".
LabBatch	Text	Y	The LabBatch is a unique code, provided by the laboratory, which represents a group of samples processed together. It groups all environmental samples with their supporting QC samples and will be used to verify completeness.
AnalysisDate	Date/Time	Y	Date the sample was processed on the analytical instrument. If not available, use "01/Jan/1950".
MethodName	Text	Y	Analytical method. If none of the existing methods apply, please contact SFEI at dts@sfei.org. Major changes in methods from previous years should be approved by the QA Officer.
MatrixName	Text	Y	Sample matrix code from MatrixLookup table (e.g., samplewater, blankwater, sediment).
AnalyteGroup	Text	N	Target parameter group.
AnalyteName	Text	Y	Target parameter name (see contract).
FractionName	Text	Y	Sample fraction from the FractionLookup table (e.g., Dissolved, Total, None).
Unit	Text	Y	Target parameter units (should match those asked for in contract). MDL and RL values should be reported in the same units as the samples. Basis is included in the units for mass per mass samples (e.g., tissue and sediment samples, mg/Kg ww or mg/kg dw) and concentrations (e.g., % lipids or %, solids). Samples that do not include basis in the unit name are mass per volume samples (e.g., water samples, mg/L) and single units (e.g., g, mL).
BlankCorrected	Yes/No	Y	Indicate if reported result is blank corrected or not "Yes" or "No"
DilFactor	Integer	Y	Recorded dilution factor; e.g. 1 part sample plus 9 parts blank is a dilution factor of 10. Default is 1.
Result	Double	Y*	Numerical result. Leave blank if the samples is a non-detect.

ResultQualCode	Text	Y	Qualifier describing the analytical result from ResQualCodeLookup table. Default is "=".
QACode	Text	Y	Qualifier describing any special condition or situation occurring during the analysis from the QACodeLookup table. Default is "None" when there is no associated QA qualifier. For multiple qualifiers, they should be in alphabetical order and separated by commas, without spaces (e.g., GN,HS).
MDL	Double	Y	Method detection limit. MDL calculation should be provided in the QA Narrative.
RL	Double	Y	Reporting limit defined by the individual laboratory; definition must be included in Submittal Cover Letter and QA Case Narrative.
ExpectedValue	Double	Y	Required for matrix spikes (sampled concentration + spike amount), blank spikes (spike amount), certified reference materials (certified reference value from manufacturer), and surrogate recovery records (use 100 representing 100%).
LabResultComments	Text	N	<p>Additional comments pertaining to the sample result, including Percent Recovery (PR), Relative Percent Difference (RPD), and Relative Standard Difference (RSD) values.</p> <p>Note: The sequence for listing more than one of the above values is PR #, RPD # (separated by a comma and space; please include a space before the number). See below for calculations:</p> <p>PR Calculation: (calculated for matrix spike and CRM recoveries) If the native for a matrix spike is a non-detect, it is treated as a zero in the PR calculation. If the result and the native are a non-detect, then notify the QA Officer. If the matrix spike/CRM concentration is a non-detect, the RMP doesn't calculate the PR, so the comment "PR NC" should be stored in this field.</p> $PR = \frac{\text{Matrix spike conc.} - \text{Native conc.}}{\text{ExpectedValue} - \text{Native conc.}} \times 100$ <p>Expected Value = Native concentration + Spike amount</p> <p>RPD/RSD Calculation: (calculated for lab replicates, CRM replicates, and matrix spike replicates). The RMP doesn't calculate the RPD/RSD when one or more the replicates is ND, so the comment "RPD NC" should be stored in this field.</p> $RPD = \frac{\text{Absolute}(\text{Field sample conc.} - \text{Replicate conc.})}{\left(\frac{\text{Field sample conc.} + \text{Replicate conc.}}{2}\right)} \times 100$ $RSD = \frac{\text{Standard Deviation}(\text{Field sample conc. and Replicate conc.})}{\text{Average}(\text{Field sample conc. and Replicate conc.})}$ <p>Note: Need at least one field sample and 2 replicates to calculate a RSD.</p>

Lab Batch Table			
LabBatch	Text	Y	Unique code provided by laboratory that represents a group of samples processed together.
LabAgencyCode	Text	Y	Agency that performed the analysis.
LabSubmissionCode	Text	Y	Unique batch qualifier code assigned to the LabBatch by the analyzing laboratory which references the quality of the LabBatch from LabSubmissionCode Lookup.
SubmittingAgencyCode	Text	N	Agency that is responsible for submission to SFEI; may be different from LabAgencyCode if analytical data were subcontracted.
LabBatchComm	Text	N	Comments related to the LabBatch

Table 9-2. List of required data fields for the SFEI Regional Data Center (RDC) tissue tables (bird eggs, sport fish and bivalves). Certain fields are not required for the CEDEN templates but are required for the SFEI templates (these fields are noted in the ‘Required’ field). Most fields have a default value as indicated the description. Fields that do not have a Default Value are noted in the ‘Required’ field.

Locations Table			
a. Holds information about location sampled			
b. Required only if actual unique latitudes and longitudes were recorded for each sampling event.			
Field Name	Data Type	Required	Description
StationCode	Text	Y, No Default	Represents a unique sampling site in a sampling design. A single waterbody may have multiple stations.
SampleDate	Date/ Time	Y	Refers to the date the sample was collected in the field. Formatted as dd/mm/yyyy hh:mm.
ProjectCode	Text	Y, No Default	References the project that is associated with the sample.
EventCode	Text	Y for SFEI RDC, No Default	Represents the primary reason, i.e. water quality, tissue or bioassessment sampling, of the sampling event at a particular station and date.
ProtocolCode	Text	Y for SFEI RDC, No Default	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as MPSTL-DFG_Field_v1.0. Established protocols may be used or Regions may document their own sampling protocols.
AgencyCode	Text	Y for SFEI RDC	Refers to the organization or agency that collected the sample. Default value equals Not Recorded if unknown
SampleComments	Text	N	Any comments applicable to all samples collected at that Station on that Date.
LocationCode	Text	Y for SFEI RDC	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. Default value equals Not Recorded if unknown
GeometryShape	Text	Y for SFEI RDC	Physical shape of the location. Example values are Line, Point, or Polygon.

CoordinateNumber	Integer	Y	Number of the coordinates recorded at a Location; e.g. 1 for Points (target and actual coordinates), 1 and 2 for Lines. Default value equals 1 if unknown.
ActualLatitude	Decimal	Y	Represents the actual latitude for the sample site in decimal degrees with 5 decimal places.
ActualLongitude	Decimal	Y	Represents the actual longitude for the sample site in decimal degrees with 5 decimal places (must be negative).
Datum	Text	Y	The Datum field records the datum that was used on the GPS Device to record the GPS measurements. Example = NAD83. Default value equals NR if unknown.
CoordinateSource	Text	Y for SFEI RDC	Describes how the coordinate was measured. For example, if measurement was taken from a map or GPS. Default value equals NR if unknown.
Elevation	Decimal	N	Elevation at which samples are taken.
UnitElevation	Text	N	Unit of measure for Elevation value.
StationDetailVerBy		N	Internal CEDEN field
StationDetailVerDate		N	Internal CEDEN field
StationDetailComments		N	Internal CEDEN field

FishComposite table

a. Used to record linking Collection information and Organism, Part and Compositing data for fish.

b. Required only if tissue is collected and must be submitted with TIResults, and LabBatch table.

Field Name	Data Type	Required	Description
StationCode	Text	Y, No Default	Represents a unique sampling site in a sampling design. A single waterbody may have multiple stations.
SampleDate	Date/ Time	Y	Refers to the date the sample was collected in the field. Formatted as dd/mm/yyyy hh:mm.
ProjectCode	Text	Y, No Default	References the project that is associated with the sample.
EventCode	Text	Y for SFEI RDC, No Default	Represents the primary reason, i.e. water quality, tissue or bioassessment sampling, of the sampling event at a particular station and date.
ProtocolCode	Text	Y for SFEI RDC, No Default	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as MPSL-DFG_Field_v1.0. Established protocols may be used or Regions may document their own sampling protocols.
AgencyCode	Text	Y for SFEI RDC	Refers to the organization or agency that collected the sample. Default value equals Not Recorded if unknown
SampleComments	Text	N	Any comments applicable to all samples collected at that Station on that Date.

LocationCode	Text	Y for SFEI RDC	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. Default value equals Not Recorded if unknown
GeometryShape	Text	Y for SFEI RDC	Physical shape of the location. Example values are Line, Point, or Polygon.
CollectionTime	Date/ Time	Y	Refers to the time when the first sample of a sampling event at a specific station was collected in the field. Format equals hh:mm. Default value equals 00:00 if unknown.
CollectionMethodCode	Text	Y	Refers to the general method of collection such as Net or Shock.. The default value of Not Recorded is utilized for environmental samples if unknown. For LabQA samples utilize Not Applicable.
Replicate	Integer	Y	Used to distinguish between replicates created at a single collection in the field. Default value is 1. Replicate samples are collected at the same station on the same date, within 15 minutes of each other. Therefore, samples collected on different dates from the same station should both have a value of 1 for Replicate. Utilize this field for pre-composite replicates.
CollectionDeviceName	Text	Y for SFEI RDC	Name of the CollectionDevice. Default value equals Not Recorded if unknown.
TisSource	Text	Y for SFEI RDC	References the original source of the collected organism; e.g. resident, transplant. Bivalves could be Res (Resident) or Trans (Transplant) while fish are NA (Not Applicable) Default value equals NR if unknown.
SampleID	Text	N	
TissueCollectionComments	Text		Any comments regarding all samples collected at any one collection time with the same method and device.
OrganismID	Text	Y for SFEI RDC, No Default	Unique identifier assigned to fish by the collection agency.
OrganismName	Text	Y for SFEI RDC, No Default	Refers to the scientific name (FinalID) of the organism collected. For LabQA samples utilize Not Applicable.
TagNumber	Text	N	References any tag number assigned to the organism.
LifeStageCode	Text	Y for SFEI RDC	Unique code referencing the stage of life of the organism; e.g. adult, juvenile Default value equals NR.
TotalCount	Integer	Y for SFEI RDC	Total count of live organisms in the tissue sample associated with the same OrganismID. For fish, this is usually 1.
PartCreated	Yes/No	N	References whether a subsequent part was created from the OrganismID, i.e. Yes would be populated if the fish was split into subsamples of skin, fillet and guts.

ForkLength	Decimal	N	The measured length of the organism from the most forward point, with mouth closed, to the center of the fork in the tail.
TotalLength	Decimal	N	The measured length of the organism from the most forward point of the head, with mouth closed, to the farthest tip of the tail.
UnitLengthFish	Text	N	Refers to the units used in measuring the length of the fish. Preferably in mm.
LengthSource	Text	N	The physical location where the length measurements were recorded; e.g. field, lab
Weight	Decimal	N	Weight of the entire fish.
UnitWeightFish	Text	N	Refers to the units used in measuring the weight of the fish. Preferably in grams.
WeightSource	Text	N	The physical location where the weight measurements were recorded; e.g. field, lab
SizeDescr	Text	N	Description of the grouping of organisms by size; e.g. small, large, 100-150cm
Age	Text	N	Describes the age of the organism.
Sex	Text	N	Refers to the sex of the organism; e.g. M, F, Unk Default value equals NR.
Anomaly	Text	N	Describes any anomalies that may be on or in the organism; e.g. Deformity-skeletal, Lesion, Parasite
POEComments	Text	N	Any comments with regards to an individual organism.
TissueID	Text	Y	Unique identifier that is assigned to each tissue part if subsampled parts are created from a single fish. If only one part is created, use the OrganismID.
TissueName	Text	Y	Name of the tissue part (FIL for fillet), or description of the processed organism (WHL for whole organism, WNG for whole without gut, etc.). NA for QA samples. For full list of codes see TissueLookup.
PrepPreservationName	Text	Y for SFEI RDC	References the preparation or preservation method performed on the tissue part in order to create the composite. This DOES NOT include the Preparation Preservation of the composite itself, e.g. freezing, drying or acidifying. An example an of applicable codes here would be 'Skin off'. If no preparation or preservation method was performed the default value is None. Default value equals Not Recorded if unknown.
EntryDateTime	Date/Time	N	Reflects the date and time when the template is filled out and can be used as a way to group data entry.
TissueWeight	Decimal	Y for SFEI RDC	Measured weight of the tissue part included in the composite. Populate with -88 if unknown.
UnitTissueWeight	Text	Y for SFEI RDC	Refers to the units used in measuring the weight of the tissue part. Default is grams.
PartsComments	Text	N	Records any comments relating to the tissue parts.

CompositeID	Text	Y	Unique identifier supplied by the Compositing Agency to identify the composited tissue parts. It can refer to either the original Composite or the SuperComposite where multiple Composites are combined to create a SuperComposite. For LABQA samples, use the LabSampleID.
CompositeType	Text	Y	Indicates the type of composite, e.g. Normal, SuperComposite, LABQA.
CompositeReplicate	Integer	Y	Composite replicate number used to distinguish between replicate composites. Default value equals 1.
CompositeWeight	Decimal	Y for SFEI RDC	Weight of the total Composite used in the analysis. Default value is -88.
UnitCompositeWeight	Text	Y for SFEI RDC	Refers to the units used in measuring the weight of the Composite.
HomogDate	Date/Time	Y for SFEI RDC	Date and time the Composite was homogenized. Date format is dd/mmm/yyyy hh:mm. If unknown, use 1/1/1950 00:00.
OrganismGroup	Text	N	Organism group of the sample, e.g. Fish, Bivalves, Crustacean, Mammal, Bird or Amphibian. BR: The default for LABQA is Not Applicable except for CRMs. The CRM should reflect the correct organism group. Default value of Not Recorded is utilized for environmental samples.
CompAgencyCode	Text	Y for SFEI RDC	Agency that physically created the Composite or SuperComposite. Default value of Not Recorded if unknown.
CompositeComments	Text	N	Describes any comments related to the Composite.

BivalveComposite table

a. Used to record linking Collection information and Organism, Part and Compositing data for bivalve.

b. Required only if tissue is collected and must be submitted with TIResults, and LabBatch table.

Field Name	Data Type	Required	Description
StationCode	Text	Y, No Default	Represents a unique sampling site in a sampling design. A single waterbody may have multiple stations.
SampleDate	Date/ Time	Y	Refers to the date the sample was collected in the field. Formatted as dd/mmm/yyyy hh:mm.
ProjectCode	Text	Y, No Default	References the project that is associated with the sample.
EventCode	Text	Y for SFEI RDC, No Default	Represents the primary reason, i.e. water quality, tissue or bioassessment sampling, of the sampling event at a particular station and date.
ProtocolCode	Text	Y for SFEI RDC, No Default	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as MPSL-DFG_Field_v1.0. Established protocols may be used or Regions may document their own sampling protocols.
AgencyCode	Text	Y for SFEI RDC	Refers to the organization or agency that collected the sample. Default value equals Not Recorded if unknown

SampleComments	Text	N	Any comments applicable to all samples collected at that Station on that Date.
LocationCode	Text	Y for SFEI RDC	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. Default value equals Not Recorded if unknown
GeometryShape	Text	Y for SFEI RDC	Physical shape of the location. Example values are Line, Point, or Polygon.
CollectionTime	Date/ Time	Y	Refers to the time when the first sample of a sampling event at a specific station was collected in the field. Format equals hh:mm. Default value equals 00:00 if unknown.
CollectionMethodCode	Text	Y	Refers to the general method of collection such as Net or Shock.. The default value of Not Recorded is utilized for environmental samples if unknown. For LabQA samples utilize Not Applicable.
Replicate	Integer	Y	Used to distinguish between replicates created at a single collection in the field. Default value is 1. Replicate samples are collected at the same station on the same date, within 15 minutes of each other. Therefore, samples collected on different dates from the same station should both have a value of 1 for Replicate. Utilize this field for pre-composite replicates.
CollectionDeviceName	Text	Y for SFEI RDC	Name of the CollectionDevice. Default value equals Not Recorded if unknown.
TisSource	Text	Y for SFEI RDC	References the original source of the collected organism; e.g. resident, transplant. Bivalves could be Res (Resident) or Trans (Transplant) while fish are NA (Not Applicable) Default value equals NR if unknown.
SampleID			
TissueCollectionComments			
OrganismID	Text	Y for SFEI RDC, No Default	Unique identifier assigned to the organism or bag of organisms by the field crew or the agency that first has possession of the field data sheets and of the fish.
OrganismName	Text	Y for SFEI RDC, No Default	Refers to scientific name (FinalID) of the organism(s) collected. For LabQA samples utilize Not Applicable.
TagNumber	Text		
LifeStageCode	Text	Y for SFEI RDC	Unique code referencing the stage of life of the organism; e.g. adult, juvenile Default value equals NR.
TotalCount	Integer	Y for SFEI RDC	Total count of live organisms in the tissue sample associated with the same OrganismID.
PartCreated	Yes/No	N	References whether a subsequent part was created from the OrganismID, i.e. Yes would be populated if the bivalve was split into parts (e.g. shell removed).

BivalveID	Integer	Y for SFEI RDC	Unique identifier (when combined with OrganismID) that is assigned to the organism. Default is '1'.
Count	Integer	N	The actual number of organisms represented by the BivalveID. Default is '1'. Often the same as TotalCount for bivalves.
ShellLength	Decimal	N	The actual measured length of the shell of the individual organism. When a group of organisms are measured and averaged, enter the average length of the shell.
ShellWidth	Decimal	N	The actual measured width of the shell of the individual organism. When a group of organisms are measured and averaged, enter the average width of the shell.
UnitShellLengthWidth	Text	N	Refers to the units used in measuring the length and width of the organism. When a group of organisms are measured and averaged, enter the unit as avg xx where xx refers to the unit.
LengthWidthType	Text	N	Describes the type of length or width measurement recorded; e.g. Ca (Carapace), Ab (Abdomen), TL (Total Length) . If two different types of measurements were recorded, enter the primary type here and the secondary type in the ProcessedOrganismsExpandedBivalvesComments field.
BeginWeight	Decimal	N	Mass or average mass of the bivalve organism at the start date. (Deploy Date)
EndWeight	Decimal	N	Mass or average mass of the bivalve organism at the end date. (Retrieval Date)
UnitWeightBivalve	Text	N	
BivalveSex	Text	N	
SizeDescrBivalve	Text	N	
POEComments	Text	N	
TissueID	Text	Y	Unique identifier that is assigned to each tissue part if subsampled parts are created from a single fish. If only one part is created, use the OrganismID.
TissueName	Text	Y	Name of the tissue part (FIL for fillet), or description of the processed organism (WHL for whole organism, WNG for whole without gut, etc.). NA for QA samples. For full list of codes see TissueLookup.
PrepPreservationName	Text	Y for SFEI RDC	References the preparation or preservation method performed on the tissue part in order to create the composite. This DOES NOT include the Preparation Preservation of the composite itself, e.g. freezing, drying or acidifying. An example an of applicable codes here would be 'Skin off'. If no preparation or preservation method was performed the default value is None. Default value equals Not Recorded if unknown.

EntryDateTime	Date/Time	N	Reflects the date and time when the template is filled out and can be used as a way to group data entry.
TissueWeight	Decimal	Y for SFEI RDC	Measured weight of the tissue part included in the composite. Populate with -88 if unknown.
UnitTissueWeight	Text	Y for SFEI RDC	Refers to the units used in measuring the weight of the tissue part. Default is grams.
PartsComments	Text	N	Records any comments relating to the tissue parts.
CompositeID	Text	Y	Unique identifier supplied by the Compositing Agency to identify the composited tissue parts. It can refer to either the original Composite or the SuperComposite where multiple Composites are combined to create a SuperComposite. For LABQA samples, use the LabSampleID.
CompositeType	Text	Y	Indicates the type of composite, e.g. Normal, SuperComposite, LABQA.
CompositeReplicate	Integer	Y	Composite replicate number used to distinguish between replicate composites. Default value equals 1.
CompositeWeight	Decimal	Y for SFEI RDC	Weight of the total Composite used in the analysis. Default value is -88.
UnitCompositeWeight	Text	Y for SFEI RDC	Refers to the units used in measuring the weight of the Composite.
HomogDate	Date/Time	Y for SFEI RDC	Date and time the Composite was homogenized. Date format is dd/mm/yyy hh:mm. If unknown, use 1/1/1950 00:00.
OrganismGroup	Text	N	Organism group of the sample, e.g. Fish, Bivalves, Crustacean, Mammal, Bird or Amphibian. BR: The default for LABQA is Not Applicable except for CRMs. The CRM should reflect the correct organism group. Default value of Not Recorded is utilized for environmental samples.
CompAgencyCode	Text	Y for SFEI RDC	Agency that physically created the Composite or SuperComposite. Default value of Not Recorded if unknown.
CompositeComments	Text	N	Describes any comments related to the Composite.

BirdComposite table

- a. Used to record linking Collection information and Organism, Part and Compositing data for bivalve.
b. Required only if tissue is collected and must be submitted with TIResults, and LabBatch table.

Field Name	Data Type	Required	Description
StationCode	Text	Y, No Default	Represents a unique sampling site in a sampling design. A single waterbody may have multiple stations.

SampleDate	Date/ Time	Y	Refers to the date the sample was collected in the field. Formatted as dd/mm/yyyy.
ProjectCode	Text	Y, No Default	References the project that is associated with the sample.
EventCode	Text	Y for SFEI RDC, No Default	Represents the primary reason, i.e. water quality, tissue or bioassessment sampling, of the sampling event at a particular station and date.
ProtocolCode	Text	Y for SFEI RDC, No Default	Represents the sampling protocol used, which includes the set of methods, methodology and/or specifications, such as MPSTL-DFG_Field_v1.0. Established protocols may be used or Regions may document their own sampling protocols.
AgencyCode	Text	Y for SFEI RDC	Refers to the organization or agency that collected the sample. Default value equals Not Recorded if unknown
SampleComments	Text	N	Any comments applicable to all samples collected at that Station on that Date.
LocationCode	Text	Y for SFEI RDC	Describes the physical location in the waterbody where the sample was collected. One sampling event may have a single or multiple locations. Default value equals Not Recorded if unknown
GeometryShape	Text	Y for SFEI RDC	Physical shape of the location. Example values are Line, Point, or Polygon.
CollectionTime	Date/ Time	Y	Refers to the time when the first sample of a sampling event at a specific station was collected in the field. Format equals hh:mm. Default value equals 00:00 if unknown.
CollectionMethodCode	Text	Y	Refers to the general method of collection such as Net or Shock.. The default value of Not Recorded is utilized for environmental samples if unknown. For LabQA samples utilize Not Applicable.
Replicate	Integer	Y	Used to distinguish between replicates created at a single collection in the field. Default value is 1. Replicate samples are collected at the same station on the same date, within 15 minutes of each other. Therefore, samples collected on different dates from the same station should both have a value of 1 for Replicate. Utilize this field for pre-composite replicates.
CollectionDeviceName	Text	Y for SFEI RDC	Name of the CollectionDevice. Default value equals Not Recorded if unknown.
TisSource	Text	Y for SFEI RDC	References the original source of the collected organism; e.g. resident, transplant. Bivalves could be Res (Resident) or Trans (Transplant) while fish are NA (Not Applicable) Default value equals NR if unknown.

TissueCollectionComments	Text	N	
OrganismID	Text	Y	Unique identifier assigned to the organism or bag of organisms by the field crew or the agency that first has possession of the field data sheets and the bird/egg.
OrganismName	Text	Y	Refers to scientific name (FinalID) of the organism(s) collected. For LabQA samples utilize Not Applicable.
TagNumber	Text	N	Unique code referencing the stage of life of the organism; e.g. adult, juvenile Default value equals NR.
LifeStageCode	Text	N	Total count of live organisms in the tissue sample associated with the same OrganismID.
PartCreated	Yes/No	N	References whether a subsequent part was created from the OrganismID, i.e. Yes would be populated if the bird was split into subsamples of breast and blood.
PersonnelCode	Text	N	PersonnelCode of the sample collector
Age	Text	N	Age of the bird/egg
Sex	Text	N	Sex of the organism if known.
Mass	Number	N	Mass of the bird/egg.
UnitMassBirdMeasurements	Text	N	The units that the mass measurements are in.
WingChordLength	Number	N	Length of the wing along the chord line. OR Distance between the wrist bend and the tip of the longest primary feather.
FlatWingLength	Number	N	Length of the wing in a flattened position.
TailLength	Number	N	Measurement taken from the base of the tail to the tip of the longest feathers.
ExposedCulmenLength	Number	N	Measurement of the exposed portion of the culmen (upper beak/bill).
DiagonalTarsusLength	Number	N	Measurement of the tarsus (leg) diagonally across the bone from the middle groove of the ankle to the top edge of the foot.
ShortTarsusLength	Number	N	
MidToeLength	Number	N	Length of the middle toe
EggLength	Number	N	Length of organism if it is an egg.
MeasurementSide	Number	N	
UnitLengthBirdMeasurements	Text	N	

POEBirdComments	Text	N	
TissueID	Text	Y	Unique identifier that is assigned to each tissue part if subsampled parts are created from a single fish. If only one part is created, use the OrganismID.
TissueName	Text	Y	Name of the tissue part (FIL for fillet), or description of the processed organism (WHL for whole organism, WNG for whole without gut, etc.). NA for QA samples. For full list of codes see TissueLookup.
PrepPreservationName	Text	Y for SFEI RDC	References the preparation or preservation method performed on the tissue part in order to create the composite. This DOES NOT include the Preparation Preservation of the composite itself, e.g. freezing, drying or acidifying. An example an of applicable codes here would be 'Skin off'. If no preparation or preservation method was performed the default value is None. Default value equals Not Recorded if unknown.
EntryDateTime	Date/Time	N	Reflects the date and time when the template is filled out and can be used as a way to group data entry.
TissueWeight	Decimal	Y for SFEI RDC	Measured weight of the tissue part included in the composite. Populate with -88 if unknown.
UnitTissueWeight	Text	Y for SFEI RDC	Refers to the units used in measuring the weight of the tissue part. Default is grams.
PartsComments	Text	N	Records any comments relating to the tissue parts.
CompositeID	Text	Y	Unique identifier supplied by the Compositing Agency to identify the composited tissue parts. It can refer to either the original Composite or the SuperComposite where multiple Composites are combined to create a SuperComposite. For LABQA samples, use the LabSampleID.
CompositeType	Text	Y	Indicates the type of composite, e.g. Normal, SuperComposite, LABQA.
CompositeReplicate	Integer	Y	Composite replicate number used to distinguish between replicate composites. Default value equals 1.
CompositeWeight	Decimal	Y for SFEI RDC	Weight of the total Composite used in the analysis. Default value is -88.
UnitCompositeWeight	Text	Y for SFEI RDC	Refers to the units used in measuring the weight of the Composite.
HomogDate	Date/Time	Y for SFEI RDC	Date and time the Composite was homogenized. Date format is dd/mm/yyyy hh:mm. If unknown, use 1/1/1950 00:00.
OrganismGroup	Text	N	Organism group of the sample, e.g. Fish, Bivalves, Crustacean, Mammal, Bird or Amphibian. BR: The default for LABQA is Not Applicable except for CRMs. The CRM should reflect the correct organism group. Default value of Not Recorded is utilized for environmental samples.

CompAgencyCode	Text	Y for SFEI RDC	Agency that physically created the Composite or SuperComposite. Default value of Not Recorded if unknown.
CompositeComments	Text	N	Describes any comments related to the Composite.
PrepPreservationName	Text	Y for SFEI RDC	References the preparation or preservation method performed on the tissue part in order to create the composite. This DOES NOT include the Preparation Preservation of the composite itself, e.g. freezing, drying or acidifying. An example an of applicable codes here would be 'Skin off'. If no preparation or preservation method was performed the default value is None. Default value equals Not Recorded if unknown.
EntryDateTime	Date/Time	N	Reflects the date and time when the template is filled out and can be used as a way to group data entry.

Super Composite Sample Table

a. Used to record tissue super composite information.

b. Required only if super composite information was compiled and must be submitted with the FishComposite and/or BivalveComposite, TIResults, and LabBatch table.

Field Name	Data Type	Required	Description
SuperCompositeID	Text	Y	Unique identifier supplied by the Compositing Agency to identify the composited tissue parts. It can refer to either the original Composite or the SuperComposite where multiple Composites are combined to create a SuperComposite.
CompositeType	Text	Y	Indicates the type of composite, e.g. Normal and SuperComposite. In the Composite template, only Normal will be recorded. In the SuperComposite template, only SuperComposite will be recorded. In the Results template, Normal and SuperComposite is recorded for samples and LABQA is recorded for LABQA.
CompositeReplicate	Integer	Y	Composite replicate number used to distinguish between replicate composites. Default value is '1'.
CompositeSourceID	Text	Y	Unique identifier supplied by the Compositing Agency to identify the composited tissue parts in the SuperComposite. This CompositeID must match the original CompositeID used in the SuperComposite.

Tissue Results Table a. Used to record all of the chemistry results for tissue analysis b. Required and must be submitted with either the FishComposite and/or BivalveComposite and LabBatch table.			
Field Name	Data Type	Required	Description
CompositeID	Text	Y, No Default	Unique identifier supplied by the Compositing Agency to identify the composited tissue parts. It can refer to either the original Composite or the SuperComposite where multiple Composites are combined to create a SuperComposite.
CompositeType	Text	Y	Indicates the type of composite, e.g. Normal, SuperComposite. In the Composite template, only Normal will be recorded. In the SuperComposite template, only SuperComposite will be recorded. In the Results template, Normal and SuperComposite is recorded for samples and LABQA is recorded for LABQA.
CompositeReplicate	Integer	Y	Composite replicate number used to distinguish between replicates created after compositing. Default value is '1'.
LabBatch	Text	Y, No Default	The LabBatch is a unique code, provided by the laboratory, which represents a group of samples processed together. It groups all environmental samples with their supporting QC samples and will be used to verify completeness.
AnalysisDate	Date/ Time	Y	Date and time the sample was processed on the analytical instrument. Formatted as dd/mm/yyyy hh:mm. Default value equals 01/Jan/1950 00:00 if unknown.
SampleTypeCode	Text	Y, No Default	Refers to the type of sample collected or analyzed.
MatrixName	Text	Y, No Default	Refers to the sample matrix, e.g. tissue, blankmatrix.
MethodName	Text	Y	Refers to the analysis method used by the laboratory to analyze the sample. Default value equals Not Recorded if unknown.
AnalyteName	Text	Y, No Default	Name of the analyte or parameter for which the analysis is conducted and result is reported. The LookUp list includes the acceptable abbreviation or name of the variable used by the database, enabling consistency across reporting.
FractionName	Text	Y, No Default	Specific descriptor of the Analyte. For tissue samples, this is Total.
UnitName	Text	Y, No Default	Refers to how the chemistry result is measured or expressed.
LabReplicate	Integer	Y	Used to distinguish between replicates created in the laboratory. It differentiates the original field sample that was analyzed from all subsequent laboratory duplicates. Default is 1.

Result	Text	Y*, No Default	The analytical result. * For ND results leave this field blank.
ResQualCode	Text	Y	Qualifies the analytical result of the sample. Default value is “=”.
MDL	Decimal	N	Minimum value below which data are documented as non-quantifiable, as determined by the laboratory.
RL	Decimal	N	Minimum value below which data are documented as not-reportable. It is the reporting limit for the sample analyzed, as determined by the laboratory.
QACode	Text	Y	Applied to the result to describe any special conditions, situations or outliers that occurred during or prior to the analysis to achieve the result. The default code, indicating no special conditions, is 'None'. Default value equals NR if unknown. If more than one code should be applied to a record, the convention is to list them in alphabetical order separated by commas and no spaces.
ComplianceCode	Text	N	Populated by the SFEI QA Officer.
DilutionFactor	Integer	Y for SFEI RDC	Factor by which a sample was diluted and is reported as a whole number. It is equal to the final volume divided by the initial volume of solution, or $DF = V_f \div V_i$. If no dilution was performed, the default value is '1'.
PrepPreservationName	Text	Y for SFEI RDC	References the preparation or preservation method performed on the samples prior to analysis. Default value equals Not Recorded if unknown.
PrepPreservationDate	Date/Time	Y for SFEI RDC	Date and time the preparation or preservation was started. Default value equals 01/Jan/1950 00:00 for unknown or null values.
DigestExtractMethod	Text	Y for SFEI RDC	References the digestion or extraction method performed on the sample prior to analysis. Default value equals Not Recorded if unknown.
DigestExtractDate	Date/Time	Y for SFEI RDC	Date and time the digestion or extraction was started. Default value equals 01/Jan/1950 00:00 for unknown or null values.

LabBatch Table

a. Used to record lab batch information necessary for analyzing the data

b. Required and must be submitted with either the FishComposite and/or BivalveComposite and TIResults, table.

Field Name	Data Type	Required	Description
LabBatch	Text	Y, No Default	The LabBatch is a unique code, provided by the laboratory, which represents a group of samples processed together. It groups all environmental samples with their supporting QC samples and will be used to verify completeness. This field is the primary key to ensure record uniqueness.
LabAgencyCode	Text	Yes, No Default	LabAgencyCode refers to the organization, agency or laboratory that performed the analysis on the sample.

LabSubmissionCode	Text	Y for SFEI RDC	The LabSubmissionCode is a qualifier code assigned to the LabBatch as a whole by the analyzing laboratory which references the quality of the data in the LabBatch. The LabSubmissionCode should be reviewed by the Project Manager or other appropriate person to ensure that the code has been applied based on project specific data quality objectives and criteria. Default value equals NR if unknown.
BatchVerificationCode	Text	Y for SFEI RDC	Qualifier code referencing the verification by a QA Officer of a batch. If the desired code is not found in the lookup list please contact your Regional Data Center for assistance. Default value equals NR if unknown.
SubmittingAgencyCode	Text	Y for SFEI RDC, No Default	Organization or agency that is responsible for submission of the data to the database. This agency may be different from LabAgencyCode if the analytical data were subcontracted to another agency.

9.1.3 Standard Operating Procedures (SOPs)

The laboratory's Standard Operating Procedures for preparation, digest extraction, and analytical methods will be submitted along with the analytical results. *The QA Officer/ Project Manager will need to approve major changes in methods from previous years.*

9.2 Data Reporting Requirements

As previously indicated, laboratory personnel shall verify that the measurement process was “in control” (i.e., all specified measurement quality objectives were met or acceptable deviations explained) for each batch of samples before proceeding with the analysis of any subsequent batch. In addition, each laboratory shall establish a system for detecting and reducing transcription and calculation errors prior to reporting data.

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. These (reporting) turnaround times are independent of holding time requirements for samples; in all cases samples should be extracted and analyzed within the holding times specified for the analytical methods used. Turnaround time requirements specified in subcontracts are generally 90 days or less.

B. DATA GENERATION AND AQUISITION

Element 10 Sampling Process Design

10.1 Study Area and Period

Sample collection points and a justification for site selection for the different elements are described in the specific project plans for each of the RMP monitoring elements. Although this QAPP only outlines plans for the next ten years, it is expected that monitoring under the RMP will continue so long as water quality issues are of concern to the Estuary. The RMP water and sediment monitoring stations are located in six hydrographic regions of the Estuary (Figures 6-1 and 6-2). Random design stations are located in five of those regions: Suisun Bay, San Pablo Bay, Central Bay, South Bay, and Lower South Bay. Historic stations are also located in each of those five regions, and additionally at the confluence of the Sacramento and San Joaquin Rivers in the freshwater Rivers region of the Estuary. Sampling timing and frequency varies for the different elements of the monitoring program:

- Bay water monitoring occurs every other year during the dry season for analysis of water quality, certain trace metals (Cu, Se, MeHg, cyanide), aquatic toxicity, and ancillary parameters. Trace organics (PCBs, PAHs, pesticides) are monitored every 10 years (next scheduled for 2023). Water monitoring occurs at 17 random sites and 5 historic sites.
- Tributary water monitoring occurs annually at 6 stations. Samples are analyzed for a subset of the analytes reported in Bay monitoring, focusing on analytes with TMDL targets and other priorities in the Municipal Regional Permit
- Sediment monitoring occurs every four years at 27 sites (20 random sites and 7 historic sites) for the analysis of trace metals, trace organics, ancillary parameters and sediment toxicity. Starting in 2014, sediments are collected in alternate seasons starting with a dry season (summer) collection event followed by a wet season (winter) collection event in the following event (2018).
- Benthic community assessments occur octennially and are collected during scheduled RMP sediment sampling events at 27 sites (20 random sites and 7 historic sites) for dry season sediment sampling years next scheduled for 2022.
- Bivalve bioaccumulation monitoring includes the analysis of trace organics (PAHs and PBDEs) and Selenium biennially. PCBs will be monitored every 8 years, with samples scheduled to be collected in 2014.
- Bird egg sampling occurs triennially for the analysis of Hg, Se, PCBs, PBDEs, and PFCs. Samples were last collected in 2012.
- Sport fish sampling occurs every five years. Samples are analyzed for Hg, Se, PCBs, PBDEs, PFCs and dioxins. Samples will be collected in 2014.

Collected data are used to evaluate future data needs and adjust the sampling and analysis plan as needed in an adaptive manner. The S&T Program is often adjusted to optimize data collection. Please see <http://www.sfei.org/content/status-trends-monitoring> for the latest S&T design.

10.2 Inaccessible Sampling Sites

Issues of site inaccessibility will be evaluated and resolved by different means depending on the project element. RMP Status and Trends ambient water and surface sediment sites that cannot be accessed will be replaced with next oversample site in the region. If there are access issues for cormorant and tern colonies, the researchers will consult with the RMP Exposure and Effects Workgroup (EEWG) and Technical Review Committee (TRC) to evaluate available options (e.g., alternative colonies and delaying sampling). Sport fish sites are popular fishing locations and therefore unlikely to have accessibility issues. Furthermore, because the fishing sites are general areas and fish are mobile, it is possible to move sites slightly while retaining the site names. Tributary loading sites have been selected with input from relevant agencies and landowners; however, if sites are rendered inaccessible (through change of ownership, finding endangered species, etc.), RMP staff will consult with the RMP Sources Pathways and Loadings Workgroup (SPLWG) and TRC to resolve the issue.

10.3 Critical Versus Informational Project Data

Data critical to this project are those that assist with the evaluation of concentrations and loads of contaminants of concern to the Bay, i.e. concentrations of contaminants and ancillary characteristics of analyzed matrices (TOC, lipid, grain size, % solids) needed to interpret measured concentrations and potential impacts (e.g., uptake, toxicity). Informational data (notes on site conditions during and/or preceding sampling events) may help in evaluating the comparability of sites and identifying the causes of variability but are not needed for establishing the validity or representativeness of the reported data. These informational data provide details on site characteristics that may be useful for the scientific interpretation of results but are not always critical for the evaluation of contaminant distribution or loads and impacts.

Element 11 Sampling Methods

The quality of samples collected in the field is addressed through a number of procedures. Proper selection of equipment and supplies and training for use of those items ensures that collection procedures and materials minimally or not 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 RMP.

11.1 Sampling Guidelines

Sampling guidelines, plans, and SOPs have been developed to ensure the collection of representative, uncontaminated, and uncompromised samples. Field personnel will strictly adhere to RMP sampling protocols to ensure the collection of representative, uncontaminated, and uncompromised samples. Briefly, the key requirements for sample collection are as follows:

1. Field personnel will be thoroughly trained in the proper use of sample collection gear and will be able to distinguish acceptable versus unacceptable samples in accordance with pre-established criteria.
2. Field personnel will be thoroughly trained to recognize and avoid potential sources of sample contamination (e.g., engine emissions, winch wires, surfaces, ice used for cooling).
3. Samplers and utensils which come in direct contact with the sample will be made of inert materials that do not contaminate for the particular analytes measured in that sample and will be thoroughly cleaned between sampling stations.
4. Sample containers will be pre-cleaned and of the recommended type for minimizing contamination for the analytes measured.
5. Samples will be sealed, labeled, preserved as needed, and stored under appropriate conditions as soon as practicable.

At Sampling Locations:

1. Stations for RMP monitoring studies will be determined before sampling commences. For sampling sediment and water, a probabilistic study design will be employed. For transplanted and resident bivalves, sites historically used by the RMP will be studied. For sampling bird eggs and sport fish, the monitoring sites will be chosen based on colony locations and popular fishing locations, respectively. For tributary loading, monitoring sites are chosen based on reconnaissance sampling, known or expected source areas, and stakeholder interest.
2. Once in the field, locate the assigned coordinates of the site as best as possible and record the actual coordinates of each station using a hand-held or shipboard global positioning system (GPS).
3. Complete any appropriate parts of Field Data Sheets/Logs. This may include: station ID, date, time, station depth, weather conditions, water color/clarity, latitude, longitude, sample collectors, etc.

4. Sample containers will either be provided by contract laboratories or by project staff according to contract specifications. Bottles will be labeled prior to sample collection according to each site- and project-specific sampling plan. Spare bottles and labels will also be taken to the field.
5. Ancillary measurements will be collected using field meters at every water and sediment site. Personnel using the meters must be trained on their use and care prior to field use. For each measurement, record the water depth. The probes will be rinsed with deionized water after each use and blotted dry prior to recapping and storage.

A multifunction water quality meter (e.g. Seabird CTD, YSI 556, WTW 340i) is used with several probes submerged into the water column to collect dissolved oxygen, pH, temperature, salinity, specific conductance and/or electrical conductance. Redox potential (Eh) of sediment is also measured at several depths in sediment core sub-samples.

Water and sediment ancillary samples will be collected in appropriate containers provided by contract laboratories or by project staff according to contract specifications. Samples measured in the laboratory will be processed within the relevant holding time.

The appropriate volume and bottle type for samples are denoted on the Field Reference Sheet. The appropriate equipment will be used to collect samples (e.g., peristaltic pump, van Veen grab) and clean-hands dirty-hands protocol will be followed.

Recommended preservation conditions and holding times for samples for chemical analyses are listed in Tables 11-1.

11.2 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 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:

Surface Waters:

Sampler

Infiltrax sampler & tubing
or integrated grab (dip) sampler
Sampler tools and spare parts

Nitrile & polyethylene gloves

XAD columns and wound glass-fiber filters

Methanol cleaned aluminum foil

Surface Sediment:

van Veen or Ponar grab sampler

Nitrile gloves.

- Polyethylene gloves
- Coated compositing bucket & sampling spoons
- Methanol, 1.0 % hydrochloric acid, & wash bottles

Bivalves:

- Appropriate diving gear
- Cages or bags for transplanted bivalves

Sport fish

- Otter trawls
- Blocks, Clean poly tubs
- Measuring boards, tape measure, id keys, fish Teflon, underwater labels
- Bone saw, filet knives, gill nets, fish picks, shackles, pliers, sharpening stone
- Rod and reels, bait, tackle box, landing net, live bait container
- Coolers, floats, anchors, patch kit
- Aluminum foil, sealable bags

Bird Eggs

- Appropriate egg packing and transport materials

Tributary Water

- Sampling containers
- Collection devices appropriate for site (D94, DH-81, ISCO Auto sampler)
- Gloves
- Coolers and ice

11.3 Field Sample Collection and Quality Assurance Procedures

11.3.1 Surface Sediment Sample Collection

Contaminants are analyzed annually in surface sediment as part of the annual RMP Status and Trends monitoring, with the sample collection alternating between wet and dry seasons. Surface sediment samples are collected at 27 stations during the dry season and at 47 stations during the wet season. Multiple (two to three) sediment grabs are taken at each site, with sediment subsamples collected for chemical and toxicity analyses. Sediment samples are collected using a Young-modified van Veen grab with a surface area of 0.1 m². The grab is made of stainless steel, and the jaws and doors are coated with Dykon® (formerly known as Kynar®) to make them chemically inert. All scoops, buckets, and stirrers used to collect and homogenize sediments are constructed of Teflon® or stainless steel coated with Dykon®. In order to further minimize sample contamination, personnel handling samples wear gloves and employ clean hands techniques.

Sediment sampling equipment is thoroughly cleaned before sampling following the procedures outlined below:

1. Soak equipment (fully immersed) for three days in a 0.5 % solution of Alconox™ detergent and deionized water.

2. Rinse equipment three times with deionized water and let dry in a clean place.
3. Rinse equipment with 1.0 % solution of hydrochloric acid, followed by a rinse with petroleum ether, followed by another set of three rinses with deionized water. All equipment is then allowed dry in a clean place.
4. The cleaned grab is wrapped in aluminum foil until used in the field. All other equipment is stored in clean Ziploc™ bags until used in the field.

Equipment is cleaned in the field between sampling locations using an abbreviated variation of those procedures:

1. Fill the compositing bucket with site water and add approximately 1/8 cup of Alconox™ detergent to the bucket, and wash all sampling scoops and glass coring tubes in the bucket with the detergent solution. Wash all Kynar™-coated parts of the van Veen/Petite Ponar grab with Alconox™ solution.
2. Completely rinse the grab, bucket, sample scoops and coring tubes with site water.
3. Rinse the grab, bucket, sample scoops and coring tubes with 1.0 % HCl followed with a rinse of methanol.
4. Completely rinse the grab, bucket, sample scoops and coring tubes with deionized water and let air-dry. Cover all cleaned parts with aluminum foil until use.

Personnel from SFEI are responsible for determining if grabs taken meet acceptance criteria. To ensure the integrity of the sediment samples, each grab must satisfy several criteria in order to be accepted: complete closure, no evidence of sediment washout through the doors, even distribution of sediment in the grab, minimum disturbance of the sediment surface, and minimum overall sediment depth appropriate for the sediment type.

Overlying water is drained off an accepted grab, and a probe is inserted directly into the sediment to measure pH. The top 5 cm of sediment is scooped from the remaining area (avoiding portions cored or probed) in each of the grabs and placed in a compositing bucket to provide a single composite sample for each site. Between sample grabs, the compositing bucket is covered with aluminum foil to prevent airborne contamination. After all sediment grabs (or at least two, if complications prevent collection of sufficient material within 20 minutes) are placed into the compositing bucket, the bucket is taken into the ship's cabin and thoroughly mixed to obtain a uniform, homogeneous mixture. Aliquots are subsequently split into appropriate containers for sediment quality, trace metal, trace organics, and toxicity analyses for archive samples.

11.3.2 Surface Water Sample Collection

Ambient surface water samples are collected biannually as part of the RMP Status and Trends monitoring. The water samples will be collected at 22 sites during the dry season every year.

Water samples are collected at a depth of approximately one meter at each sampling site. To avoid aerosol contamination, the sample tubing inlet and outlet will be kept covered until the boat engines are turned off, and the engine will remain off until sampling is completed and the tubing inlet and outlet are once again covered. The inlet of the sampling pump tubing will be attached to an extendable sampling pole and deployed upcurrent and upwind of the sampling vessel where possible.

Collection of water samples for analysis of trace organic contaminants:

An AXYS Infiltrax 300 system (AXYS Environmental Systems, Ltd., Sidney, B.C.) is used to collect all RMP water samples for analysis of trace organic contaminants. It consists of a constant-flow, gear-driven positive displacement pump, 3/8 inch outer diameter fluoropolymer tubing, 1 µm glass fiber cartridge particulate filter, and two parallel Teflon® columns each filled with 75mL of XAD-2 resin beads (size range of 300-900 µm). Amberlite XAD-2 resin is a macroreticular, styrene-divinyl benzene copolymer, nonionic bead, and each bead is an agglomeration of microspheres. The hydrophobic resin beads effectively concentrate hydrophobic contaminants.

Samples are pumped at a flow rate of 1.5 L/min as a compromise between collection yield and speed (~60-70% recovery at 1.5 L/min, versus 80-90% at half that speed). To remove large debris that may jam the pump, the sample water is first passed through a coarse (~1mm mesh) screen before the fluoropolymer intake line. Particles greater than 140 µm are removed by a second inline pre-filter. The water passes through the pump head and a pressure gauge, then through a four-inch diameter, wound glass fiber filter (1 µm nominal pore size). Flow may be redirected to a second installed filter if the first filter becomes clogged. Material retained on the glass fiber filter (or filters) is designated the particulate fraction. After passing through the filter, the water is split and routed through the XAD-2 resin filled columns. Material adsorbed to the XAD-2 resin is designated as the dissolved fraction. Lastly, the water passes through a flow meter and out the exit tube, where the extracted water volume is verified by filling pre-measured carboys.

Whole water samples are collected in clean 4L amber glass bottles for select trace organic analysis using the AXYS Infiltrax System to pump the water (without filters and columns). Once the AXYS Infiltrax system is flushed, the exit tubing is pulled on board and the water samples are collected in 4L amber bottles, being careful not to touch the inside of the bottle or neck of the bottle with the tubing (the outside of the tubing is considered to be contaminated – considerable care needs to be taken not to contaminate the sample). The samples are placed on wet ice. Whole water samples collected for analysis of pesticides are transported to SFEI at the end of each day, preserved with dichloromethane, stored in a refrigerator overnight, and shipped to the lab the following day.

Collection of water samples for analysis of trace element contaminants:

For trace metals, water samples are collected 1 m below the surface using a peristaltic pump system equipped with C-Flex tubing in the pump head. Sample containers, which are stored double-bagged, are filled on deck on the windward side of the ship to minimize contamination from shipboard sources (Flegal and Stukas, 1987). Unfiltered (total) water samples are pumped directly into acid-cleaned containers. Filtered (dissolved fraction) water samples are collected through an acid-cleaned polypropylene filter cartridge (Voss Technologies or Micron Separations, Inc., 0.45 µm pore size) on the outlet of the pumping system. Prior to collecting water samples, several liters of water are pumped through the system and sample bottles are rinsed three times with site water before filling, except those containing a preservative, which are filled without rinsing. A designated “clean hands” collector wearing polyethylene-gloves handles bottles. The sample tubing and fittings are acid-cleaned polyethylene or fluoropolymer, and the inlets and outlets are kept covered except during actual sampling.

For total mercury water samples, 250 to 500 ml of estuary water is collected in mercury-clean fluorinated polyethylene (FLPE) bottles, which are then double-bagged in zip-lock bags. The samples are immediately placed in a cooler on ice.

For methylmercury analyses, samples are collected into 250 ml FLPE bottles, then double-bagged in zip-lock bags. Samples are preserved with 1 – 2 mL 50% sulfuric acid in the field and immediately placed on ice in a cooler.

11.4 Field Sampling SOPs for Sampling Procedures and Equipment

All personnel participating in field sampling of surface water, surface sediment, sediment core elements, and bivalves are required to follow the guidelines set out in the Field Sampling Manual for the Regional Monitoring Program for Trace Substances (David et al. 2001; available online at <http://www.sfei.org/rmp/documentation/fom/FOM2001.pdf>) in order to minimize discrepancy in field results and provide useful, accurate scientific data. Sport fish sampling follows the guidelines set out in the Standard Operating Procedures for Field and Laboratory Processing of Fish Tissue (MLML/MPSL 2001). Bird egg collections are performed as described in Ackerman et al. (2013).

Meter Calibration

Prior to going into the field, all meters are calibrated. The multimeter is calibrated for conductivity with a KCl standard, for dissolved oxygen using a mixture of CoCl_2 and NaSO_3 and/or built-in water saturated air calibration, and for pH using buffers of pH 4, 7, and 10. The Sea-Bird SBE 19 CTD Profiler is factory calibrated and inspected annually by Sea-Bird Electronics in Bellevue, Washington. During normal conditions, the CTD will maintain nominal calibration drift for all sensors except for the oxygen sensor, which must be checked and calibrated prior to each water cruise.

11.5 Corrective Action

If goals stated in the Field Sampling SOPs for the collection of samples or the measurement of water quality parameters are not achieved, where possible, samples will be recollected or measurements repeated 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 later on entered into the electronic version of the Sample Details document that is maintained by SFEI and will be submitted to the Field Supervisor with the final report for this Project. The individuals responsible for assuring that the field staff are properly trained and implement the field SOPs are the SFEI Project Manager, Field Supervisor, and the QA Officer.

Table 11-1. Field Sampling Methods, Sample Size, and Preservation.

Matrix collected	Parameter Group	Analytical Parameter	Method	Fraction	Sampling Method	Target Sample Size	Container Type, size	Field Preservation	Hold Time
Bird egg	ORG	Dioxins/Furans	EPA 1613BM	Total	Hand collected from nests	7 homogenized eggs	Egg, Whirlpack	Store at < 4 °C	1 year
Bird egg	ORG	PBDE	EPA 8081BM	Total	Hand collected from nests	7 homogenized eggs	Egg	Store at <20°C	1 year
Bird egg	ORG	Pesticides	EPA 8081BM	Total	Hand collected from nests	Individual Egg	Egg	Store at <20°C	1 year
Bird egg	ORG	PFC	AXYS MLA-043 Rev 08	Total	Hand collected from nests	Individual Egg	Egg	Store at < 4 °C	NA
Bird egg	TE	Mercury	EPA 7473	Total	Hand collected from nests	Individual Egg	Egg	None	28 days
Bird egg	TE	Selenium	EPA 200.8	Total	Hand collected from nests	7 homogenized eggs	Egg	Store at 4 °C	None
Bivalve	ANC	Growth & Survival	None	None	Transplanted bivalves deployed in unmaintained cages at fixed mooring	30 individuals	Double wrapped in two Ziploc® bags	Frozen on dry ice	NA
Bivalve	ORG	PAH	EPA 8270M	None	Transplanted bivalves deployed in unmaintained cages at fixed	90 individuals	Aluminum foil and Ziploc® bags	Frozen on dry ice	1 year

Matrix collected	Parameter Group	Analytical Parameter	Method	Fraction	Sampling Method	Target Sample Size	Container Type, size	Field Preservation	Hold Time
					mooring				
Bivalve	ORG	PBDE	EPA 1614M	None	Transplanted bivalves deployed in unmaintained cages at fixed mooring	75 individuals	Aluminum foil and Ziploc® bags	Frozen on dry ice	1 year
Bivalve	ORG	PCB	EPA 1668A	None	Transplanted bivalves deployed in unmaintained cages at fixed mooring	75 individuals	Aluminum foil and Ziploc® bags	Frozen on dry ice	1 year
Bivalve	ORG	Pesticides	AXYS MLA-028	None	Transplanted bivalves deployed in unmaintained cages at fixed mooring	75 individuals	Aluminum foil and Ziploc® bags	Frozen on dry ice	1 year
Bivalve	TE	Selenium	EPA 1638M	Total	Transplanted bivalves deployed in unmaintained cages at fixed mooring	15 individuals	Double wrapped in two Ziploc® bags	Frozen on dry ice	1 year

Matrix collected	Parameter Group	Analytical Parameter	Method	Fraction	Sampling Method	Target Sample Size	Container Type, size	Field Preservation	Hold Time
Bivalve	TE	Trace element Suite (Ag, Al, Cd, Cu, Fe, Mn, Ni, Pb, Se, Zn, % Moisture)	EPA 6020AM	Total	Transplanted bivalves deployed in unmaintained cages at fixed mooring	30 individuals	Double wrapped in two Ziploc [®] bags	Frozen on dry ice	30 days @ 4 C, 1 year frozen @< -15C
Sediment	ANC	Eh	None	None	Surface Sediment (0-5cm), annual, alternate wet/dry seasons	None	Measurement on board vessel	None	NA
Sediment	ANC	Grainsize	BCPSA	various	Surface Sediment (0-5cm)	---	Whirl-pak bags	Dark, 4°C	None (for digested samples)
Sediment	ANC	pH	None	None	Surface Sediment (0-5cm), annual, alternate wet/dry seasons	None	Measurement on board vessel	None	NA
Sediment	ANC	TOC/CHN	EPA 440	Total	Surface Sediment (0-5cm)	60mL	Glass 60 mL	Freeze at end of day	TOC - 28 days; CHN - 100 days
Sediment	ORG	Dioxins/Furans	EPA 1613B	Total	Surface Sediment (0-5cm), annual, alternate wet/dry seasons	100 g	Glass 250mL Teflon lid	Dark, frozen	1 year

Matrix collected	Parameter Group	Analytical Parameter	Method	Fraction	Sampling Method	Target Sample Size	Container Type, size	Field Preservation	Hold Time
Sediment	ORG	PAH	EPA 8270	Total	Surface Sediment (0-5cm), annual, alternate wet/dry seasons	250 mL	Clear glass 250 mL	Frozen on dry ice	120 days
Sediment	ORG	PBDE	EPA 1614M	Total	Surface Sediment (0-5cm), annual, alternate wet/dry seasons	250 mL	Clear glass 250 mL	Frozen on dry ice	1 year
Sediment	ORG	PCB	EPA 1668A	Total	Surface Sediment (0-5cm), annual, alternate wet/dry seasons	250 mL	Clear glass 250 mL	Frozen on dry ice	1 year
Sediment	ORG	Pesticides	EPA 1668AM	Total	Surface Sediment (0-5cm), annual, alternate wet/dry seasons	250 mL	Clear glass 250 mL	Frozen on dry ice	1 year
Sediment	ORG	Pyrethroids	EPA 8081BM	Total	Surface Sediment (0-5cm), annual, alternate wet/dry seasons	250 mL	Clear glass 250 mL	Frozen on dry ice	1 year

Matrix collected	Parameter Group	Analytical Parameter	Method	Fraction	Sampling Method	Target Sample Size	Container Type, size	Field Preservation	Hold Time
Sediment	TE	Trace Element Suite (Al, Ag, Cd, Cu, Fe, Pb, Mn, Ni, Zn)	EPA 6020	Total	Surface Sediment (0-5cm)	250 mL	HDPE 250 mL	Frozen on dry ice	30 days @ 4 C, 1 year frozen @<-15C
Sediment	TE	Trace Element Suite (As, Se, Hg, MeHg, % Solids)	various	Total	Surface Sediment (0-5cm)	250 mL	HDPE 250 mL	Frozen on dry ice within 20 minutes of collection	1 year
Sediment, elutriate	TOX	Toxicity	EPA 600/R-94-025	None	Surface Sediment (0-5cm),	4 L	Plastic 1 L	Dark, 4°C	8 weeks
Sediment, overlying water	TOX	Toxicity	EPA 821/R-02-012M	None	Surface Water Interface Cores (SWICs)	3" Cores	3" Cores	Dark, 4°C	2 weeks
Sport fish	ORG	Dioxins/Furans	AXYS MLA-017	Total	Fish caught in San Francisco Bay	Varies by species	Wrapped in aluminum and double bagged	Frozen on dry ice	1 year
Sport fish	ORG	PBDE	EPA 8081BM	Total	Fish caught in San Francisco Bay	Varies by species	Wrapped in aluminum and double bagged	Frozen on dry ice	1 year
Sport fish	ORG	PCB	EPA 8082M	Total	Fish caught in San Francisco Bay	Varies by species	Wrapped in aluminum and double bagged	Frozen on dry ice	1 year
Sport fish	ORG	Pesticides	EPA 8081BM	Total	Fish caught in San Francisco Bay	Varies by species	Wrapped in aluminum and double bagged	Frozen on dry ice	1 year

Matrix collected	Parameter Group	Analytical Parameter	Method	Fraction	Sampling Method	Target Sample Size	Container Type, size	Field Preservation	Hold Time
Sport fish	ORG	PFC	EPA 1613B	Total	Fish caught in San Francisco Bay	Varies by species	Wrapped in aluminum and double bagged	Frozen on dry ice	NA
Sport fish	TE	Mercury	EPA 7473	Total	Fish caught in San Francisco Bay	Varies by species	Wrapped in aluminum and double bagged	Frozen on dry ice	28 days
Sport fish	TE	Selenium	EPA 200.8	Total	Fish caught in San Francisco Bay	Varies by species	Wrapped in aluminum and double bagged	Frozen on dry ice	None
Water, bay	ANC	Ammonium as N	Solorzano, L., 1969	Dissolved	Surface Water (1-2 ft depth)	500 mL	PE 500 mL	H2SO4	28 days
Water, bay	ANC	Chlorophyll	SM 10200 H-2bM	Particulate	Surface Water particulate (1-2 ft depth)	1-2 filters	Place filter in small amber vial	90% MeOH, frozen on dry ice	21 Days
Water, bay	ANC	Dissolved Organic Carbon	EPA 9060	Dissolved	Surface Water dissolved (1-2 ft depth)	250 mL	HDPE 250 mL	1-2 mL H2SO4	28 days
Water, bay	ANC	DO, Conductivity, pH, temp, OBS	None	None	CTD Deployment	None	Measurement on board vessel	None	NA
Water, bay	ANC	DO, Conductivity, pH, temp, Sal	None	None	Grab Measurement on board vessel	None	Measurement on board vessel	None	NA

Matrix collected	Parameter Group	Analytical Parameter	Method	Fraction	Sampling Method	Target Sample Size	Container Type, size	Field Preservation	Hold Time
Water, bay	ANC	Hardness as CaCO ₃	SM 2340 C	Dissolved	Surface Water dissolved (1-2 ft depth) annual summer	500 mL	PE 500 mL	Dark, 4°C	180 days
Water, bay	ANC	Nitrate and Nitrite	EPA 353.2	Dissolved	Surface Water (1-2 ft depth) annual summer	500 mL	PE 500 mL	Frozen on dry ice	48 hours
Water, bay	ANC	OrthoPhosphate as P	EPA 365.3	Dissolved	Surface Water (1-2 ft depth) annual summer	500 mL	PE 500 mL	Frozen on dry ice	48 hours
Water, bay	ANC	Particulate Organic Carbon	EPA 9060M	Particulate	Surface Water particulate (1-2 ft depth)	1-2 filters	Place filter in small amber vial	Frozen on dry ice	100 days
Water, bay	ANC	Phaeophytin	SM 10200 H-2aM	Particulate	Surface Water particulate (1-2 ft depth)	1-2 filters	Place filter in small amber vial	90% MeOH, frozen on dry ice	21 Days
Water, bay	ANC	Salinity	SM 2520 B v20	Dissolved	Surface Water dissolved (1-2 ft depth) annual summer	500 mL	PE 500 mL	Dark, 4°C	28 days
Water, bay	ANC	Silica as SiO ₂	SM 4500-SiO ₂ C	Dissolved	Surface Water dissolved (1-2 ft depth) annual summer	500 mL	PE 500 mL	HNO ₃	28 Days

Matrix collected	Parameter Group	Analytical Parameter	Method	Fraction	Sampling Method	Target Sample Size	Container Type, size	Field Preservation	Hold Time
Water, bay	ANC	Suspended Sediment Concentration	ASTM D3977	Total	Surface Water (1-2 ft depth)	1L and 500ml PE	1L and 500ml PE	Dark, 4°C	7 days
Water, bay	ORG	Dioxins/Furans	EPA 1613B	Dissolved	Surface water (1m depth) 100 liter solid phase extraction	~100 L	XAD Column (column) - Glass, Resin	Dark, 4°C	Undefined
Water, bay	ORG	Dioxins/Furans	EPA 1613B	Particulate	Surface water (1m depth) 100 liter solid phase extraction	~100 L	XAD Column - wound glass filter, foil wrapped	Dark, 4°C	Undefined
Water, bay	ORG	PAH	EPA 8270M	Total	Whole Surface Water (1m depth)	8 L	Amber glass 2 X 4 L	Dark, 4°C, 50 mg/L sodium azide.	7 days
Water, bay	ORG	PAH	EPA 8270M	Dissolved	Surface water (1m depth) 100 liter solid phase extraction	~100 L	XAD Column (column) - Glass, Resin	Dark, 4°C	1 year
Water, bay	ORG	PAH	EPA 8270M	Particulate	Surface water (1m depth) 100 liter solid phase extraction	~100 L	XAD Column - wound glass filter, foil wrapped	Dark, 4°C	1 year
Water, bay	ORG	PAH	EPA 1614M	Particulate	Surface water (1m depth) 100 liter solid phase extraction	~100 L	XAD Column - wound glass filter, foil wrapped	Dark, 4°C	1 year

Matrix collected	Parameter Group	Analytical Parameter	Method	Fraction	Sampling Method	Target Sample Size	Container Type, size	Field Preservation	Hold Time
Water, bay	ORG	PBDE	EPA 1614M	Total	Whole Surface Water (1m depth) annual summer	4 L	Amber glass 4 L	Dark, 4°C	1 year
Water, bay	ORG	PBDE	EPA 1614M	Dissolved	Surface water (1m depth) 100 liter solid phase extraction	~100 L	XAD Column (column) - Glass, Resin	Dark, 4°C	1 year
Water, bay	ORG	PCB	EPA 1668A	Total	Whole Surface Water (1m depth) annual summer	4 L	Amber glass 4 L	Dark, 4°C	1 year
Water, bay	ORG	PCB	EPA 1668A	Dissolved	Surface water (1m depth) 100 liter solid phase extraction	~100 L	XAD Column (column) - Glass, Resin	Dark, 4°C	Undefined
Water, bay	ORG	PCB	EPA 1668A	Particulate	Surface water (1m depth) 100 liter solid phase extraction	~100 L	XAD Column - wound glass filter, foil wrapped	Dark, 4°C	Undefined
Water, bay	ORG	Pesticides	EPA 1699M	Total	Whole Surface Water (1m depth) annual summer	4 L	Amber glass 4 L	200 mL DCM	Not established

Matrix collected	Parameter Group	Analytical Parameter	Method	Fraction	Sampling Method	Target Sample Size	Container Type, size	Field Preservation	Hold Time
Water, bay	ORG	Pesticides	AXYS MLA-028	Dissolved	Surface water (1m depth) 100 liter solid phase extraction	~100 L	XAD Column (column) - Glass, Resin	Dark, 4°C	Undefined
Water, bay	ORG	Pesticides	AXYS MLA-028	Particulate	Surface water (1m depth) 100 liter solid phase extraction	~100 L	XAD Column - wound glass filter, foil wrapped	Dark, 4°C	Undefined
Water, bay	TE	Cyanide	SM 4500-CN I v20	Weak Acid Dissociable	Surface Water (1-2 ft depth)	500 mL	HDPE 500 mL	NaOH to a pH ≥ 12	14 days if preserved
Water, bay	TE	Iron/Manganese	EPA 1638M	Total/Dissolved	Surface Water (1-2 ft depth)	500 mL	HDPE 500 mL	Dark, 4°C	6 months
Water, bay	TE	Mercury	EPA 1631E	Total/Dissolved	Surface Water (1-2 ft depth)	250 mL	FLPE 250 mL	Dark, 4°C	90 days
Water, bay	TE	Methyl Mercury	EPA 1630M	Total/Dissolved	Surface Water (1-2 ft depth)	250 mL	FLPE 250 mL	1-2 ml 50% H2SO4	6 months
Water, bay	TE	Silver	EPA 1640M	Total/Dissolved	Surface Water (1-2 ft depth)	1 L	HDPE 1 L	Dark, 4°C	6 months
Water, bay	TE	Trace Elements Suite (As, Cd, Co, Cu, Ni, Pb, Se, Zn)	EPA 1640M	Total/Dissolved	Surface Water (1-2 ft depth)	500 mL	HDPE 500 mL	Dark, 4°C	6 months
Water, bay	TOX	Toxicity	EPA 1007.0	None	Surface water (1m depth)	20L	20L FLPE	Dark, 4°C	36 hours

Matrix collected	Parameter Group	Analytical Parameter	Method	Fraction	Sampling Method	Target Sample Size	Container Type, size	Field Preservation	Hold Time
Water, tributary	ANC	Ammonium as N	Solorzano, L., 1969	Dissolved	ISCO Pump, hand filled	50 ml	1 pint	H2S04	28 days
Water, tributary	ANC	Hardness as CaCO3	EPA 1638M	Total	ISCO Auto Sampler	1.8 L	1.8 L	HNO3	180 days
Water, tributary	ANC	Nitrate as N	EPA 300.1	Dissolved	ISCO Pump, hand filled	200 ml	1 pint	Ice	48 hours
Water, tributary	ANC	Nitrite as N	EPA 300.1	Dissolved	ISCO Pump, hand filled	200 ml	1 pint	Ice	48 hours
Water, tributary	ANC	Nitrogen, Total Kjeldahl	SM 4500-N org C	Total	ISCO Pump, hand filled	150 ml	1 quart	H2S04	28 days
Water, tributary	ANC	OrthoPhosphate as P	EPA 300.1	Dissolved	ISCO Pump, hand filled	200 ml	1 pint	Ice	48 hours
Water, tributary	ANC	Phosphorus as P	SM4500-P E	Total	ISCO Pump, hand filled	150 ml	1 quart	H2S04	28 days
Water, tributary	ANC	Suspended Sediment Concentration	ASTM D3977	Total	4 Wheel Boom Truck with D-95 lowered by winch	100 ml	232 ml	Ice	7 days
Water, tributary	ANC	Total Organic Carbon	SM 5310 C	Total	ISCO Pump, hand filled	40 ml	3 X 40 ml	HCL	28 days
Water, tributary	ORG	Carbaryl	EPA 632M	Total	ISCO Auto Sampler	1.8 L	1.8 L	Ice	7 days
Water, tributary	ORG	Fiprinol	EPA 619M	Total	ISCO Auto Sampler	1.8 L	1.8 L	Ice	7 days
Water, tributary	ORG	PAH	EPA 8270M	Total	ISCO Pump, hand filled	2.5 L	2.5 L	Ice	7 days
Water, tributary	ORG	PBDE	EPA 1614M	Total	ISCO Pump, hand filled	2.5 L	2.5 L	Ice	One year
Water, tributary	ORG	PCB	EPA 1668A	Total	ISCO Pump, hand filled	2.5 L	2.5 L	Ice	One year

Matrix collected	Parameter Group	Analytical Parameter	Method	Fraction	Sampling Method	Target Sample Size	Container Type, size	Field Preservation	Hold Time
Water, tributary	ORG	Pyrethroids	AXYS MLA-046	Total	ISCO Auto Sampler	0.9 L	1.8 L	Ice	3 days
Water, tributary	TE	Copper	EPA 1638M	Total/Dissolved	ISCO Auto Sampler	1.8 L	1.8 L	HNO3	180 days
Water, tributary	TE	Mercury	EPA 1631EM	Total	4 Wheel Boom Truck with D-95 lowered by winch	100 ml	500 ml	HCL	90 days
Water, tributary	TE	Mercury, Methyl	EPA 1630M	Total	4 Wheel Boom Truck with D-95 lowered by winch	100 ml	500 ml	HCL	90 days
Water, tributary	TE	Selenium	EPA 1638M	Total/Dissolved	ISCO Auto Sampler	1.8 L	1.8 L	HNO3	180 days
Water, tributary	TOX	Toxicity	EPA 821/R-02-013 (4 day test duration) or EPA 600/R-99-064M (10 day test duration)	None	ISCO Auto Sampler	15 L	4-3.7 L	Ice	48 hours

Element 12 Sample Handling and Custody

12.1 Field Sample Handling and Shipping Procedures

Samples are maintained chilled on ice in coolers or refrigerators or frozen on dry ice or in freezers, if required. Appropriate preservation conditions and holding times for various sample types and analyses are given in Tables 11-1 and 12-1. Samples will be checked periodically to ensure that samples are appropriately protected and ice is added as needed. Container lids are checked for tightness and sealed with tape if necessary. Immediately upon return from the field, the samples will be packed with more ice or dry ice as appropriate, and then protectively wrapped and shipped to the respective laboratories via overnight carrier, or placed into appropriate storage (refrigerator or freezer, or kept in coolers on wet or dry ice), if shipping that day is not possible. For sampling events occurring on Thursdays or Fridays, staff should consider the potential for shipping delays (e.g. customs, bad weather) and the laboratory work schedule, which could allow samples to thaw or warm. Consult with laboratory staff as needed to determine whether holding time or storage condition is a more critical factor to sample integrity for the analyses to be performed.

All shipped samples will be accompanied by a 'Chain of Custody' form that serves as a shipping record and indicates the pertinent sample identification information and analyses requested for each sample (Figure 12-1). Chain of custody (COC) forms are filled out, copied, and stored each time control of samples is transferred (e.g., from the field to a receiving laboratory or between laboratories). In addition to standard shipping information, the following information is required: sampling event number, site name and code, collection date, sample type, analysis required, preservatives added, and other remarks as needed. If the field crew is identical to the laboratory analysts, COCs are not required, but are recommended to document sample identification and handling information.

The Project Manager at SFEI is responsible for sample handling, tracking, and chain of custody forms. Copies of all COCs are maintained in SFEI records.

12.2 Sample Disposal Procedures

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.

Page 123 of 180

Element 13 Analytical Methods

13.1 Field Analytical/ Measurement Methods

Measurements performed in the field are recorded in field logs (electronic or paper) for subsequent entry in the RMP database. Samples collected in the field are 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 log. 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.

All SFEI field staff will follow the Field Sampling Manual for the Regional Monitoring Program for Trace Substances (David et al. 2001; available online at <http://www.sfei.org/rmp/documentation/fom/FOM2001.pdf>) for standard water quality measurements and the collection of water, sediment, and bioassessment samples outlined in Element 11. Equipment will be deployed continuously only at tributary sampling sites, where a boom is deployed in the water for monitoring of turbidity. The turbidity probe has an automatic wiper that clears the lens of any possible fouling every five minutes. No modifications to the method described in the Field Sampling Manual are necessary.

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 SFEI Project Manager, Field Operations Manager, and the QAO will be responsible for ensuring that staff document all deviations from planned operations and schedule repairs and/or additional training as needed.

13.2 Laboratory Analytical Methods

A Performance-Based Measurement System (PBMS) is a flexible approach wherein the data quality needs, mandates or limitations of a program or project are specified, and serve as criteria for selecting appropriate methods to meet those needs in a cost-effective manner, rather than prescribing particular methods for analyses. Although methods for laboratory analyses are listed in Tables 12-1, the RMP ascribes to a PBMS approach, so the listed methods document the methods being currently being used or planned for Project studies rather than prescribing particular analytical methods. Additional parameters may be added to these lists for future monitoring.

Using the PBMS approach, the SFEI Project Manager must apply systematic planning utilizing the Monitoring Plan, the Project Assessment and Evaluation Plan (PAEP), and the QAPP to establish the goals and data quality needs for the particular project. He/she must also have answered key questions addressed through these three planning documents that help determine the appropriate methods to be used.

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.

13.2.1 Laboratory SOPs

All analytical methods SOPs will be requested from the respective analytical laboratories. Copies of laboratory SOPs are also stored at SFEI but cannot be released to any external parties without prior consent of the laboratory.

13.2.2 Corrective Actions Procedures

Corrective actions for laboratory analytical failures will be specified in the laboratory analytical method SOPs.

13.3 Non-Standard Methods Used

Due to extremely low surface water concentrations of many organic analytes, a non-standard method for pre-concentration of large (~100 L) water samples through use of wound fiberglass filters and adsorbent resin (XAD-2) columns is employed to allow detection of some of the less abundant congeners. This method provides concentrations that often bias (~30-40%) low relative to results from whole water grab samples collected at the same time for various organic analytes (PCBs and PAHs), so results generally represent likely minimum concentrations of those compounds in water. Large (2 to 10L) whole water samples may also be collected for some analytes (e.g., for some legacy and current use pesticides), which will also deviate slightly from a laboratory's or EPA's standard methods, as standardized methods often describe procedures for extraction and analysis of 1 L samples. These latter modifications of sample size (rather than of sampling method) are generally considered inconsequential unless QA/QC data included with reporting of samples indicate otherwise.

Element 14 Quality Control

14.1 Field QC Procedures

14.1.1 Field QC Measurements

Calibration of any field meters (e.g. hand-held pH, temperature, conductivity, DO, or other measurements) should be checked in the field at least once daily and recalibrated using certified standards where possible. Instruments will be recalibrated when significant drift or miscalibration 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 replicates at a frequency of one per day or per 20 measurements, taken on a spatial and temporal scale at which measurements are expected to be relatively invariant, as the goal is to establish the precision of a measurement, rather than just characterize the variability of the ecosystem.

14.1.2 Field QC Samples

Field QC samples that are frequently collected for later lab analysis in sampling protocols are listed below. Some of these samples only need to be taken when an established procedure is changed or when problems are identified, whereas others need to be taken at intervals throughout the sampling process. These may include:

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.
3. Field Blanks: These account for all of the above sources of contamination that might be introduced to a sample as well as those due to the immediate field environment. 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.
4. Field Replicates: These account for variability in the field collection and laboratory analysis combined.

Routine preparation, collection, and analysis of all the field performance samples mentioned above are generally not necessary. Of the possible blank samples, only 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. 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 field effort (e.g. a set of samples collected by the same methods over the duration of a sampling cruise) or approximately per 20 sites. 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, without adding any water matrix, as “clean” lab water that might be used in a field blank could introduce contamination not present in any field samples taken (i.e., lab water is not normally mixed with site water in a sample). Field blanks for integrated (Infiltrax-collected) water samples will be generated through simulated loading and unloading of the Infiltrax system, again without pumping any water through the collection filter or columns. Collection of true

sediment field blanks is similarly logistically difficult and has been deemed unnecessary due to precautions taken that minimize contamination of the samples, previously outlined in section 11.3 of this QAPP.

In studies performed for other SFEI projects, travel/bottle blanks analyzed usually showed that they are not a significant source of contamination, so travel blanks are seldom collected. Labs generally send sample containers that have already been checked for contamination, and transport of unopened bottles is unlikely to introduce contamination. Possible contamination during the transport between the laboratory and field site will be mitigated by measures taken to keep the sample bottles in an enclosed microenvironment (e.g. double bagging). Travel and equipment blanks will rarely be collected unless field blanks or field sample results indicate potential problems.

Field replicates of all types of samples to be analyzed will be routinely collected at a minimum frequency of 1 per 20 samples to evaluate variability including performance of the sampling system and methodology. Short-term environmental variability, most notably due to changing currents and heterogeneous suspended sediment loads, can affect the sampling reproducibility, although water is generally more easily mixed and thus often consistent between field replicates. In contrast, sediment contaminant concentrations can vary greatly within small distances. Therefore, much of the variability captured in sediment field replicates reflects spatial variability of the sampling scheme rather than of performance of the collection and analytical methods.

14.2 Laboratory QC Procedures

14.2.1 Laboratory QC Samples

Sample types and MQOs for laboratory analyses were previously specified in Section 7 of this QAPP. Data to be provided to the project manager for evaluation 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
4. Replicate precision:(field, CRM, matrix spike, blank matrix spike samples)
5. Certified/Lab Reference Material (CRM) Recovery

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. Results for organic analytes should generally be reported as surrogate-corrected, unless specific issues are identified (e.g. analytical interference for the surrogate, but not the target compound) that would render the surrogate-corrected result less accurate than the uncorrected result. The results for individual surrogates should also be reported, as percent recoveries (i.e., not just applied to correct target analyte results).

Method blanks should be run at a minimum frequency of one per batch 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, even (and especially) when field sample results are reported as blank-corrected. Batches with a single method blank measurement cannot be reported as blank-corrected, as in such cases there is no data on the variability (and thus appropriateness) of the subtracted blank value.

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 (Section 14.2.1). 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 or RSDs 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 frequency of one per 20 samples, a minimum of one per set (e.g., reported for one sampling season) of samples analyzed, with results 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 14.1 provides specific laboratory analytical QC requirements for each parameter. In the table below, “1 per 20 or batch” indicates a minimum of 1 sample per 20 (field samples) in larger batches, or 1 in each batch of less than 20 samples. In contrast, a frequency of “1 per 20 or set” indicates 1 sample per 20 (field samples) analyzed, regardless of analytical batch size, with a minimum of 1 for each set of project samples reported (e.g., from one sampling cruise).

Table 14-1. Laboratory Analytical QC

⁺ Lab Duplicates – although duplicates of field samples are preferred, in all the tables below, lab duplicates of other sample types (e.g., CRMs, LRMs, MSs) may be used to supplement (e.g., where field sample concentrations are variable and include non-detects) or to replace duplicates of field samples (e.g., where concentrations are expected to be all non-detects based on past monitoring). Such substitutions of duplicate sample types should be discussed with and approved by the Project Manager and QAO beforehand.

Cormorant and Tern Bird Eggs

Matrix: Cormorant/Tern Bird Eggs		
Sampling SOP: USGS Egg Collection Report		
Analytical Parameter(s): Trace Metals – Mercury (Total)		
Analytical Method/SOP Reference: EPA 7473		
# Sample locations: All In-Bay Nesting Colonies		
Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	NA	
Others:	NA	

Matrix: Cormorant/Tern Bird Eggs		
Sampling SOP: USGS Egg Collection Report		
Analytical Parameter(s): Trace Metals – Selenium		
Analytical Method/SOP Reference: EPA 200.8		
# Sample locations: All In-Bay Nesting Colonies		
Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	NA	
Others:	NA	

Matrix: Cormorant Bird Eggs		
Sampling SOP: USGS Egg Collection Report		
Analytical Parameter(s): Dioxins		
Analytical Method/SOP Reference: EPA 1613BM		
# Sample locations: All In-Bay Nesting Colonies		
Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL

Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate ⁺	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per EPA 1613BM
Others:	NA	

Matrix: Cormorant/Tern Bird Eggs
Sampling SOP: USGS Egg Collection Report
Analytical Parameter(s): PBDEs
Analytical Method/SOP Reference: EPA 8081BM
Sample locations: All In-Bay Nesting Colonies

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per EPA 8081BM
Others:	NA	

Matrix: Cormorant Bird Eggs
Sampling SOP: USGS Egg Collection Report
Analytical Parameter(s): PCBs
Analytical Method/SOP Reference: EPA 8082M
Sample locations: All In-Bay Nesting Colonies

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per EPA 8082M
Others:	NA	

Matrix: Cormorant Bird Eggs
Sampling SOP: USGS Egg Collection Report
Analytical Parameter(s): Perfluorinated Compounds (PFCs)
Analytical Method/SOP Reference: AXYS MLA-043 Rev 08
Sample locations: All In-Bay Nesting Colonies

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL

Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per AXYS MLA-043 Rev 08
Others:	NA	

Matrix: Cormorant Bird Eggs

Sampling SOP: USGS Egg Collection Report

Analytical Parameter(s): Pesticides

Analytical Method/SOP Reference: EPA 8081BM

Sample locations: All In-Bay Nesting Colonies

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per EPA 8081BM
Others:	NA	

Tissue - Bivalves

Matrix: Tissue (Bivalves)

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates – Survival, Dry Weight, and Growth (weight)

Analytical Method/SOP Reference: None

Sample locations: All Bivalve Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	NA	
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	NA	
Lab. Duplicate	1 per 20 or batch	RPD or RSD NA
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value NA
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value NA
Surrogates	NA	
Others:	NA	

Matrix: Tissue (Bivalves)

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates – Lipids and Moisture

Analytical Method/SOP Reference: AXYS MLA-010 Rev 11, AXYS MLA-028 Rev 06, AXYS MLA-033 Rev 06

Sample locations: All Bivalve Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <20%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 20%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 20%
Surrogates	NA	
Others:	NA	

Matrix: Tissue (Bivalves)

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Trace Metals - Selenium

Analytical Method/SOP Reference: EPA 1638M

Sample locations: All Bivalve Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	NA	
Others:	NA	

Matrix: Tissue (Bivalves)

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): PAHs

Analytical Method/SOP Reference: AXYS MLA-021 Rev 10 (EPA 8270M)

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per AXYS MLA-021 Rev 10 (EPA 8270M)
Others:	NA	

Matrix: Tissue (Bivalves)

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): PBDEs

Analytical Method/SOP Reference: AXYS MLA-033 Rev 04 (EPA 1614M)

Sample locations: All Bivalve Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per AXYS MLA-033 Rev 04 (EPA 1614M)
Others:	NA	

Matrix: Tissue (Bivalves)

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): PCBs

Analytical Method/SOP Reference: AXYS MLA-010 Rev 09 (EPA 1668AM)

Sample locations: All Bivalve Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per AXYS MLA-010 Rev 09
Others:	NA	

Matrix: Tissue (Bivalves)

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Pesticides

Analytical Method/SOP Reference: AXYS MLA-028 Rev 05

Sample locations: All Bivalve Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per AXYS MLA-028 Rev 05
Others:	NA	

Sediment

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates – Clay, Fine, Granule + Pebble, Sand, Silt

Analytical Method/SOP Reference: BCPSA

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <20% of total mass/volume
Lab. Matrix Spike/Duplicate	NA	Expected Value NA
Lab./Cert. Ref. Material	1 per 20 or set	Set by lab
Surrogates	NA	
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates - Total Nitrogen

Analytical Method/SOP Reference: EPA 440

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <15%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 15\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 15\%$
Surrogates	NA	
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates - Total Organic Carbon

Analytical Method/SOP Reference: EPA 440

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <10%

Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 10\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 10\%$
Surrogates	NA	
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Trace Metals – Total Solids

Analytical Method/SOP Reference: EPA 160.3, EPA 1684, EPA 6020AM, SM 2540 G, WPCL SOP 67 (EPA 8081BM)

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD NA
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value NA
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value NA
Surrogates	NA	
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Trace Metals - Arsenic

Analytical Method/SOP Reference: EPA 1638M

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	NA	
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Trace Metals – Aluminum, Cadmium, Copper, Iron, Lead, Manganese, Nickel, Silver, and Zinc

Analytical Method/SOP Reference: EPA 6020AM

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	

Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <25%%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 25%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 25%
Surrogates	NA	
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Trace Metals - Mercury

Analytical Method/SOP Reference: BR-0002 Rev 010 (EPA 1631M)

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	NA	
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Trace Metals – Methyl Mercury

Analytical Method/SOP Reference: EPA 1630M

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	NA	
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Trace Metals - Selenium

Analytical Method/SOP Reference: BR-0020 Rev 007 (EPA 1632M/EPA 1632AM)

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab

Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	NA	
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Dioxins

Analytical Method/SOP Reference: EPA 1613B

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per EPA 1613B
Others:	NA	

Matrix: Sediment

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): PAHs

Analytical Method/SOP Reference: EPA 8270M

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per EPA 8270M
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): PBDEs

Analytical Method/SOP Reference: EPA 1614M

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab

Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per EPA 1614M
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): PCBs

Analytical Method/SOP Reference: EPA 1668A, 1668AM, and 1614M

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per EPA 1668A, 1668AM, and 1614M
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Pesticides

Analytical Method/SOP Reference: EPA 1668AM

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per EPA 1668AM
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Pyrethroids

Analytical Method/SOP Reference: EPA 8081BM

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab

Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per EPA 8081BM
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Toxicity – *Ceriodaphnia dubia* - Survival

Analytical Method/SOP Reference: EPA 821/R-02-012M

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD NA
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value NA
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value NA
Surrogates	NA	
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Toxicity – *Eohaustorius estuarius* - Survival

Analytical Method/SOP Reference: EPA 600/R-94-025

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD NA
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value NA
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value NA
Surrogates	NA	
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Toxicity – *Hyalella azteca* – Growth (wt/surv indiv) and Survival

Analytical Method/SOP Reference: EPA 600/R-99-064

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab

Lab. Duplicate	1 per 20 or batch	RPD or RSD NA
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value NA
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value NA
Surrogates	NA	
Others:	NA	

Matrix: Sediment

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Toxicity – *Mytilus galloprovincialis* – Survival

Analytical Method/SOP Reference: EPA 600/R-95-136M

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD NA
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value NA
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value NA
Surrogates	NA	
Others:	NA	

Sport Fish

Matrix: Sportfish – Striped Bass, Shiner Surfperch, and Leopard Shark

Sampling SOP: RMP Fish Monitoring Program Field Plans

Analytical Parameter(s): Trace Metals – Mercury

Analytical Method/SOP Reference: EPA 7473

Sample locations: All In-Bay Waters

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value ±35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value ±35%
Surrogates	NA	
Others:	NA	

Matrix: Sportfish – All Target Species

Sampling SOP: RMP Fish Monitoring Program Field Plans

Analytical Parameter(s): Trace Metals – Selenium

Analytical Method/SOP Reference: EPA 200.8

Sample locations: All In-Bay Waters

Laboratory QC	Frequency/Number	Acceptance Limits
---------------	------------------	-------------------

Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	NA	
Others:	NA	

Matrix: Sportfish – White Croaker and Shiner Surfperch
Sampling SOP: RMP Fish Monitoring Program Field Plans
Analytical Parameter(s): Dioxins
Analytical Method/SOP Reference: AXYS MLA-017 Rev 17
Sample locations: All In-Bay Waters

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate ⁺	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per AXYS MLA-017 Rev 17
Others:	NA	

Matrix: Sportfish – All Target Species
Sampling SOP: RMP Fish Monitoring Program Field Plans
Analytical Parameter(s): PBDEs
Analytical Method/SOP Reference: EPA 8081BM
Sample locations: All In-Bay Waters

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per EPA 8081BM
Others:	NA	

Matrix: Sportfish – All Target Species
Sampling SOP: RMP Fish Monitoring Program Field Plans
Analytical Parameter(s): PCBs
Analytical Method/SOP Reference: EPA 8082M
Sample locations: All In-Bay Waters

Laboratory QC	Frequency/Number	Acceptance Limits
---------------	------------------	-------------------

Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per EPA 8082M
Others:	NA	

Matrix: Sportfish – All Target Species except Jacksmelt
Sampling SOP: RMP Fish Monitoring Program Field Plans
Analytical Parameter(s): Perfluorinated Compounds (PFCs)
Analytical Method/SOP Reference: AXYS MLA-043 Rev 08
Sample locations: All In-Bay Waters

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per AXYS MLA-043 Rev 08
Others:	NA	

Matrix: Sportfish – All Target Species
Sampling SOP: RMP Fish Monitoring Program Field Plans
Analytical Parameter(s): Pesticides
Analytical Method/SOP Reference: EPA 8081BM
Sample locations: All In-Bay Waters

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per EPA 8081BM
Others:	NA	

Tributary Water

Matrix: Tributary Water
Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Cognates - Ammonium as N

Analytical Method/SOP Reference: Solorzano, L., 1969

Sample locations: All In-Bay Tributary Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <15%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 15\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 15\%$
Surrogates	NA	
Others:	NA	

Matrix: Tributary Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Cognates - Hardness as CaCO₃/Total Hardness (calc)

Analytical Method/SOP Reference: SM 2340 C and EPA 1638M

Sample locations: All In-Bay Tributary Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <5%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 5\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 5\%$
Surrogates	NA	
Others:	NA	

Matrix: Tributary Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Cognates - Nitrate as N

Analytical Method/SOP Reference: EPA 300.1 and SM 4500-NO₃ F

Sample locations: All In-Bay Tributary Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <15%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 15\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 15\%$
Surrogates	NA	
Others:	NA	

Matrix: Tributary Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Cognates - Nitrite as N

Analytical Method/SOP Reference: EPA 300.1 and SM 4500-NO₂ B

Sample locations: All In-Bay Tributary Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <15%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 15%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 15%
Surrogates	NA	
Others:	NA	

Matrix: Tributary Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Cognates - Nitrogen, Total Kjeldahl

Analytical Method/SOP Reference: SM 4500-N org C and SM 4500-NH₃ C v20

Sample locations: All In-Bay Tributary Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <15%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 15%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 15%
Surrogates	NA	
Others:	NA	

Matrix: Tributary Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Cognates - Orthophosphate as P

Analytical Method/SOP Reference: EPA 300.1 and SM 4500-P E

Sample locations: All In-Bay Tributary Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <10%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 10%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 10%
Surrogates	NA	
Others:	NA	

Matrix: Tributary Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Cognates – Phosphorus as P

Analytical Method/SOP Reference: SM 4500-P E

Sample locations: All In-Bay Tributary Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <10%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 10\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 10\%$
Surrogates	NA	
Others:	NA	

Matrix: Tributary Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Cognates - Suspended Sediment Concentration

Analytical Method/SOP Reference: ASTM D3977

Sample locations: All In-Bay Tributary Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <10%
Lab. Matrix Spike/Duplicate	NA	NA
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 10\%$
Surrogates	NA	
Others:	NA	

Matrix: Tributary Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Cognates - Total Organic Carbon

Analytical Method/SOP Reference: SM 5310 B and SM 5310 C

Sample locations: All In-Bay Tributary Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <10%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 10\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 10\%$
Surrogates	NA	
Others:	NA	

Matrix: Tributary Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Trace Metals – Copper and Selenium

Analytical Method/SOP Reference: EPA 1638 and EPA 1638M

Sample locations: All In-Bay Tributary Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD Cu <25%; Se <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value Cu $\pm 25\%$; Se $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value Cu $\pm 25\%$; Se $\pm 35\%$
Surrogates	NA	
Others:	NA	

Matrix: Tributary Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Trace Metals – Mercury

Analytical Method/SOP Reference: EPA 1631, EPA 1631E, and EPA 1631EM

Sample locations: All In-Bay Tributary Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	NA	
Others:	NA	

Matrix: Tributary Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Trace Metals – Mercury, Methyl

Analytical Method/SOP Reference: EPA 1630 and EPA 1630M

Sample locations: All In-Bay Tributary Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	NA	
Others:	NA	

Matrix: Tributary Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): Carbaryl

Analytical Method/SOP Reference: EPA 632M		
# Sample locations: All In-Bay Tributary Water		
Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per EPA 632M
Others:	NA	

Matrix: Tributary Water		
Sampling SOP: Internal Field Sampling Manuals		
Analytical Parameter(s): Fipronil		
Analytical Method/SOP Reference: EPA 619M		
# Sample locations: All In-Bay Tributary Water		
Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per EPA 619M
Others:	NA	

Matrix: Tributary Water		
Sampling SOP: Internal Field Sampling Manuals		
Analytical Parameter(s): PAHs		
Analytical Method/SOP Reference: AXYS MLA-021 Rev 10 (EPA 8270M)		
# Sample locations: All In-Bay Tributary Water		
Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per AXYS MLA-021 Rev 10 (EPA 8270M)
Others:	NA	

Matrix: Tributary Water		
Sampling SOP: Internal Field Sampling Manuals		
Analytical Parameter(s): PBDEs		

Analytical Method/SOP Reference: AXYS MLA-033 Rev 06 (EPA 1614M)		
# Sample locations: All In-Bay Tributary Water		
Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per AXYS MLA-033 Rev 06 (EPA 1614M)
Others:	NA	

Matrix: Tributary Water		
Sampling SOP: Internal Field Sampling Manuals		
Analytical Parameter(s): PCBs		
Analytical Method/SOP Reference: AXYS MLA-010 Rev 11 (EPA 1668A)		
# Sample locations: All In-Bay Tributary Water		
Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per AXYS MLA-010 Rev 11 (EPA 1668A)
Others:	NA	

Matrix: Tributary Water		
Sampling SOP: Internal Field Sampling Manuals		
Analytical Parameter(s): Pyrethroids		
Analytical Method/SOP Reference: AXYS MLA-046 Rev 04 and EPA 8270M_NCI		
# Sample locations: All In-Bay Tributary Water		
Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per AXYS MLA-046 Rev 04 and EPA 8270M_NCI
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates - Ammonium as N

Analytical Method/SOP Reference: Solorzano, L., 1969

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <15%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 15\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 15\%$
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates - Chlorophyll a, Phaeophytin a

Analytical Method/SOP Reference: SM 10200 H-2aM, SM 10200 H-2bM

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <10%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 10\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 10\%$
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates - Dissolved Organic Carbon

Analytical Method/SOP Reference: EPA 9060

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <10%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 10\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 10\%$
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates - Hardness as CaCO₃

Analytical Method/SOP Reference: EPA 130.2

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <5%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 5%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 5%
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates - Nitrate as N and Nitrite as N

Analytical Method/SOP Reference: EPA 353.2

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <15%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 15%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 15%
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates - Orthophosphate as P

Analytical Method/SOP Reference: EPA 365.3

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <10%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 10%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 10%
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates - Particulate Organic Carbon

Analytical Method/SOP Reference: EPA 9060M

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <10%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 10\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 10\%$
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates - Salinity

Analytical Method/SOP Reference: SM 2520B

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <5%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 5\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 5\%$
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates - Silica as SiO₂

Analytical Method/SOP Reference: SM 4500-SiO₂ C (EPA 370.1)

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <10%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 10\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 10\%$
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Cognates - Suspended Sediment Concentration

Analytical Method/SOP Reference: ASTM D3977

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <10%
Lab. Matrix Spike/Duplicate	NA	NA
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 10%
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Field Measures – CTD Meter – Backscatter, Density, Dissolved Oxygen, Electrical Conductivity, Pressure, Salinity, and Temperature

Analytical Method/SOP Reference: SeaBird SB-19

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD NA
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value NA
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value NA
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Field Measures - Shipboard – Dissolved Oxygen, pH, Salinity, Specific Conductivity, and Temperature

Analytical Method/SOP Reference: YSI 556 Water Quality Meter

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD NA
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value NA
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value NA
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Trace Metals – Arsenic, Cadmium, Cobalt, Copper, Lead, Nickel, Selenium, Silver, and Zinc

Analytical Method/SOP Reference: EPA 1640

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <25%; As and Se <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 25\%$; As and Se ± 35
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 25\%$; As and Se ± 35
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Trace Metals – Cyanide

Analytical Method/SOP Reference: SM 4500-CN I v20

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <25%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 25\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 25\%$
Surrogates	NA	
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Trace Metals – Iron and Manganese

Analytical Method/SOP Reference: EPA 1638M

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <25%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 25\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 25\%$
Surrogates	NA	
Others:	NA	

Matrix: Water
 Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances
Analytical Parameter(s): Trace Metals – Mercury
 Analytical Method/SOP Reference: EPA 1631EM
 # Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	NA	
Others:	NA	

Matrix: Water
 Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances
Analytical Parameter(s): Trace Metals – Methyl Mercury
 Analytical Method/SOP Reference: EPA 1630M
 # Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	NA	
Others:	NA	

Matrix: Water
 Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances
Analytical Parameter(s): Dioxins
 Analytical Method/SOP Reference: EPA 1613B
 # Sample locations: All In-Bay Surface Water & Tributary Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate ⁺	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per EPA 1613B
Others:	NA	

Matrix: Water

Sampling SOP: Internal Field Sampling Manuals

Analytical Parameter(s): PAHs

Analytical Method/SOP Reference: AXYS MLA-021 Rev 10 (EPA 8270M)

Sample locations: All Surface Sediment Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per AXYS MLA-021 Rev 10 (EPA 8270M)
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): PBDEs

Analytical Method/SOP Reference: AXYS MLA-033 Rev 05 (EPA 1614M)

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per AXYS MLA-033 Rev 05 (EPA 1614M)
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): PCBs

Analytical Method/SOP Reference: AXYS MLA-010 Rev 10 (EPA 1668A)

Sample locations: All In-Bay Surface Water

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value $\pm 35\%$
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value $\pm 35\%$
Surrogates	Every sample	Per AXYS MLA-010 Rev 10 (EPA 1668A)
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Pesticides

Analytical Method/SOP Reference: AXYS MLA-035 Rev 05 (EPA 1699M)

Sample locations: All In-Bay Surface Water Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD <35%
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value \pm 35%
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value \pm 35%
Surrogates	Every sample	Per AXYS MLA-035 Rev 05 (EPA 1699M)
Others:	NA	

Matrix: Water

Sampling SOP: Field Sampling Manual for the Regional Monitoring Program for Trace Substances

Analytical Parameter(s): Toxicity – *Americamysis bahia* – Biomass (wt/orig indiv) and Survival

Analytical Method/SOP Reference: EPA 1007.0

Sample locations: All In-Bay Surface Water Sites

Laboratory QC	Frequency/Number	Acceptance Limits
Method Blank	1 per 20 or batch	<MDL
Reagent Blank	NA	
Storage Blank	NA	
Instrument Blank	12 hours	Set by lab
Lab. Duplicate	1 per 20 or batch	RPD or RSD NA
Lab. Matrix Spike/Duplicate	1 per 20 or batch	Expected Value NA
Lab./Cert. Ref. Material	1 per 20 or set	Expected Value NA
Surrogates	NA	
Others:	NA	

Element 15 Instrument/Equipment Testing, Inspection, and Maintenance

Field measurement equipment will be checked for operation in accordance with the manufacturer's specifications. This includes battery checks, routine replacement of membranes, and cleaning of electrodes. All equipment will be inspected for damage or malfunction when first handed out and when returned from use by the field sampling crew. Needed repairs or operational problems are to be reported to the Field Supervisor. The Field Supervisor will also (or instruct appropriate staff to) examine equipment at least quarterly for operational status, even if no sampling using that equipment is immediately planned.

Operating manual for the SFEI field instruments can be found at the following links:

YSI 556: https://www.ysi.com/DocumentServer/DocumentServer?docID=WQS_556_MANUAL

WTW Multi 340i: http://www.wtw.com/media/LabandFieldCatalog2006_I.pdf

Hach 2100p: http://www.fondriest.com/products/hach_2100p.htm

Instruments delivered through a manufacturer were equipped with a corresponding accessory case including spare parts and maintenance supplies. All spare parts will be transported to the site and will be available for replacing malfunctioning parts. Additionally, two extra sets of batteries will be available in the field.

If any instrument deficiency should occur, troubleshooting can be conducted on site utilizing the instrument manual and experience of the field staff, making any necessary repairs, and re-calibration. All incidents and issues regarding the proper functioning of the equipment will be recorded on the Field Form and reported to the SFEI Field Supervisor.

Contract laboratories maintains 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.

Recommended frequencies for equipment testing, inspection, and maintenance activities are listed in Table 15-1.

Table 15-1. Testing, inspection, maintenance of field equipment and laboratory instruments

Equipment / Instrument	Maintenance, Testing, or Inspection Activity	Responsible Person	Frequency	SOP Reference
HRGC/HRMS	1. Checking 2. Replacing consumables	Chemist	Daily	SIN-005 and SIN-004
Campbell Scientific CS450 (stage)	1. Cleaning 2. Factory calibration	1. Field operator(s) 2. Manufacturer	1. Monthly 2. Semi-annually	CS450 Instruction Manual
Campbell Scientific OBS-500 (turbidity)	1. Cleaning 2. Factory calibration	1. Field operator(s) 2. Manufacturer	1. Monthly 2. Annually	OBS-500 Operators Manual
DH-81	1. Cleaning 2. Testing operation	Field operator(s)	Before storm event	2014 POC Monitoring Field Instructions
FISP D-95	1. Cleaning 2. Testing operation	Field operator(s)	Before storm event	2014 POC Monitoring Field Instructions
FTS DTS-12 (turbidity)	1. Cleaning 2. Factory calibration	1. Field operator(s) 2. Manufacturer	1. Monthly 2. Annually	DTS-12 Instruction Manual
Hach 2100p (turbidity)	1. Cleaning 2. Testing	Field operator(s)	1. After use 2. Quarterly or ~7 days before use	Hach 2100p Operating Manual 7 th ed. (Aug2001)
Infiltrex	1. Cleaning 2. Testing operation	Field operator(s)	1. After use 2. Prior to use	See below
ISCO 6712	1. Cleaning 2. Testing operation	Field operator(s)	Before storm event	2014 POC Monitoring Field Instructions
TE-525 (rainfall)	1. Cleaning 2. Calibration	Field operator(s)	1. Monthly 2. Annually	TE525 Instruction Manual
van Veen	1. Cleaning 2. Testing operation	Field operator(s)	1. After use 2. Prior to use	See below
WTW Multi 340i (pH, Specific Conductivity, DO)	1. Cleaning 2. Testing	Field operator(s)	1. After use 2. Quarterly or ~7 days before use	WTW operating manual Mar2004
YSI 556 Multimeter	1. Cleaning 2. Testing	Field operator(s)	1. After use 2. Quarterly or ~7 days before use	YSI 556 operations manual (2004)

Element 16 Instrument/Equipment and Calibration Frequency

Prior to use in the field (typically several days before), 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. If possible, problems with an instrument are addressed by field staff, who will also notify the Field Supervisor and other staff trained in troubleshooting and/or repair. For instruments that cannot be repaired in-house, the Field Supervisor in consultation with the Program Manager will choose an appropriate course of action, either sending the instrument for repair, or purchasing a replacement as necessary.

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 at least a 2-point calibration covering the range of expected measurements. Use the 3rd pH standard (or standard supplied by another manufacturer) to verify calibration accuracy.
2. Conductivity – use KCl or other standard with known specific conductivity (often ~1.4mS/cm). Verify instrument response with DI water or other standard of lower or higher concentration.
3. Dissolved oxygen – use calibration procedure recommended by manufacturer, typically in water-saturated air. Check response in deoxygenated water or site water with either higher or lower DO than at saturation.
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.
5. Turbidity – calibrate Hach 2100p using appropriate dilutions of manufacturer-recommended standard (Formazin stock solution or Gelex secondary standards)

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 0.990 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 minimum of three analytical standards of increasing concentration, 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, 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.

Table 16-1. Calibration of equipment and analytical instruments

Equipment / Instrument	Testing Activity or Inspection Activity	Responsible Person	Frequency	SOP Reference
3-Point balance	Calibration	Professional	Annually	EPA 1640
Analytical Balance	Calibration	Lab Operator	Every day	ASTM D3977
AQ2 computer controlled multi-chemistry discrete analyzer	Initial Calibration	Lab Operator	Annually	SM 4500-NO3 F
AQ2 computer controlled multi-chemistry discrete analyzer	Initial Calibration Verification	Lab Operator	Before every analytical run	SM 4500-NO3 F
AQ2 computer controlled multi-chemistry discrete analyzer	Continuing Calibration	Lab Operator	Every 10 Samples	SM 4500-NO3 F
Atomic Absorption Spectrophotometer	Primary Calibration	Lab Operator	Initially	EPA 7473
Atomic Absorption Spectrophotometer	Daily Calibration	Lab Operator	Before each run	EPA 7473
Atomic fluorescence spectrophotometer	Calibration	Lab Operator	Initially	EPA 1631E
Atomic fluorescence spectrophotometer	Calibration	Lab Operator	Every day and whenever CCV recovery falls outside criteria	EPA 1631EM
Bran & Luebbe AA3 Flow Injection Analyzer and Data System	Establish Calibration Curve	Lab Operator	Not specified	EPA 353.2
Bran & Luebbe AA3 Flow Injection Analyzer and Data System	Calibration Verification	Lab Operator	Every analysis	EPA 353.2
Conductivity Meter	Check Standard	Lab Operator	Before every	SM 2520B

Equipment / Instrument	Testing Activity or Inspection Activity	Responsible Person	Frequency	SOP Reference
Conductivity Meter	Calibration	Lab Operator	analytical run Monthly or if check standard is outside of 688-724 µmho/cm	SM 2520B
GC/MS	Initial Calibration	Lab Operator	Before every analytical run	EPA 8270M
GC/MS	Daily Calibration	Lab Operator	Every 12 hours	EPA 8270M
GC-ECD/GC-MSMS	Calibration Standards	Lab Operator	Before every analytical run	EPA 8081BM
GC-ECD/GC-MSMS	Second Source Check Standards	Lab Operator	Before every analytical run	EPA 8081BM
GC-ECD/GC-MSMS	Initial Calibration	Lab Operator	Before every analytical run	EPA 8081BM
GC-ECD/GC-MSMS	Initial Calibration Verification	Lab Operator	Before every analytical run	EPA 8081BM
GC-ECD/GC-MSMS	Continuing Calibration	Lab Operator	Every 10 Samples	EPA 8081BM
GC-ECD/GC-MSMS	Initial Calibration	Lab Operator	Before every analytical run	EPA 8082M
GC-ECD/GC-MSMS	Initial Calibration Verification	Lab Operator	Before every analytical run	EPA 8082M
GC-ECD/GC-MSMS	Continuing Calibration	Lab Operator	Every 10 Samples	EPA 8082M
GC-ECD/GC-MSMS	Calibration Standards	Lab Operator	Before every analytical run	EPA 8082M
HPLC-MS/MS	Initial Calibration	Lab Operator	Initially and as required to maintain verification daily	AXYS MLA-043
HRGC/HRMS	Initial Calibration	Lab Operator	Initially and as required to maintain verification daily	AXYS MLA-010, AXYS MLA-028, AXYS MLA-035, AXYS MLA-043, AXYS MLA-046, AXYS MLA-017, AXYS MLA-033, EPA1614M
HRGC/HRMS	Calibration Verification	Lab Operator	Every 12 hours	AXYS MLA-010, AXYS MLA-028, AXYS MLA-035,

Equipment / Instrument	Testing Activity or Inspection Activity	Responsible Person	Frequency	SOP Reference
				AXYS MLA-046, AXYS MLA-017, AXYS MLA-033, EPA1614M
HRGC/HRMS	PFK Calibration	Lab Operator	Initially and as required to maintain verification	EPA 1668A, EPA 1668AM
HRGC/HRMS	Ion abundance ratios	Lab Operator	Every analysis	EPA 1668A, EPA 1668AM
HRGC/HRMS	Isotope Dilution Calibration	Lab Operator	Every analysis	EPA 1668A, EPA 1668AM
HRGC/HRMS	Internal Standard Calibration	Lab Operator	Every analysis	EPA 1668A, EPA 1668AM
HRGC/LRMS	Sensitivity Check	Lab Operator	Before every analytical run	AXYS MLA-021
HRGC/LRMS	Initial Calibration	Lab Operator	Initially and as required to maintain verification daily	AXYS MLA-021
HRGC/LRMS	Calibration Verification	Lab Operator	Every 12 hours for PAHs, Every 12 to 14 hours for alkanes.	AXYS MLA-021
HRGC/LRMS	Bracketing Calibration	Lab Operator	Between analytical runs	AXYS MLA-021
ICP-MS	Instrument Performance Check	Lab Operator	Before the start of each analytical run	EPA 200.8
ICP-MS	Continuous Calibration	Lab Operator	Run calibration blank and standards following each calibration routine, after every 10 samples and at the end of each run	EPA 200.8
ICP-MS	Instrument Performance Check	Lab Operator	Before the start of each analytical run	EPA 1638M
ICP-MS	Dual Detector Cross Calibration	Lab Operator	Before the start of each analytical run	EPA 1638M
ICP-MS	Internal Standard Calibration	Lab Operator	Before the start of each analytical run	EPA 1638M

Equipment / Instrument	Testing Activity or Inspection Activity	Responsible Person	Frequency	SOP Reference
Inductively coupled plasma-mass spectrometer	Initial Calibration	Lab Operator	Daily	EPA 6020AM
Inductively coupled plasma-mass spectrometer	Initial Calibration Verification	Lab Operator	Every analysis	EPA 6020AM
Inductively coupled plasma-mass spectrometer	Continuing Calibration Verification	Lab Operator	At the end of each run and after every 10 samples	EPA 6020AM
Inductively coupled plasma-mass spectrometer	Low Level Continuing Calibration Verification	Lab Operator	At the end of each run, optionally after every 10 samples if low-level sample concentrations are expected	EPA 6020AM
Inductively coupled plasma-mass spectrometer	Interference Check	Lab Operator	At the beginning of each run or once every 12 hours, whichever is more frequent	EPA 6020AM
Inductively coupled plasma-mass spectrometer	Linear Dynamic Range	Lab Operator	Initial setup or after significant maintenance	EPA 6020AM
Ion chromatograph	Initial Calibration Check	Lab Operator	Before start of each analytical run	EBMUD 300.1
Ion chromatograph	Continuous calibration	Lab Operator	Every 10 samples and at the end of every run	EBMUD 300.1
Lachat QuikChem AE Flow Injection Analyzer and Data System	Establish Calibration Curve	Lab Operator	Not specified	EPA 353.2
Lachat QuikChem AE Flow Injection Analyzer and Data System	Calibration Verification	Lab Operator	Every analysis	EPA 353.2
MERX Methylmercury Autoanalyzer	Initial Calibration	Lab Operator	Initially	EPA 1630
MERX Methylmercury Autoanalyzer	Calibration	Lab Operator	Used to establish initial calibration	EPA 1630M

Equipment / Instrument	Testing Activity or Inspection Activity	Responsible Person	Frequency	SOP Reference
MERX Methylmercury Autoanalyzer	Continuous Calibration	Lab Operator	After 10 runs	EPA 1630M
Model 1010 Total Organic Carbon Analyzer	Infrared detector linearization	Lab Operator	Before every analytical run	EPA 9060
Model 1010 Total Organic Carbon Analyzer	Infrared detector linearization verification	Lab Operator	Before every analytical run	EPA 9060
Model 1010 Total Organic Carbon Analyzer	Independent Calibration Verification	Lab Operator	Before every analytical run	EPA 9060
Model 1010 Total Organic Carbon Analyzer	Continuing Calibration	Lab Operator	Every 10 Samples	EPA 9060
Perkin Elmer model 2400 or LECO Micro Truspec CHN	Initial Calibration	Lab Operator	Every analysis	EPA 440
Perkin Elmer model 2400 or LECO Micro Truspec CHN	Calibration Verification	Lab Operator	Every analysis	EPA 440
Perkin Elmer model 2400 or LECO Micro Truspec CHN	Continuing Calibration	Lab Operator	Every analysis	EPA 440
Shimadzu TOC_VCSH Analyzer	Initial Calibration	Lab Operator	Annually	SM 5130 B
Shimadzu TOC_VCSH Analyzer	Initial Calibration Verification	Lab Operator	Before every analytical run	SM 5130 B
Shimadzu TOC_VCSH Analyzer	Continuing Calibration	Lab Operator	Every 10 Samples	SM 5130 B
Spectrophotometer	Calibration	Lab Operator	Daily	EBMUD 437
Spectrophotometer	Calibration	Lab Operator	With every analyte	EBMUD 488 Phosphorus
Spectrophotometer	O-Phos and T-Phos Calibration	Lab Operator	Every analysis	EPA 365.3
Spectrophotometer	Calibration Verification	Lab Operator	Every analysis	EPA 365.3, SM 4500-P E

Equipment / Instrument	Testing Activity or Inspection Activity	Responsible Person	Frequency	SOP Reference
Spectrophotometer	Continuing Calibration	Lab Operator	3 times per 17 samples	SM 4500-SiO ₂ C, EPA 370.1
Spectrophotometer	Zero with DI Water		Before every analytical run	SM 4500-CN
Spectrophotometer	Performance Evaluation		Annually	SM 4500-CN
Spectrophotometer	Wavelength Check		Annually	SM 4500-CN
Spectrophotometer	Method Detection Limit		Annually	SM 4500-CN
Spectrophotometer	Initial Calibration	Lab Operator	Annually	SM 4500-NO ₂ B
Spectrophotometer	Initial Calibration Verification	Lab Operator	Before every analytical run	SM 4500-NO ₂ B
Spectrophotometer	Continuing Calibration	Lab Operator	Every 10 Samples	SM 4500-NO ₂ B
Spectrophotometer	Initial Calibration	Lab Operator	Annually	SM 4500-P E
Spectrophotometer	Initial Calibration Verification	Lab Operator	Before every analytical run	SM 4500-P E
Spectrophotometer	Continuing Calibration	Lab Operator	Every 10 Samples	SM 4500-P E
Spectrophotometer	Zero with 90% Methanol		Before every analytical run	SM 10200 H-2bM
Spectrophotometer	Calibration		Before every analytical run	SM 10200 H-2bM
Spectrophotometer	Calibration		Daily	Solorzano, L., 1969
Spectrophotometer	Continuing Calibration		Minimum 1 calibration blank and 3 calibration standards per workgroup	Solorzano, L., 1969
Tecator auto analyzer	Initial Calibration	Lab Operator	Initially	SM 4500-NH ₃ C
UV-Persulfate TOC Analyzer, Dohrmann Phoenix8000	Calibration	Lab Operator	Before each run	SM 5130 C

Element 17 Inspection/Acceptance of Supplies and Consumables

Supplies are examined for completeness, damage, and/or suitability for use as they are received whenever possible, and upon use for supplies that should remain sealed (e.g. Infiltrax wound fiberglass filters are wrapped in foil and cannot be opened and viewed without risking contamination). The Project Manager or designated staff (e.g. Field Supervisor, or field sampling personnel) will be responsible for inspecting supplies for damage and suitability for use. Checks should include the following:

1. Sample containers – should be appropriately sealed (e.g. double bagged), of the correct/expected materials, with appropriate documentation of cleaning or testing (batch numbers, residue tests), visibly clean, and intact (no evidence of degradation, damage).
2. pH, conductivity, and other standards are to be checked by comparing their measurements with those generated by the current lot of standards, unless the current lot is expired or is suspected to have been compromised. Standards must agree within 1%. If results disagree, the instruments should be checked with standards from another source.
3. Other supplies such as gloves, coolers, and ice packs should be checked for condition and integrity before use in the field. Supplies should be of appropriate materials both to avoid contaminating samples (e.g. powder free gloves) and to protect field staff from chemicals to which they might be exposed during sampling (methanol washes, preservative acids, etc.)

Missing, damaged, or incorrect field supplies should be noted and immediately reported to the SFEI Project Manager and Field Supervisor, who will then contact the appropriate suppliers and laboratories to replace damaged items. Chemical supplies and calibration standards should be checked at least quarterly to meet the required criteria (e.g., expiration date) and to assure that decreasing and missing supplies are reordered. The SFEI staff responsible for ordering laboratory supplies and chemicals are Linda Russio and Phil Trowbridge. The analytical laboratory maintains 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 or issues noted by SFEI staff receiving supplies indicate otherwise (e.g. container damage, visible contamination). SFEI 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 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.

Element 18 Non-direct Measurements (Existing Data)

Non-direct measurements, in the form of data from previously conducted studies by SFEI and other parties in the region, 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 Element 7 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.

Element 19 Data Management

Data Formatting and Transfer

Laboratories may provide analytical data and associated QA/QC information in a format and time frame agreed upon with the Project Manager or designee. Each year, data formatting and reporting expectations are clearly identified and distributed to participating laboratories.

Data are maintained as established in Element 9. SFEI maintains an inventory of data and its forms and periodically checks the inventory against the records in their possession. Laboratories should maintain a record of recently transferred records and periodically assesses them against those actually held by SFEI. SFEI's database is backed up to tape on a weekly basis. Backup tapes are kept for eight weeks before they are written over, with annual backups maintained indefinitely as archives in case of corruption or loss of data on SFEI data servers and weekly backups. Each backup session validates whether the files on tape are accurate copies of the data currently on servers. SFEI also maintains an access log showing who accessed the database when and what was done during the session. All changes to the database are stored in a transaction database with the possibility of rollback, if necessary.

The data management scheme for field data is to maintain these results in a series of tables within the database as per the SWAMP database design.

SFEI's standard record keeping and tracking practices include maintaining a tracking database of all datasets received and uploaded to the project's database and an update table in the database to track all additions, deletions, and updates to the data tables.

The document control system used by SFEI is to append the date received to the name of each new version of a dataset, document, or database. In addition, separate folders are maintained to organize original files received, work files, and final files.

The contact individual responsible for steps and tasks of data management is Amy Franz (email: amy@sfei.org; telephone: 510-746-7394).

To determine acceptability of new software and hardware, SFEI's System Administrator carefully reviews the suitability of the software and hardware for SFEI's information technology infrastructure.

19.1 Checklist Used for Data Management

EDD SUMMARY FORM

Dataset: (Year/Program/Matrix/ Analyte)			
	Last updated:		
	Next step:		
	Lab:		
	Date Received:		
	Tracking ID:		
File Location:			

Formatting/QA Review Steps	Date	Staff
Format		
• Data Submitted through EDD Checker		
• SOPs on file		
• Review QA Narrative		
• Check PRs and RPDs		
• Format data		
• Prepare Appendix Table(s)		
QA Review		
• Generate QA/QC Summary		
• Validate according to SFEI SOP/QAPP		
• Notify RMP staff of changes/final status		
• Update Compliance Code (From 'Pend' to 'Com' or 'Rej')		
QA Review Feedback		
• Send QA review summary to lab		

Dataset Issues and Comments:

Question/Description	Response/ Status	Date Resolved	Staff

Formatting Issue to be addressed:

Data Quality Issues to be addressed:

QA/QC Summary:

C. ASSESSMENT AND OVERSIGHT

Element 20 Assessment and Response Actions

Laboratory Performance Audits/Corrective Action

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 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).

The progress of the work conducted on RMP studies will be evaluated monthly. If data quality issues are identified, a preliminary meeting will be held between SFEP'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.

Element 21 Reports to Management

RMP data are publicized through RMP Annual Monitoring or/and Pulse of the Estuary reports, which are available online via the SFEI website or as printed hardcopies, as well as in downloadable data tables. Reporting of pilot and special study results are included in reports for those components, e.g. in triennial reports on contaminants in fish and bird egg monitoring.

Following general goals for RMP reporting, data from monitoring samples are reviewed and available for dissemination within one year of the sample collection. More detailed analyses such as statistical analyses and/or modeling of temporal and spatial trends follow the specific reporting timelines of those program elements. Reporting goals may be modified as study plans are further developed.

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 analyses and reports generated from the data, to ensure that QA issues are appropriately acknowledged and addressed.

Table 21-1. Reporting Time Line

Deliverable	Deliverable Due Date
Sample receipt at the laboratory	Within holding times requirements, <1 month for holding time ≥ 6 months
Data package submission by lab	90 days after sample receipt or as stipulated by contract
Data reviewed and approved, or QC issues identified and corrective action planned	1 month after data package receipt
Corrective actions taken (e.g. reanalysis)	1 month after corrective action planned
Final Report	1 year after sampling complete

D. DATA VALIDATION AND USABILITY

Element 1 Data Review, Verification, and Validation

After data are submitted and included in the RMP database, SFEI staff examine 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 QAO or designee will examine submitted QA data for conformance with MQOs, specified previously (Element 7). 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 may be flagged to alert data users to uncertainties in quantitation. Results greatly outside the target MQO range (z-scores or p-scores >2) 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 RMP. Characteristics of reported data are examined to identify possible problems in the generation and transmission of data. Data submitted to the RMP are compared to values in the literature for comparable environments and from previous SFEI monitoring to evaluate their environmental coherence. 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.

Where groups of analytes or results in different environmental phases are or can be summed to generate totals (e.g., % gravel + sand + fines = 100%, dissolved + particulate = total), data sets or individual samples will be further checked for internal consistency. For example, total water concentrations of contaminants should generally be greater than dissolved concentrations. Gross deviances may be used to identify problems in sampling, analysis, quantitation, or data transcription and transmission. Problems found by SFEI staff will be relayed to the appropriate laboratory and field sampling staff to address. However, in some cases (particularly where the differences are on the order of the MDL), dissolved results less than totals may indicate the uncertainty typical for the analytical method and apparent anomalies will be evaluated on a case-by-case basis.

Element 2 Verification and Validation Methods

Data are submitted to SFEI in electronic and hardcopy form. The Project Manager 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. A minimum of 5% of submitted data are spot-checked visually and recorded as checked by initials and dates to ensure that electronic and hardcopy reports agree. SFEI's QA Officer performs all reviews and SFEI's Project Manager performs a check of 10% of the reports. 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 are reviewed by SFEI. 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, etc.).

Reported QC sample data are compared to measurement quality criteria specified previously (Element 7). 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's Project Manager, QAO, Field Supervisor, and Analyst(s) with 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 Project Manager and QAO in consultation with the Laboratory, results for sample groups with data outside of MQOs may be flagged, 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. However, consider for example a batch of samples in which the odds of an airborne microparticulate contaminant in the lab falling into an individual sample is 10%. In a batch of samples, 1 in 10 times that contamination enters the blank sample, raising alarm and perhaps triggering reanalysis. Repeated blank analysis in various batches will apparently pass muster 90% of the time, but contamination may in reality still affect 10% of the non-blank field samples. By eliminating the "failed" batches with contamination in blanks, all that remain are the seemingly good batches, with no indication of the level of contamination that is truly still present in many (10%) of the samples. As a good practice, sample results in batches with detected blank contamination will be flagged (for field samples with analyte concentration >3x those found in method blanks) or censored (for results <3x those in blanks) by SFEI, 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 $\pm 50\%$ 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 reanalyses are 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 analyses 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, but 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.

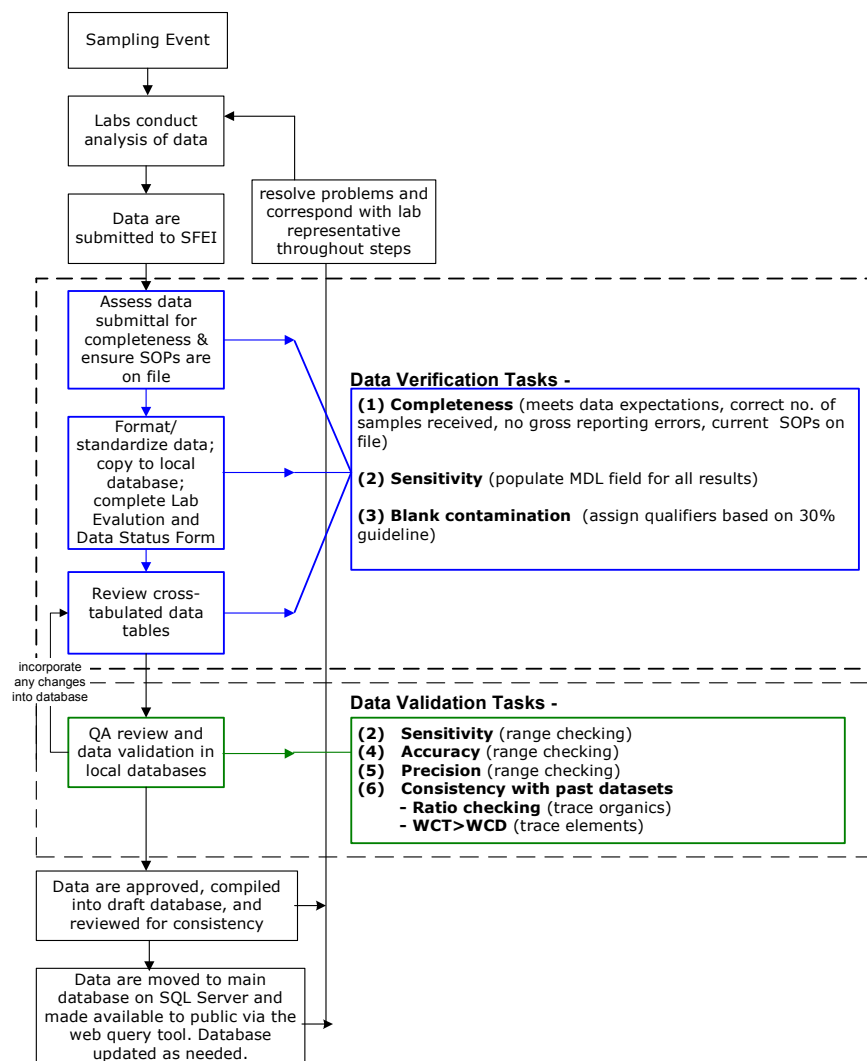
The QA/QC requirements presented in the preceding sections are intended to provide a common foundation for each laboratory's protocols; the resultant QC data will enable assessment of the comparability and uncertainty of results generated by different laboratories and analytical procedures. It should 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.

4. Relative abundance in sample fractions or matrices – contaminants often partition between phases in predictable ratios, depending on their chemical properties and ambient conditions such as dissolved organic carbon and sediment organic carbon content. Big differences from expected ratios in dissolved versus particulate phases for water samples or sediment versus porewater concentrations may indicate problems with extraction or analysis for individual samples or sets of samples. In particular, sample concentrations for filtered (dissolved phase) water samples should always be lower than results for whole (dissolved and particulate phase) water, although at low concentrations, the variability in quantitation may be sufficient for some total water results to be reported at concentrations lower than those for dissolved phase alone.

RMP DATA FLOW DIAGRAM



Element 3 Reconciliation with User Requirements

RMP studies need sufficient numbers of data points, as represented by the completeness data quality objective, in order to characterize ambient condition, conduct trend analyses, and evaluate the potential impact on water quality. A failure to achieve the numbers of data points cited could mean an inability to provide these assessments.

All data are reviewed by the QAO to determine if the results have met the 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 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 RMP uses a subset of the available codes to flag various QC issues as needed.

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

Measurement quality objectives listed previously (Section 14) 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 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 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.

Element 4 References

- Ackerman, J. T., Herzog, M. P. and Schwarzbach, S. E. 2013. Methylmercury is the Predominant Form of Mercury in Bird Eggs: A Synthesis. *Environmental Science and Technology* 47(4):2052-2060.
- CEDEN. 2014. CEDEN - California Environmental Data Exchange Network. Data Templates. Retrieved from http://www.ceden.org/ceden_datatemplates.shtml
- Keith, L. H. 1991. *Environmental Sampling and Analysis: A Practical Guide*. Lewis Publishers. Chelsea, MI.
- Keith, L. H., Crummett, W., Deegan, J., Libby, R. A., Taylor, J. K. and Wentler, G. 1983. Principles of Environmental Analysis. *Analytical Chemistry* 55(14): 2210-2218.
- SFBRWQCB. 2010. San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan). California Regional Water Quality Control Board, San Francisco Bay Region. Oakland, CA.
- Solorzano, L. 1969. Determination of ammonia in natural waters by the phenolhypochlorite method. *Limnology and Oceanography* 14:799.
- USEPA. 1985. Ambient Water Quality Criteria for Mercury - 1984. EPA 440/5-84-026. Office of Water Regulations and Standard Criteria and Standards Division. United States Environmental Protection Agency. Washington, DC.
- USEPA. 1986. Quality Criteria for Water 1986. EPA 440/5-86-001. Office of Water Regulations and Standard Criteria and Standards Division. United States Environmental Protection Agency. Washington, DC.
- USEPA. 1993. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliances. *Federal Register* 57(246):60848.
- USEPA. 1997. 40 CFR Part 131.38. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Proposed Rule. *Federal Register* 62(150):42159-42208.

Element 5 Appendices

Abbreviations

Abbreviation	Meaning
ASTM	American Society of Testing and Materials
AXYS	AXYS Analytical Services, Ltd.
BPTCP	Bay Protection and Toxic Cleanup Program
CEDEN	California Environmental Data Exchange Network
CDFG	California Department of Fish and Game
COC	Chain of Custody
CRM	Certified Reference Material
DOC	Dissolved Organic Carbon
DO	Dissolved Oxygen
MQO	Measurement Quality Objective
EC ₅₀	Effect concentration of toxicant that produces a specific measurable effect in 50% of the test organisms within stated study time
EPA	Environmental Protection Agency
ELAP	Environmental Laboratory Accreditation Program
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GC	Gas Chromatography
GC-ECD	Gas Chromatography-Electron Capture Detection
GLP	Good Laboratory Practice
GPS	Global Positioning System
LC ₅₀	Concentration at which a toxicant is lethal to 50% of test organisms
LRM	Laboratory Control Material
LOEC	Lowest Observable Effects Concentration
LOQ	Limit of Quantitation
MDL	Method Detection Limits
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NELAP	National Environmental Laboratory Accreditation Program
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NOEC	No Observable Effect Concentration
NPDES	National Pollutant Discharge Elimination System
NRCC	National Research Council Canada
NS&T	National Status and Trends Program
OSHA	Occupational Safety and Health Administration
ORP	Oxidation Reduction Potential
PMSD	Percent Minimum Significant Difference
QA/QC	Quality Assurance/Quality Control
QAO	Quality Assurance Officer
QAPP	Quality Assurance Program Plan
RDC	Regional Data Center
RMP	Regional Monitoring Program for Water Quality in San Francisco Bay

Abbreviation	Meaning
RSD	Relative Standard Deviation
SFEI	San Francisco Estuary Institute
SOP	Standard Operating Procedure
SSC	Suspended Sediment Concentration
STDEV	Standard Deviation
SWRCB	(California) State Water Resources Control Board
SWAMP	(California) Surface Water Ambient Monitoring Program
TEQ	Toxic Equivalent
TOC	Total Organic Carbon
USGS WERC	United States Geological Survey Western Ecological Research Center