October Cruise Report

2023 RMP Water Cruise

Contract No. 1649

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Submitted to:

San Francisco Estuary Institute
4911 Central Ave
Richmond, CA 94804

Submitted by:

APPLIED marine SCIENCES

4749 Bennett Drive, Suite L
Livermore, CA 94551
925-373-7142

1. Introduction

This report details activities associated with the biannual Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP) water cruise. The RMP water sampling program was redesigned in 2002 to adopt a randomized sampling design at thirty-one sites in place of the twenty-six "spine of the Estuary" stations sampled previously. In 2007, the number of sites was decreased to twenty-two stations, combined probabilistic and historic, and it remained as such for 2023.

2. Cruise Report

2.1. Objectives

All sampling was conducted from the *RV TomCat* operated by Marine Applied Research and Exploration (MARE). The objectives of the sampling effort were to collect the following:

Collect Real-time Data on Field Parameters

1. Real-time data over the duration of sampling for conductivity, temperature, optical backscatter (OBS), and dissolved oxygen (DO) by AMS (1 meter CTD cast for duration of sampling, plus a full water column profile where water depth allows).
2. Logged data from 22 stations for on-board (field meter) measurement of DO, pH, salinity, conductivity,turbidity, and temperature by AMS.
3. Document current and recent weather conditions at each station.

Collect Water Samples - Total Fraction (Unfiltered water samples)

4. 22 stations (and 2 field replicates and 1 field blank) for analysis of Weak Acid Dissociable (WAD) Cyanide (CalTest)
5. 22 stations (and 2 field replicates and 1 field blank) for analysis of SSC (CalTest)
6. 5 stations (and 1 field split for lab dupe) for analysis of SSC (CCSF)
7. 22 stations (and 2 field replicates) for analysis of Chl-a (CalTest)
8. 22 stations (and 2 field replicates and 2 field blanks and 2 matrix spikes) for analysis of bisphenols (SGS-AXYS)
9. 22 stations (and 2 field replicates and 2 field blanks and 2 matrix spikes) for analysis of organophosphate esters (SGS-AXYS)
10. 22 stations (and 2 field replicates and 2 field blanks and 2 matrix spikes) for analysis of PFAS (SGS-AXYS)
11. 22 stations (and 2 field replicates and 2 field blanks) for analysis of TOP (SGS-AXYS)
12. 1 station for analysis of PFAS (Eurofins West Sacramento)
13. 1 station for analysis of PFAS (Enthalpy)
14. 5 stations (and 2 field blanks) for analysis of quaternary ammonium compounds (UMN)
15. 4 stations (and 1 field blank and 1 [field-prepared] lab control spike and 4 field replicates) for analysis of pharmaceuticals (GEM; Global Estuaries Monitoring)

Collect Water Samples - Particulate Fraction (Filters)

16. 22 stations (and 2 field replicates and 1 field blank) for Particulate Organic Carbon (POC) (ALS)
17. 22 stations (and 2 field replicates and 1 field blank) for analysis of particulate Cu (BAL)
18. 5 stations (plus matrix spike and lab dupe filters at one station) for analysis of particulate Cu (CCSF)

Collect Water Samples - Dissolved Fraction (Filtrate)

Whole water sample collected and to be filtered in the cabin:

19. 22 stations (and 2 replicates and 1 blank) for analysis of Dissolved Organic Carbon (DOC) (ALS)

Water collected after attaching pre-cleaned filter provided by BAL to the end of the tubing:

20. 22 stations (and 2 replicates and 1 blank) for analysis of hardness (BAL)
21. 22 stations (and 2 replicates and 1 blank) for analysis of dissolved Cu - column chelation (BAL)
22. 5 stations for analysis of hardness (CCSF)
23. 5 stations for analysis of dissolved Cu - column chelation (CCSF)

2.2. Personnel

The personnel and work assignments for this cruise are shown in Table 1.

Table 1. Personnel for 2023 RMP Water Cruise

Name	Affiliation	Duties
Jackie Mohay	AMS	Cruise Manager (9/21, 9/22)
Paul Salop	AMS	Cruise Manager (9/21, 9/28, 10/2)
Theresa Venello	AMS	Cruise Manager (9/28, 10/3)
Ellen Goldenberg	AMS	Cruise Manager (10/2, 10/3)
Martin Trinh	AMS	Field Sampling (9/21, 9/22, 9/28, 10/2)
Amy Kleckner	SFEI	Field Sampling (9/21, 9/28, 10/2)
Don Yee	SFEI	Field Sampling (9/21, 9/22, 10/3)
Ezra Miller	SFEI	Field Sampling (9/21, 9/22, 10/2, 10/3)
Jennifer Dougherty	SFEI	Field Sampling (9/21, 9/22)
Kyle Stark	SFEI	Field Sampling (9/22)
Kayli Paterson	SFEI	Field Sampling (9/28, 10/2, 10/3)
Helen Casendino	SFEI	Field Sampling (9/28)
Shira Bezalel	SFEI	Photography (9/28, 10/2)
Luis Martinez	MARE	Captain, *RV TomCat* (9/21, 9/22, 10/2, 10/3)
Abby Nickels	MARE	First mate (9/21, 9/22)
Court Mast	MARE	Captain, *RV TomCat* (9/28)

Name	Affiliation	Duties
Dirk Rosen	MARE	First mate (9/28, 10/2, 10/3)
Nina Hipkins	MARE	First mate (9/28)

2.3. Sampling Activities

Sampling activities for the 2023 RMP Water Cruise are shown in Table 2

Table 2. Sampling Activities for 2023 RMP Water Cruise

Date	Time	Activity
Aug 25	1000-1200	AMS and SFEI staff mobilize sampling equipment on *RV TomCat* at private residence, Richmond, CA.
Aug 27	1200-1500	MARE discovers engine failure in preparation for transit to Redwood City, cruise delayed.
Sept 19	0800-1700	*RV TomCat r*epairs completed.
Sept 21	0500-0700	*RV TomCat* transits from Richmond to **Westpoint Harbor Marina**.
	0700-1542	AMS and SFEI personnel mobilize sampling equipment and load aboard vessel *RV TomCat* at **Westpoint Harbor Marina.** Sampled BA30, LSB086W, LSB085W, LSB087W, LSB088W, and LSB089W. Returned to **Westpoint Harbor Marina** and demobilized vessel.
	1630-1830	Caltest courier retrieved Chl-a, CN, and SSC samples from the vessel. SFEI retained special study samples for transfer to SFEI. Unified Delivery courier retrieved all remaining samples for transfer to AMS.
Sept 22	0700-1310	Mobilized remaining sampling gear aboard vessel at **Westpoint Harbor Marina**. Sampled SB082W, SB081W, SB083W, and CB056W. Transited to **Safe Harbor Marina, Emeryville** and demobilized vessel.
	1400-1530	Caltest courier retrieved Chl-a, CN, and SSC samples from the vessel. SFEI retained special study samples for transfer to SFEI. Unified Delivery courier retrieved all remaining samples for transfer to AMS. Golden State Transportation delivers sampling personnel to their personal vehicles in Redwood City.
Sept 28	0700-1505	Mobilized remaining sampling gear aboard vessel at **Safe Harbor Marina, Richmond**. Sampled BA20. During transit to the Golden Gate, engine loses a belt and unable to continue sampling. Vessel towed back to dock.
	1505 - 1630	SFEI retained all Chl-a, CN, and SSC and special study samples for transfer to SFEI. Unified Delivery courier retrieved all remaining samples for transfer to AMS.
Oct 1	0800-1700	*RV TomCat r*epairs completed.
Oct 2	0700-1413	Mobilized sampling gear aboard vessel at **Safe Harbor Marina, Richmond**. Sampled BC10, CB057W, CB055W, SPB052W, SPB053W, and SPB054W. Returned to **Benicia Marina** and demobilized vessel.
		Caltest courier retrieved Chl-a, CN, and SSC samples from the vessel. SFEI retained special study samples for transfer to SFEI. Unified Delivery courier retrieved all

Date	Time	Activity
	1430-1600	remaining samples for transfer to AMS. Golden State Transportation delivers sampling personnel to their personal vehicles in Richmond.
Oct 3	0730-1421	Mobilized sampling gear aboard vessel at **Benicia Marina**. Sampled SU063W, SU061W, SU062W, BG20, and BG30. Transited to **Pittsburg Marina** to offload samples and sampling equipment. Returned to **Benicia Marina** to deliver sampling personnel. Vessel transited to Richmond.
	1421-1700	Caltest courier retrieved Chl-a, CN, and SSC samples from the vessel. SFEI retained special study samples for transfer to SFEI. AMS removed all remaining samples and sampling equipment and returned to Livermore.

2.4. Discussion

The onset of the cruise was delayed by approximately one month by a vessel engine breakdown. Following re-start, all cruise activities proceeded in one- to two-day efforts, with additional alterations made in response to a sampling staff positive Covid test identified on 9/23 and a second mechanical issue experienced while sampling BC20 on September 28th. The planned schedule was adjusted after each delaying event to accommodate changes in tides and logistical constraints.

Due to ongoing issues with the SFEI SeaBird SBE-19 CTD, the main CTD employed for the cruise was the AMS' Eureka Manta 35+. At four stations, the Manta was deployed side-by-side with the SBE-19 to assess their performance relative to each other (LSB085W, LSB088W, SPB054W, and SU062W). Ongoing issues with the turbidity sensor on the Manta were observed throughout the cruise, making this measurement uncertain; all turbidity data collected by the Manta will therefore be censored. Manual measurements using SFEI's portable turbidity meter were used at each station to inform sample collection volumes where required.

AMS' YSI Pro DSS was deployed at a depth of approximately 1 m throughout sampling efforts at each station. Turbidity calibration also appears to be an issue with these measurements, and will therefore also be censored.

Field replicate samples were collected at sites LSB089W (BLIND1) and SB083W (BLIND2). Field blank samples were collected at sites BA30, LSB078W, BC10, and BC20 for requested analytes using techniques and supplies tailored to each analysis as described below:

- All samples for analysis by Caltest, ALS, CCSF, and BAL were collected using blank water provided by BAL.
- For BP and OPE analyses, 2 L total of blank water were provided by the laboratory with supplies for water sampling. Field blanks for both BP and OPE analyses were collected at station BA30 on the first day of sampling. A second round of blanks for OPEs and BP were collected using water previously supplied for use on the August sediment sampling cruise. For the 9/21 blank samples, laboratory-supplied bottles containing blank water bottles were opened and kept open during

sample collection of the associated field sample. For the blank samples collected at site BC10 on 10/2, blank water was poured from the laboratory HDPE containers into 1 L amber glass bottles.

- Commercially-supplied UPLC water was used to collect blank samples for QACs.
- GEM supplied water for the GEM blank samples.

Of the samples under its possession, AMS shipped samples for analysis of dissolved copper and hardness to BAL mid-cruise in order to achieve required hold times. All remaining samples were shipped the week of October 9th, following the cruise's completion. All samples arrived securely in a timely fashion.

2.5. Sample Labeling

The sample ID system for all samples was as follows:

RMP-23WC-XXXX

Where:

RMP	=	Project
23	=	Cruise Year
WC	=	Matrix (Water Cruise)
XXXX	=	Unique ID number

2.6. Sampling Sites

2023 RMP Water Cruise sampling sites are listed in Table 3. The location of one site, SU063W was adjusted in the field due to vessel traffic conditions near Avon Wharf that made sampling unsafe.

All samples collected are listed in Table 4. Sample containers and sample handling procedures are summarized in Table 5. Weather conditions encountered at time of sampling are shown in Table 6. Snapshot of water quality parameters recorded from SFEI YSI meter are shown in Table 7.

Table 3. 2023 RMP Water Cruise Site Coordinates and Water Depth at Initiation of Sampling. Sample depths are not corrected for tidal action.

Site Code	Target		Actual		Depth (m)
	Lat	Long	Lat	Long	
BG20	38.05967	-121.81127	38.05970	-121.81160	9.1
BG30	38.02054	-121.80627	38.02054	-121.80627	10.3
SU061W	38.05637	-122.09071	38.05631	-122.09093	3.9
SU062W	38.05199	-121.96629	38.05199	-121.96613	3.6
SU063W	38.05065	-122.09151	38.05296	-122.08897	10
SPB052W	38.00580	-122.37839	38.00595	-122.37730	2.1
SPB053W	38.06179	-122.38435	38.06325	-122.38487	3.9
SPB054W	38.04544	-122.27827	38.04581	-122.27783	4.1

Site Code	Target		Actual		Depth (m)
	Lat	Long	Lat	Long	
BC10	37.82158	-122.34950	37.82333	-122.35144	6.9
BC20	37.79150	-122.67333	37.80548	-122.67045	30
CB055W	37.89452	-122.41497	37.89637	-122.41349	13.8
CB056W	37.71092	-122.33666	37.71064	-122.33678	12.3
CB057W	37.83801	-122.41669	37.83960	-122.41713	36
BA30	37.51375	-122.13462	37.51411	-122.13483	8.2
SB083W	37.64900	-122.26460	37.64917	-122.26474	5.2
SB081W	37.62615	-122.24158	37.62631	-122.24145	3.7
SB082W	37.53782	-122.16731	37.53787	-122.16717	4.3
LSB089W	37.49466	-122.09668	37.49439	-122.09671	6.4
LSB085W	37.48810	-122.09832	37.48768	-122.09699	2
LSB086W	37.49421	-122.10941	37.49388	-122.10888	3
LSB087W	37.48529	-122.07982	37.48521	-122.07990	1.9
LSB088W	37.49413	-122.08938	37.49424	-122.08926	1.8

Table 4. 2023 RMP Water Samples Collected by Site.

Parameter	Field Blank(s)	BG20	BG30	SU061W	SU062W	SU063W	SPB052W	SPB053W	SPB054W	BC10	BC20	CB055W	CB056W	CB057W	BA30	SB083W+FB1	SB081W	SB082W	LSB089W+FB2	LSB085W	LSB086W	LSB087W	LSB088W	Total
CN_CT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	25
SSC_CT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	25
SSC_CCSF	0	1	1	0	0	0	0	0	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0	5
CHLA_CT	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	24
OPE_AXYS	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2[a]	1	1	2[a]	1	1	1	1	26
BP_AXYS	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2[a]	1	1	2[a]	1	1	1	1	26
PFAS_AXYS[b]	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2[a]	1	1	2[a]	1	1	1	1	26
PTOP_AXYS	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2[a]	1	1	2[a]	1	1	1	1	26
PFAS_EF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
PFAS_EN	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
QAC_UMN	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	6
POC_ALS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2[a]	1	1	2[a]	1	1	1	1	25
DOC_ALS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	25
PCU_BAL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	25
PCU_CCSF	0	1	1	0	0	0	0	0	0	1	1	0	0	0	1[a]	0	0	0	0	0	0	0	0	5
DCU/HAR_BAL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	25
HAR_CCSF	0	1	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	5
DCU_CCSF	1	1	1	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	6

pharm_GEM	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	5

Notes: [a]Extra volume collected for QA purposes
[b]Additional 500 mL identified for lab reps not collected

Table 5. Containers and Sample Handling for 2021 RMP Water Cruise (T=total, P=particulate, D=dissolved). Samples to be stored with no additional preservation, on wet ice or refrigerated (4C), and in the dark, unless otherwise noted.

Parameter	T/P/D	Lab	Container	Handling Requirements
DO, cond, pH, temp, turbidity	T	AMS	None	CTD, YSI deployments
POC	P	ALS	1 filter	Field filtered (particulate on filter of DOC sample) put back into foil and freeze and ship on dry ice.
DOC	D	ALS	125 mL amber glass	Field filtered (filtrate of POC sample); pre-preserved with 1-2 mL H2SO4; stored and shipped at 0 – 6º C.
Cu (P)	P	BAL	2 filters	Field filtered; stored and shipped at 0 – 6º C.
Cu (P)	P	CCSF	2 filters	Field filtered; retained by SFEI staff and delivered at 0 – 6º C.
CN (WAD)	T	Caltest	500 mL amber glass	Pre-preserved containers with 130 uL of 50% NaOH to pH >10. Stored on wet ice on the vessel; retrieved by Caltest courier at end of day.
SSC	T	Caltest	1 L and 250 mL HDPE	Store on wet ice on boat; retrieved by Caltest courier at end of day.
SSC	T	CCSF	125 mL L and 250 mL HDPE	Store on wet ice on boat; retained by SFEI staff and delivered at 0 – 6º C.
Chl-a	T	Caltest	3 – 1 L Amber HDPE bottles	Store on wet ice on the boat; retrieved by Caltest courier at end of day.
Cu / Hardness	D	BAL	60 mL HDPE	Field filtered (peristaltic pump); stored and shipped at 0 – 6º C.
OPEs	T	SGS Axys	1 L amber glass	Store on wet ice on boat; frozen at AMS at end of day; shipped chilled
Bisphenols	T	SGS Axys	1 L amber glass	Store on wet ice on boat; frozen at AMS at end of day; shipped chilled
PTOP	T	SGS Axys	125 mL HDPE	Store on wet ice on boat; frozen at AMS at end of day; shipped chilled
PFAS	T	SGS Axys	500 mL HDPE	Store on wet ice on boat; frozen at AMS at end of day; shipped chilled
PFAS	T	Enthalpy	500 mL HDPE	Store on wet ice on boat; retained by SFEI staff and shipped at 0 – 6º C.

PFAS	T	Eurofins	3 HDPE (250 mL, and 125 mL)	Store on wet ice on boat; retained by SFEI staff and shipped at 0 – 6º C.
QACs	T	UMN	1 L polycarbonate (3 per site)	Store on wet ice on boat; frozen at AMS at end of day; shipped frozen on dry ice

Table 6. Weather Conditions for 2023 RMP Water Cruise.

Site	Sea State	Tide Stage & Current (kts)	Wind Speed (kts)	Wind Dir.	Cloud Cover, % Overcast	Comments
BG20	<1' seas	Flood, 0.7	5 – 10	W	0%	
BG30	Calm	Light flood	5	NW	0%	
SU061W	1 – 3' seas	Slack	5 - 10	W	0%	
SU062W	1-3' seas	Flood, 1	5 – 10	W	0%	
SU063W	1-3' seas	Light ebb	Calm	-	0%	
SPB052W	1-3' seas	Flood, 1.6	5 - 10	W	10%	
SPB053W	1-3' seas	Flood, 0.5	5 - 10	WNW	40%	
SPB054W	1-3' seas	Flood, 0.5	5 - 10	NW	5%	
BC10	1' seas	Light ebb	5 - 10	N	90%	
BC20	4-6' swells	Light flood	5 - 10	N	10%	
CB055W	1-3' seas	Flood, <0.5	5 - 10	SW	10%	
CB056W	2' seas	Flood, 1	<5	NE	50%	
CB057W	1-3' seas	Light flood	5 - 10	NE	10%	
BA30	Calm	Ebb, 0.75	<5	N	0%	
SB083W	1' seas	Ebb, 1.8	<5	ENE	70%	
SB081W	1' seas	Ebb, 0.5	<5	NNE	70%	
SB082W	1' seas	Ebb, 1.9	<5	WNW	50% (hazy)	
LSB089W	Calm	Flood, 0.5	<5	NNE	0%	
LSB085W	Calm	Flood, 0.75	<5	ENE	0% (hazy)	
LSB086W	Calm	Flood, <0.5	<5	ENE	0% (hazy)	
LSB087W	Calm	Flood, <0.5	<5	NNE	0% (hazy)	

LSB088W	Calm	Flood, 0.6	5	NNE	0% (hazy)	

Table 7. Recorded Water Quality Parameters. All results recorded as snapshot from AMS YSI ProDSS meter deployed at approximately 1m depth for duration of sampling. NR=Not recorded.

Site	DO (%)	DO (mg/L)	Cond. (mS/cm)	Temp (°C)	pH	Salinity (ppt)	Turbidity[a] (NTU)
BG20	93.8	8.66	0.70	19.1	8.04	0.3	22
BG30	92.3	8.49	0.75	19.4	7.8	0.4	18
SU061W	92.0	8.04	17.13	19.0	7.82	10.1	60
SU062W	93.9	8.49	6.71	19.2	8.06	3.7	31
SU063W	92.3	8.12	16.82	18.7	7.69	9.9	21.5
SPB052W	92.2	7.40	40.36	18.5	7.78	25.9	31
SPB053W	93.9	7.70	33.52	18.9	7.75	21.0	9
SPB054W	98.7	8.08	28.97	20.1	7.70	18.6	8
BC10	90.9	7.15	45.47	18.4	7.71	29.5	7
BC20	107.0	8.55	49.50	16.7	7.96	32.4	4
CB055W	94.9	7.58	43.19	18.2	7.78	27.9	6
CB056W	93.2	7.03	46.40	20.5	7.84	30.2	6
CB057W	93.4	7.50	44.72	17.5	7.70	29.0	8
BA30	85.6	6.44	44.03	21.2	7.97	28.4	14
SB083W	90.7	6.85	45.76	20.6	7.83	29.7	6
SB081W	86.6	6.60	45.35	20.1	7.84	29.4	6
SB082W	87.6	6.58	44.70	21.1	7.82	28.9	12
LSB089W	86.2	6.46	43.91	21.4	7.79	28.4	23.5
LSB085W	86.9	6.57	42.16	21.4	7.84	27.1	12
LSB086W	85.0	6.45	42.29	21.1	7.83	27.2	15
LSB087W	88.0	6.69	41.40	21.2	7.82	26.9	29.5
LSB088W	82.9	6.28	43.16	21.0	7.78	27.9	142

Notes:
[a] Measurements from SFEI portable turbidity meter (averaged)