TECHNICAL MEMORANDUM 2-3

Water Quality

Yuba River Development Project

FERC Project No. 2246

February 2013

TECHNICAL MEMORANDUM 2-3

EXECUTIVE SUMMARY

In 2012, Yuba County Water Agency's (YCWA) investigated the quality of surface water potentially affected by the Yuba River Development Project (Project), including the water within: 1) the Middle Yuba River from and including Our House Diversion Dam Impoundment to the confluence with the North Yuba River; 2) Oregon Creek from and including the Log Cabin Diversion Dam Impoundment to the confluence with the Middle Yuba River; 3) the North Yuba River from and including New Bullards Bar Dam Reservoir to the confluence with the Middle Yuba River; and 4) and the portion of the Yuba River from the confluence of the North and Middle Yuba rivers to the Feather River, including the United States Army Corps of Engineer's Englebright Reservoir. Background conditions were also sampled, by sampling sites upstream of all Project facilities.

The investigation consisted of three elements: 1) a general water quality element; 2) a recreation-related water quality element; and 3) a turbidity-associated mercury element. Each element of the study was conducted at the time and place where Project effects were expected to be most pronounced, if they occur. During the 2012 spring and summer seasons, surface water samples were collected from 28 locations upstream, within, and downstream of the Project and samples were analyzed for 48 general physical water quality parameters and chemical constituents. During the 2012 fall season, a single surface water sample was collected downstream of the Project and analyzed for the spring and summer samplings' analyte list. During the 30 days surrounding and including the 2012 Independence Day and Labor Day holidays, five rounds of surface water samples were collected adjacent to six reservoir and impoundment sites and analyzed for bacteria and hydrocarbons. During a high-turbidity event and when the powerhouses were in operation, one surface water quality sample was collected each from the New Colgate Powerhouse tailrace and the Narrows No. 2 Powerhouse tailrace and analyzed for turbidity, total suspended sediment, total dissolved sediment, total mercury and methylmercury.

General water quality and recreation element data were evaluated for spatial trends and for consistency with 14 applicable State of California's Basin Plan Water Quality Objectives (CVRWQCB 1998). When numeric Water Quality Objectives were not available, data were examined in context with other relevant guidelines and benchmarks, including the Environmental Protection Agency's (EPA) (2000) California Toxics Rule. Turbidity-associated mercury data were evaluated in the context of ambient and hydrological information.

YCWA found that general water quality is high, with most analytes reported at non-detect to just above reporting limit concentrations, and there does not appear to be a pattern of increasing chemical concentrations from upstream to downstream of Project impoundments and facilities. With the exception of water temperature,[1] in spring 2012, YCWA found no inconsistencies with the Basin Plan Water Quality Objectives except for the Dissolved Oxygen Objective at two locations in New Bullards Bar Reservoir and the Toxicity Objective in Englebright Reservoir,

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[1] Water Temperature is addressed in YCWA's Technical Memorandum 2-5, Water Temperature Monitoring.

i.e., dissolved copper, silver and nickel concentrations were occasionally greater than the EPA (2000) California Toxics Rule (CTR) guidelines. Likewise, in summer 2012, YCWA found no inconsistencies with the Basin Plan Water Quality Objectives except for the Dissolved Oxygen Objective at three hypolimnion locations and the Toxicity Objective at all six hypolimnion samples, i.e. dissolved copper was found at concentrations greater than CTR guidelines at each location. No inconsistencies were observed in the fall sample.

YCWA and the Relicensing Participants met on January 30, 2013 to collaborate regarding the need for a second year focused study. Relicensing Participants did not identify any additional data gathering needs based on the results of this study.

The study is complete.

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WATER QUALITY[2]

Yuba County Water Agency (YCWA) continued operation and maintenance (O&M) of the Yuba River Development Project (Project) and recreation in Project reservoirs has the potential to adversely affect water quality.[3]

1.0 Goals and Objectives

The goals of the study were: 1) to characterize existing water quality conditions in Project reservoirs and Project-affected reaches of the North, Middle and mainstem Yuba rivers and tributaries including Oregon Creek; 2) to determine consistency with state and federal water quality objectives, standards, and criteria; and 3) to identify potential Project O&M related causes for Basin Plan Objectives and Beneficial Use protections to not be met.

The objective of the study was to collect water quality data adequate to meet the study goals.

Water temperature is not addressed in this study but in two separate studies: Water Temperature Monitoring and Water Temperature Modeling. Additionally, consistency of water quality with methylmercury fish tissue objectives is addressed in a separate study: Bioaccumulation.

2.0 Methods

The study consists of three elements: 1) a water quality element; 2) a recreation water quality element; and 3) a turbidity-associated mercury element.

2.1 Water Quality Element

2.1.1 Sample Locations

General water quality samples were collected within New Bullards Bar Reservoir and the United States Army Corps of Engineers' (USACE) Englebright Reservoir (See Figure 1 of Attachment 2-1A). At each reservoir location, general water chemistry samples were collected for laboratory analysis at two depths: within the hypolimnion and just below the surface in the epilimnion (Table 2.1-1).

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[2] This technical memorandum presents the results for Study 2.3, Water Quality, included in YCWA's August 17, 2011 Revised Study Plan filed with FERC and modified by YCWA on September 8, 2011. FERC's September 30, 2011 Study Determination modified and approved the study. There were no modifications to Study 2.3 subsequent to FERC's September 30, 2011 Study Determination.

[3] Water temperature and mercury bioaccumulation in fish are addressed in separate relicensing technical memoranda.

Table 2.1-1. General water quality sample locations in reservoirs.

Reservoir	Sample Depth	Location
NORTH YUBA RIVER		
New Bullards Bar Reservoir	Surface	Three Sites: 1) Near Madrone Cove, 2) Mid-Reservoir at influence of Slate Creek, and 3) Near Dam
	Bottom	
YUBA RIVER		
Englebright Reservoir	Surface	Three Sites: 1) Upper reservoir, 2) Mid-Reservoir, and 3) Near Dam
	Bottom	

In spring and summer, stream samples were collected upstream and downstream of New Bullards Bar Reservoir, Our House Diversion Dam Impoundment, Log Cabin Diversion Dam Impoundment, and Englebright Reservoir, as well as at four locations between Englebright Dam and the Feather River. In fall, a single stream sample was collected downstream of New Bullards Bar Dam. Water chemistry samples were grab samples collected for laboratory analysis from the moving water (Table 2.1-2).

Table 2.1-2. General water quality sample locations in streams.

Stream Reach	Sample Depth	Location	Notes
MIDDLE YUBA RIVER			
--	Surface	Above Our House Diversion Dam Impoundment	Above New Bullards Bar Inflow (SYRCL Sampling Site)
Our House Diversion Dam Reach	Surface	Below Our House Diversion Dam	Immediately downstream of dam
--	Surface	Middle Yuba River upstream of confluence with North Yuba River	Middle Yuba River and Oregon Creek conditions
OREGON CREEK			
--	Surface	Above Log Cabin Diversion Dam	Immediately upstream of the impoundment and above inflow from tunnel
Log Cabin Diversion Dam Reach	Surface	Below Log Cabin Diversion Dam	Immediately downstream of dam
NORTH YUBA RIVER			
--	Surface	Below Fiddle Creek at Hwy 49[1]	SYRCL Sampling Site
New Bullards Bar Dam Reach	Surface	Below New Bullards Bar Dam	--
YUBA RIVER			
--	Surface	Above New Colgate Powerhouse	SYRCL Sampling Site
Colgate Powerhouse Reach	Surface	Below New Colgate Powerhouse	--
	Surface	Downstream of Dobbins Creek/ upstream of South Yuba River confluence & Englebright Reservoir's normal maximum water surface elevation	Mixing of Dobbins with New Bullards/New Colgate Powerhouse flow in Yuba River
SOUTH YUBA RIVER			
--	Surface	South Yuba River State Park – South Yuba River upstream of Englebright Reservoir's normal maximum water surface elevation	South Yuba River delivery conditions from Yuba-Bear and Drum-Spaulding projects; and routing (SYRCL's Bridgeport sampling site)

Table 2.1-2. (continued)

Stream Reach	Sample Depth	Location	Notes
YUBA RIVER			
--	Surface	Narrows 2 Powerhouse Tailrace/ Below Englebright Dam	--
Narrows 2 Powerhouse Reach	Surface	Below Deer Creek at Hwy 20	SYRCL Sampling Site
Daguerre Point Dam Reach	Surface	Below Daguerre Point Dam	SYRCL Sampling Site
	Surface	At Walnut Avenue	--
	Surface	Marysville	SYRCL Sampling Site

Key: Hwy = Highway MYR = Middle Yuba River SYR = South Yuba River
SYRCL = South Yuba River Citizens League
[1] A location in flowing water upstream of the reservoir

2.1.2 In-Situ and Laboratory Analyses

Table 2.1-3 shows the method, target reporting limit,[4] and method detection limit[5] associated with each constituent measured for this study. Water temperature, dissolved oxygen (DO), pH, specific conductance, and turbidity were measured in the field using a Hydrolab DataSonde 5 or Quanta. Laboratory analyses were conducted using the Environmental Protection Agency's (EPA) Analytical Methods (EPA 2010), Standard Methods (APHA et al. 2010), or an equivalent method sufficiently sensitive to detect and report levels necessary for evaluation against state and federal water quality standards.

Table 2.1-3. In-situ and laboratory analyses for water quality parameters.

Analyte			Method	Target Reporting Limit µg/L (or other)	Hold Time
GENERAL WATER QUALITY	**BASIC WATER QUALITY- IN SITU**				
	Dissolved Oxygen	DO	SM 4500-O	0.1 mg/L	Field (*in situ*)
	Specific conductance	--	SM 2510A	0.001 µmhos	Field (*in situ*)
	pH	--	SM 4500-H	0.1 su	Field (*in situ*)
	Turbidity	--	SM 2130 B	0.1 NTU	Field (*in situ*)
	Secchi Disc	--	--	--	Field (*in situ*)
	BASIC WATER QUALITY—LABORATORY				
	Total Organic Carbon	TOC	SM 5310	0.2 mg/L	28 d
	Dissolved Organic Carbon	DOC	EPA 415.1 D	0.5/0.1	28 d
	Total Dissolved Solids	TDS	EPA 2540 C SM 2340 C	1 mg/L	7d
	Total Suspended Solids	TSS	EPA 2520 D SM 2340 D	1 mg/L	7d
	INORGANIC IONS				
	Total Alkalinity	--	SM 2340 B	2000	14 d
	Calcium	Ca	EPA 6010 B	30	180 d
	Chloride	Cl	EPA 300.0	20	28 d
	Hardness (measured value)	--	EPA 2340 B SM 2340 C	1 mg/L as $CaCO_3$	14 d
	Magnesium	Mg	EPA 6010 B	1	180 d
	Potassium	K	EPA 6010 B	500	180 d
	Sodium	Na	EPA 6010 B	29	180 d
	Sulfate	SO_4^{2-}	EPA 300.0	1.0 mg/L	28 d
	Sulfide	S^{2-}	SM 4500 S2 - D	0.05 mg/L	28 d

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[4] The reporting limit is the lowest concentration at which an analyte can be detected with a reliable precision and accuracy. At the low concentration, both the identity of the analyte and its quantity are certain.

[5] The method detection limit is the lowest concentration that an analyte can be detected and distinguished from other chemicals. At the low concentration, the identity of the analyte is certain, but its quantity is uncertain.

Table 2.1-3. (continued)

Analyte			Method	Target Reporting Limit µg/L (or other)	Hold Time
	NUTRIENTS				
GENERAL WATER QUALITY ELEEMNET (cont.)	Nitrate-Nitrite	--	EPA 300.0	2	28 d <pH 2
	Total Ammonia as N	--	EPA 4500-NH3 SM 4500-NH3	0.02	28 d <pH 2
	Total Kjeldahl Nitrogen as N	TKN	SM 4500 N	100	28 d <pH 2
	Total phosphorus	TP	SM4500 P	20	28 d <pH 2
	Dissolved Orthophosphate	PO_4	EPA 365.1 EPA 300.0	0.01	48 h at 4 °C
	METALS (total and dissolved)				
	Aluminum (total and dissolved)	Al	EPA 200.8/EPA 1638	4.0/ 0.4	180 d
	Arsenic (total and dissolved)	As	EPA 200.8/1638	0.15/0.04	180 d
	Cadmium (total and dissolved)	Cd	EPA 200.8/1638	0.020/0.004	180 d
	Chromium, Total (total and dissolved)	Cr	EPA 200.8/1638	0.010/0.03	180 d
	Copper (total and dissolved)	Cu	EPA 200.8/1638	0.10/0.01	180 d
	Iron (total and dissolved)	Fe	EPA 200.8/1638	10.0/3.2	180 d
	Lead (total and dissolved)	Pb	EPA 200.8/EPA 1638	0.040/0.003	180 d
	Mercury (total)	Hg	EPA 1631	0.0005/0.00008	28 d
	Methylmercury (total and dissolved)	CH_3Hg	EPA 1630	0.00005/0.000019	90 d
	Nickel (total and dissolved)	Ni	EPA 200.8/1638	0.10/0.01	180 d
	Selenium (total)	Se	EPA 200.8/1638	0.60/0.19	180 d
	Silver (total and dissolved)	Ag	EPA 200.8/1638	0.20/0.006	180 d
	Zinc (total and dissolved)	Zn	EPA 200.8/1638	0.2/0.1	180 d
RECREATION ELEWMENT	**BACTERIA**				
	Total coliform	--	SM 9221	1.1 MPN	24 h
	Fecal coliform	--	SM 9221	1.1 MPN	24 h
	Escherichia coli	*E. coli*	SM 9223	1.1 MPN	24 h
	PETROLEUM HYDROCARBONS				
	Total Petroleum Hydrocarbons (gasoline range)	TPH-g	SW 8015B	50	14 d
	Oil & Grease	O&G	Visual Observation	--	--

Key:
EPA = United States Environmental Protection Agency
$CaCO_3$ = Calcium carbonate
d = days
h = hours
µmhos = micro-ohms
µg/L = micrograms per liter (equals parts per billion)
mg/L = milligrams per liter (equals parts per million)
MPN = Most Probable Number
NTU = Nephelometric Turbidity Units
SM = Standard Method
su = Standard Unit

California-certified laboratories analyzed the water samples for basic water chemistry, inorganic ions, metals, nutrients, and herbicides and pesticides. Frontier Geosciences, Inc., Seattle, Washington, conducted laboratory analyses for trace metals. CalScience Environmental Laboratories, Inc., Garden Grove, California, conducted all other laboratory analyses.

2.1.3 Data Collection

Hydrolab sondes were rented from Hach Hydromet in Loveland, Colorado. Calibration of each sonde was performed by Hach Hydromet prior to deployment (Attachment 2-3B). Calibration was also verified in the field using the manufacturer's recommended calibration methods. YCWA noted relevant conditions during each sampling event on the field data sheet (i.e., air temperature, flow, description of location, floating material, and evidence of oil and grease). Shared sampling equipment was thoroughly cleaned between sampling sites.

Each laboratory sample was collected in laboratory-supplied clean containers. Water samples to be analyzed for metals were taken using "clean hands" methods consistent with the EPA Method 1669 sampling protocol as described in *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria* (EPA 1996). Samples collected for dissolved metals analysis were filtered in the field in accordance with standard protocols.

All sample containers were labeled with the date and time that the sample was collected, assigned a sample number, and handled in a manner consistent with appropriate chain-of-custody protocols. Samples were preserved as appropriate, stored, and delivered to a California-certified water quality laboratory for analyses of the parameters listed in Table 2.1-2 in accordance with maximum holding periods for each parameter. A chain-of-custody record was maintained with the samples at all times. The sampling site location was recorded using a hand-held Global Positioning System (GPS) unit and the coordinates were recorded in a field logbook.

2.1.4 Quality Assurance

Samples were collected and analyzed in accordance with the Project-specific QAPP, provided as Attachment 2-3B to this document. All data were verified and/or validated, as appropriate. In brief, following the field sampling and laboratory analyses, which includes the laboratories' own QA/QC analysis, YCWA subjected all data to QA/QC procedures including, but not limited to: spot-checks of transcription; review of electronic data submissions for completeness; comparison of results to field blank and rinsate results; and, identification of any data that seem inconsistent. If any inconsistencies were found, YCWA consulted with the laboratory to identify any potential sources of error before concluding that the data were correct.

All verified chemical detections, including data whose results are "J" qualified,[6] were used for this assessment. When the laboratory needed to re-extract samples and re-run the sample under different calibration conditions, the data identified by the laboratory as the most certain was used. If field-sampling conditions, as measured by the field blank and the rinsate sample results, indicated that samples were corrupted, YCWA identified it as such.

2.2 Recreation Element

For the recreation element of the study, bacteria and total petroleum hydrocarbon (TPH) samplings were conducted at some near-shore locations adjacent to unmanaged and low-managed recreation facilities. Each site sampled was identified by the recreation facility condition reconnaissance survey as having the potential to affect water quality.

2.2.1 Sample Locations

In New Bullards Bar Reservoir, four recreation water quality samples were collected, one each from the surface of the reservoir near the boat ramps in Emerald Cove and Dark Day Campground, the shoreline near the Dark Day informal day use area, and the shoreline of Moran

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[6] Results with a "J" qualifier are results where the chemical was detected, but there is uncertainty in the quantity. The quantity is above the method detection limit, but below the reporting limit.

Cove Day Use Area (See Figure 2 of Attachment 2-1A). In addition, one sample was collected from Our House Diversion Dam Impoundment and one sample from Log Cabin Diversion Dam Impoundment (Table 2.2-1).

Table 2.2-1. Recreation water quality sample locations in reservoir.

Reservoir	Sample Depth	Location
New Bullards Bar Reservoir	Surface	Emerald Cove Near the Boat Ramp
	Surface	Dark Day Cove Boat Ramp
	Surface	Dark Day Cove informal day use area.[1]
	Surface	Moran Cove Day Use Area Shoreline
Our House Diversion Dam Impoundment	Surface	Near Shore Upstream from Dam
Log Cabin Diversion Dam Impoundment	Surface	Near Shore Upstream from Dam

[1] New Bullards Bar does not have any beaches, due to the reservoir's steep shoreline. However, at low water levels, the exposed shoreline near Dark Day Cove boat ramp is more gently sloped and recreationists have been observed swimming at this location.

2.2.2 Laboratory Analyses

Water samples associated with recreation activities were analyzed for bacteria and TPH (Table 2.2-2). Bacteria samples were delivered to Cranmer Engineering, Inc., Grass Valley, California for analysis. TPH samples were sent to CalScience Environmental Laboratories, Inc., Garden Grove, California. Both laboratories are certified by the State of California.

Table 2.2-2. Water quality parameters addressed in the Recreation Element of the study.

Parameter	Symbol or Abbreviation	Method	Target Reporting Limit/ Method Detection Limit	Hold time
BACTERIA				
Total coliform	--	SM 9221B	2/100 mL	24 h
Fecal coliform	--	SM 9221E	2 MPN/100 mL	24 h
Escherichia coli	E. coli	SM 9221F	2 MPN/100 mL	24 h
PETROLEUM HYDROCARBONS				
Total Petroleum Hydrocarbon—gasoline	TPH-g	EPA 8015B(Modified)	50/48 µg/L	14 d
Oil & Grease	O&G	Visual Observation	--	--

Key: d = days h = hours mg/L = milligrams per liter MPN = Most Probable Number
ppb = parts per billion SM = Standard Method

Visual observations of oil and grease were recorded in the field notebook.

2.2.3 Data Collection

In accordance with bacteria sampling protocols (CVRWQCB 1998), bacteria samples were collected on five different days within a 30-day period including a holiday weekend. For this study, samples were collected in the 30 days surrounding and including both the 2012 Independence Day Holiday and Labor Day weekends. A single TPH sample was also collected at each location during the holiday weekends.

At each near-shore sample location, surface water grab samples were collected from the near surface (bacteria) and/or the surface (petroleum hydrocarbons). Visual observations of oil and grease were recorded in the field notebook, as well.

2.2.4 Quality Assurance

All data were verified and/or validated as appropriate. In brief, following field surveys and laboratory analysis, which included the laboratory's own QA/QC analysis, YCWA subjected all data to QA/QC procedures including, but not limited to: spot-checks of transcription; review of electronic data submissions for completeness; comparison of Geographic Information System (GIS) maps with field notes on locations; and, identification of any inconsistent data.

2.3 Turbidity-associated Mercury Sample Element

2.3.1 Sample Locations

One surface water sample was collected from the New Colgate Powerhouse tailrace and one from the Narrows No. 2 Powerhouse tailrace when the powerhouses were in operation during a single period expected to be of high turbidity in 2012. A flow of 5,000 cubic feet per second (cfs), as measured at the Smartsville gage,[7] when flows as measured at Smartsville have increased by at least 100 percent in the previous 7 days, triggered the sampling event.

2.3.2 Laboratory Analyses

Water samples were analyzed for turbidity, total suspended sediment, total dissolved sediment, total mercury and methylmercury using the methods described in Section 2.1.1 and Table 2.1-2. Samples were sent to the he Marine Pollution Studies Laboratory (MPSL) of the California Department of Fish and Wildlife (Cal Fish and Wildlife)[8] at Moss Landing for analyses. MPSL-Cal Fish and Wildlife is a California-certified laboratory.

2.3.3 Data Collection

Water chemistry samples were grab samples collected for collected as near as safely possible to the powerhouse outlet laboratory analysis from the moving water, consistent with Section 2.1.3.

2.3.4 Quality Assurance

All data were verified and/or validated as appropriate, consistent with Section 2.1.4

2.4 Consistency with Water Quality Objectives

2.4.1 All Samples Excluding Samples Collected From Powerhouse Release

Table 2.4-1 shows the standards, criteria and benchmark values that were used to assist with the assessment of sample results and their consistency with the Basin Plan Objectives. The selected values primarily consist of the Title 22 drinking water standards, which are incorporated by

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[7] http://cdec.water.ca.gov/cgi-progs/queryF?s=YRS

[8] The California Department of Fish and Game changed its name to the California Department of Fish and Wildlife in January 2013.

reference into the Basin Plan itself, and the California Toxics Rule (CTR) (EPA 2000). However, when a study analyte did not have a compliance threshold (standard or criteria) in one these preferred sources, benchmarks were selected from *A Compilation of Water Quality Goals* (Marshack 2008, as amended for July 2008 – April 2010); *Water Quality Standards for Recreational Waters* (EPA 2003; another compilation with multiple regional sources); and others as cited.

Table 2.4-1. Standards, criteria and benchmarks used for determining consistency with Basin Plan Objectives and designated beneficial uses of water in Project reservoirs and Project-affected stream reaches.[1]

Analyte	Symbol or Abbreviation	Standard, Criteria or Benchmark Value	Reference	Notes
BACTERIA (MUN, REC-1)				
Total coliform	--	< 10,000 MPN per 100 mL < 240 MPN per 100 mL (geometric mean);	EPA 2003	Water contact recreation, single-day sample; Water contact recreation, 30-day geometric mean
Fecal coliform	--	< 200 MPN per 100 mL (geometric mean); < 10% of samples > 400 MPN per 100 mL	CVRWQCB 1998	Water contact recreation, 30-day geometric mean; with individual samples not > 400 MPN/100 mL
Escherichia coli	*E. coli*	< 126 MPN per 100 mL (geometric mean) < 235 MPN per 100 mL in any single sample	CVRWQCB 2002; EPA 2003	Water contact recreation, 30-day geometric mean
BIOSTIMULATORY SUBSTANCES (COLD, SPAWN)				
Total Kjeldahl Nitrogen	TKN	None	--	--
Total Phosphorous	TP	None	--	--
CHEMICAL CONSTITUENTS (MUN)				
Alkalinity	--	20 mg/L	Marshack 2008	EPA AWQC; less than 20 mg/L can affect water treatment
Aluminum	Al	1 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64431 Primary MCL
Arsenic	As	0.01 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64431 Primary MCL
Cadmium	Cd	5 µg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64431 Primary MCL
Calcium	Ca	None	--	--
Chromium (total)	Cr (total)	50 µg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64431 Primary MCL
Copper	Cu	1.3 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64431 Primary MCL
Lead	Pb	15 µg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64431 Primary MCL
Mercury (inorganic)	Hg	2 µg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64431 Primary MCL
Nickel	Ni	100 µg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64431 Primary MCL
Nitrate	NO_3-N	45 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64431 Primary MCL
Nitrite	NO_2-N	1 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64431 Primary MCL
Nitrate + Nitrite	NO_3-N+NO_2-N	10 mg/L (combined total)	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64431 Primary MCL
Potassium	K	None	--	--
Selenium	Se	50 µg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64431 Primary MCL
Sodium	Na	20 mg/L	Marshack 2008	Sodium Restricted Diet[2]

Table 2.4-1. (continued)

Analyte	Symbol or Abbreviation	Standard, Criteria or Benchmark Value	Reference	Notes
DISSOLVED OXYGEN (COLD, SPAWN)				
Dissolved Oxygen	DO	> 7 mg/L (minimum)	CVRWQCB 1998	Aquatic life protection
FLOATING MATERIAL (REC-1, REC-2)				
Floating Material	--	Narrative Criteria	CVRWQCB 1998	Aesthetics – Absent by visual observation
OIL & GREASE (REC-1, REC-2)				
Oil & Grease	--	Narrative	CVRWQCB 1998	Aesthetics – Absent by visual observation
Total Petroleum Hydrocarbons	TPH	None	--	--
pH (MUN, COLD, SPAWN, WILD)				
pH	--	6.5-8.5	CVRWQCB 1998	Aquatic life protection
SEDIMENT AND SETTLEABLE SOLIDS (REC-2, SPAWN, WILD)				
Sediment	--	Narrative	CVRWQCB 1998	See Geology and Soil Resources
TASTES & ODOR (MUN)				
Aluminum	Al	0.2 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64449 Secondary MCL
Chloride	Cl	250 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64449 Secondary MCL
Copper	Cu	1.0 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64449 Secondary MCL
Iron	Fe	0.3 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64449 Secondary MCL
Silver	Ag	0.1 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64449 Secondary MCL
Specific conductance	--	900 µS/cm	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64449 Secondary MCL
Sulfate	SO_4^{2-}	250 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64449 Secondary MCL
Total Dissolved Solids	TDS	500 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64449 Secondary MCL
Zinc	Zn	5 mg/L	CDPH 2010 cited in CVRWQCB 1998	22 CCR §64449 Secondary MCL
TEMPERATURE (COLD, SPAWN)				
Temperature	--	Narrative	CVRWQCB 1998	See Water Temperature Study
TOXICITY (COLD, SPAWN, MUN)				
Alkalinity	--	20 mg/L	Marshack 2008	EPA AWQC; buffering capacity
Aluminum	Al	0.087 µg/L	Marshack 2008	EPA AWQC; aquatic life protective[3]
Ammonia as N (pH and Temp dependent)	NH_3-N	24.1 mg/L (CMC); 4.1-5.9 mg/L (CCC)	EPA 2000	CTR criteria over 0-20ºC assuming pH 7.0
		5.6 mg/L (CMC); 1.7-2.4 mg/L (CCC)	EPA 2000	CTR criteria over 0-20ºC assuming pH 8.0
		0.9 mg/L (CMC); 0.3-0.5 mg/L (CCC)	EPA 2000	CTR criteria over 0-20ºC assuming pH 9.0
Arsenic	As	0.34 mg/L (CMC); 0.15 mg/L (CCC)	EPA 2000	CTR criteria
Cadmium (hardness dependent)	Cd	0.16 µg/L (CMC); 0.25 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		0.35 µg/L (CMC); 0.41 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$

Table 2.4-1. (continued)

Analyte	Symbol or Abbreviation	Standard, Criteria or Benchmark Value	Reference	Notes
TOXICITY (COLD, SPAWN, MUN) (continued)				
Cadmium (hardness dependent)	Cd	0.54 µg/L (CMC); 0.56 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		0.95 µg/L (CMC); 0.81 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$
Chloride	Cl-	860 mg/L (CMC); 230 mg/L (CCC)	Marshack 2008	EPA AWQC; aquatic life protective
Chromium (hardness dependent)	Cr	47.19 µg/L (CMC); 15.31 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		83.25 µg/L (CMC); 27.0 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
		116.03 µg/L (CMC); 37.64 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		176.31 µg/L (CMC); 57.19 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$
Copper (hardness dependent)	Cu	0.8 µg/L (CMC); 0.69 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		1.54 µg/L (CMC); 1.25 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
		2.25 µg/L (CMC); 1.77 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		3.64 µg/L (CMC); 2.74 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$
Iron	Fe	1 mg/L (CCC)	Marshack 2008	EPA AWQC; aquatic life protective
Mercury (total)	Hg	0.050 µg/L	EPA 2000 40 CFR 131.38	CTR/Federal Register. 5/18/00
Nickel (hardness dependent)	Ni	37.2 µg/L (CMC); 4.1 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		66.9 µg/L (CMC); 7.4 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
		94.3 µg/L (CMC); 10.5 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		145.2 µg/L (CMC); 16.1 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$
Selenium (total)	Se	20 µg/L (CMC) 5 µg/L (CCC)	Marshack 2008	EPA AWQC; aquatic life protective
Silver (hardness dependent)	Ag	0.02 µg/L (CMC) Instantaneous	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		0.07 µg/L (CMC) instantaneous	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
Silver (hardness dependent)	Ag	0.13 µg/L (CMC) instantaneous	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$

Table 2.4 -1. (continued)

Analyte	Symbol or Abbreviation	Standard, Criteria or Benchmark Value	Reference	Notes
TOXICITY (COLD, SPAWN, MUN) (continued)				
		0.32 µg/L (CMC) instantaneous	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$
Lead (hardness dependent)	Pb	2 µg/L (CMC) 0.086 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		5 µg/L (CMC) 0.191 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
		8 µg/L (CMC) 0.303 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		14 µg/L (CMC) 0.54 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$
Specific conductance	--	150 µmhos	CVRWQCB 1998	Aquatic Life Protection[4]
Zinc (hardness dependent)	Zn	9.26 µg/L (CMC) 9.33 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 5 mg/L as $CaCO_3$
		16.66 µg/L (CMC) 16.79 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 10 mg/L as $CaCO_3$
		23.48 µg/L (CMC) 23.68 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 15 mg/L as $CaCO_3$
		36.20 µg/L (CMC) 36.50 µg/L (CCC)	EPA 2000	CTR for dissolved sample assuming hardness of 25 mg/L as $CaCO_3$
TURBIDITY (COLD, SPAWN, WILD, MUN)				
Turbidity	NTU	increase < 1 NTU for 1-5 NTU background; increase < 20% for 5-50 NTU background; increase < 10 NTU for 50-100 NTU background	CVRWQCB 1998	Aesthetics, disinfection

Key: AWQC = Ambient Water Quality Criteria
EPA = Environmental Protection Agency
$CaCO_3$ = Calcium carbonate
CMC = Criterion Maximum Concentration (1-hour acute exposure) for aquatic toxicity as defined by EPA (2000)
CCC = Criterion Continuous Concentration (4-day chronic exposure) for aquatic toxicity as defined by EPA (2000)
CTR = California Toxics Rule
MCL = Maximum Contaminant Level
µmhos = micromhos
µg/L = micrograms per liter
mg/L = milligrams per liter
MPN = Most Probable Number
NTU = Nephelometric turbidity units
SM = Standard Method
su = standard unit

[1] Note: a constituent may be listed under more than one beneficial use. When a standard or criterion was not available, benchmarks were excerpted from EPA (2003) and Marshack (2008).

[2] Sodium level is a guidance level to protect those individuals restricted to a total sodium intake of 500 mg/day (Marshack 2008).

[3] Aquatic life protective aluminum benchmark is likely overly protective, as EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 0.087 µg aluminum/L, when either total recoverable or dissolved is measured (Marshack 2008).

[4] Applies to Sacramento River (CVRWQCB 1998). Converted from µmhos to µSiemens for comparisons.

The CVRWQCB has adopted, by reference, California Title 22 maximum contaminant levels (MCL) for drinking water as Basin Plan objectives (CVRWQCB 1998), with the exception that more stringent criteria may apply as necessary for protection of specific beneficial uses. Hence, MCL values were adopted as the drinking water standard. In so doing, chemical concentrations that were originally intended to apply to finished tap water, rather than to untreated sources of drinking water, were applied to the untreated reservoir or river water.

For water quality objectives related to aquatic toxicity for ammonia and trace metals, the CTR (EPA 2000) was the preferred benchmark source. Part 40 CFR §131.38 established Criterion Maximum Concentrations (CMC) as the highest concentrations to which aquatic life can be exposed for a short period[9] (i.e., 1 hour) without deleterious effects and Criterion Continuous Concentrations (CCC) as the highest concentration to which aquatic life can be exposed for an extended period of time (i.e., 4 days) without deleterious effects. When single grab samples were collected, it was assumed that constituent concentrations were representative of the continuous ambient condition, and CCC values were therefore used as the appropriate criteria to compare against environmental sample results.

Because of differences in acute and chronic toxicity to aquatic organisms of many elements and compounds, as well as variations with ambient water quality such as pH or hardness, several entries in Table 2.4-1 have multiple benchmarks to illustrate this range. The benchmarks for seven of the metals (i.e., cadmium, chromium, copper, lead, nickel, silver, and zinc) were reported for dissolved metals from the CTR (EPA 2000). In Table 2.4-1, benchmarks for these metals were calculated in 5 mg/L increments of hardness since the aquatic toxicity of these metals reportedly increases as hardness decreases. Similarly, the CMC and CCC levels for ammonia are a function of both pH and temperature and were presented for the temperature range of 0º -20 degrees Centigrade (ºC) in pH increments of 1.0 su in Table 2.4-1.

2.4.2 Samples Collected From Powerhouse Release

YCWA compared the samples collected from the powerhouse tailraces to ambient levels of total mercury and methylmercury, as determined by YCWA's sampling at other locations and seasons, as well as regional studies performed by others.

3.0 Results

Results of the water quality, recreation, and turbidity-associated mercury elements are provided in Attachment 2-3C and summarized below.

3.1 Water Quality Element

In 2012, water samples were collected from the surface or epilimnion at the 22 locations shown in Attachment 2-3A, Figure 1 on two occasions: between June 4 and 8, 2012 (Spring) and between August 27 and 31, 2012 (Summer). At the same time, hypolimnion samples were collected from six locations, three within New Bullards Bar Reservoir and three within Englebright Reservoir. A single sample was also taken downstream of New Bullards Bar Reservoir, Our House Dam Impoundment, and Log Cabin Impoundment in October 2012.

As a first step to determine consistency with Basin Plan Water Quality Objectives, analytical results for the water quality element were compared to the selected numeric standards, criteria, or benchmarks in Table 2.4-1. Numerical standards, criteria and benchmarks in Table 2.4-1 were

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[9] Based on extended sample collection and one-hour averaging.

either numeric Water Quality Objectives, i.e. standards, excerpted directly from the Basin Plan (CVRWQCB 1998) or, when the Basin Plan's Water Quality Objectives are narrative, they were surrogate values. When results were found outside of the standards, criteria, or benchmarks of Table 2.4-1, they were discussed further.

Analytical results and results of these comparisons are provided in Attachment 2-3C and summarized below. Each summary consists of the parameter's frequency of detection, range of results (i.e., minimum and maximum) and average value, by season. The standard, criterion, or benchmark used for the comparison from Table 2.4-1 and the location(s) of any value above or below the standard, criterion, or benchmark (as defined) were excerpted from Attachment 2-3C and provided in the summary tables. For completeness, analytes that were not detected in any sample are also listed in Tables 3.1-1, 3.1-2 and Table 3.1-3.

3.1.1 Spring 2012 Sample Results

Water chemistry data from samples collected between June 28 and 30, 2012, show that water quality in the Project Area[10] is high. Most analytes are at non-detect levels to just above reporting limit concentrations and/or at concentrations that were consistent with CVRWQCB (1998) Basin Plan Water Quality Objectives (Table 3.1-1; Attachment 2-3C). In fact, of 48 constituents examined, only five—dissolved oxygen, aluminum, copper, nickel and silver — were detected in any sample at a concentration that is potentially inconsistent with the standards, criteria, and benchmarks of Table 2.4-1 (Table 3.1-1; Attachment 2-3C).

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[10] For the Purposes of this document, the Project Area is defined as the area within the FERC Project Boundary and the land immediately surrounding the FERC Project Boundary (i.e., within about 0.25 mile of the FERC Project Boundary) and includes Project-affected reaches between facilities and downstream to the next major water controlling feature or structure.

Table 3.1-1. Summary of Water Quality Element results - Spring 2012.

Analyte	Units	Results[1,2,3]				Standard, Criteria or Benchmark Comparison	
		Detection Frequency[2]	Minimum	Maximum	Average	Standard, Criteria or Benchmark[3.4]	Location Exceedence(s)
GENERAL CHEMISTRY—IN SITU							
Secchi	ft	2/2	6	6	6	--	None
Temperature	°C	31/31	6.84	17.1	13.7	--	See Water Temperature Monitoring Technical Memorandum
Specific Conductance	µSiemans/cm	31/31	0.10	104	61	900	None
pH	stnd units	31/31	6.65	8.3	7.49	6.5-8.5	None
Dissolved Oxygen	mg/L	31/31	6.92	13.1	9.14	7 mg/L (minimum)	6.96 New Bullards Bar Reservoir Near Madrone--Surface 6.92 New Bullards Bar Reservoir Near Dam--Bottom
Turbidity	NTU	31/31	0	550	36.1	--	--
GENERAL CHEMISTRY AND NUTRIENTS—LABORATORY							
Alkalinity, Total (as CaCO3)	mg/L	31/31	24	48	33.45	20 (minimum)[5]	None
Ammonia (as N)	mg/L	0/31	< 0.10	< 0.10	< 0.10	Temp & pH Dep't[6]	None
Calcium	mg/L	31/31	6.12	12.6	8.60	--	--
Carbon, Dissolved Organic	mg/L	31/31	4.6	6.7	5.35	--	--
Carbon, Total Organic	mg/L	31/31	3.7	5.9	4.75	--	--
Chloride	mg/L	31/31	0.51 J	1.6	0.84	230	None
Hardness, Total	mg/L	31/31	25	46	33.3	--	--
Magnesium	mg/L	31/31	1.9	4.81 B	2.79	--	None
Nitrate (as N)	mg/L	12/31	0.04 J	0.15	0.09 J	10	None
Nitrite (as N)	mg/L	0/31	< 0.10	< 0.10	< 0.10	1	None
o-Phosphate (as P)	mg/L	0/31	< 0.10	< 0.10	< 0.10	--	--
Phosphorus, Total	mg/L	31/31	0.09 J	0.28	0.18	--	--
Potassium	mg/L	31/31	0.34 J	0.84	0.53	--	--
Sodium	mg/L	31/31	1.46	5.04	2.90	20	None
Solids, Total Dissolved	mg/L	30/31	33	77	52.26	500	None
Solids, Total Suspended	mg/L	8/31	< 1	9	1.69	--	--
Sulfate	mg/L	30/31	1.5	6	2.81	250	None
Sulfide, Total	mg/L	0/31	< 0.05	< 0.05	< 0.05	--	--
Total Kjeldahl Nitrogen	mg/L	6/31	0.49 J	0.98	< 0.5	--	--
METALS, TOTAL							
Aluminum	µg/L	31/31	3.0 J	213	34.3	87	130 Englebright Reservoir Mid-reservoir--Surface 213 Englebright Reservoir Near Dam
Arsenic	µg/L	31/31	0.231	3.30	0.94	10	None
Cadmium	µg/L	13/31	0.003 J	0.020 ND	0.010 J	5	None
Chromium	µg/L	31/31	0.13	0.40	0.24	50	None
Copper	µg/L	31/31	0.26	0.86	0.42	1000	None
Iron	µg/L	31/31	2 J	107	36	300	None
Lead	µg/L	30/31	0.004 J	0.077	0.022 J	15	None
Nickel	µg/L	31/31	0.40	5.17	1.01	100	None

Table 3.1-1. (continued)

Analyte	Units	Results[1,2,3]				Standard, Criteria or Benchmark Comparison	
		Detection Frequency[2]	Minimum	Maximum	Average	Standard, Criteria or Benchmark[3.4]	Location Exceedence(s)
METALS, TOTAL (continued)							
Selenium	µg/L	0/31	< 0.60	< 0.60	< 0.60	5	None
Silver	µg/L	7/31	0.002 J	< 0.02	< 0.02	100	None
Zinc	µg/L	30/31	0.05 J	2.82	0.39	5000	None
Mercury	ng/L	31/31	0.27 J	3.58	1.15	50	None
Methyl Mercury	ng/L	17/31	0.029 J	1.08	0.083	--	--
METALS, DISSOLVED							
Aluminum	µg/L	31/31	2.2 J	55.6	12.5	--	--
Arsenic	µg/L	31/31	0.20	3.34	0.93	--	--
Cadmium	µg/L	16/31	0.003 J	< 0.020	0.0116 J	Hardness Dep't[6]	None
Chromium	µg/L	31/31	0.13	0.33	0.21	--	--
Copper	µg/L	31/31	0.26	1.61	0.43	Hardness Dep't[6]	0.39 (CTR=0.37) Englebright Mid-Reservoir--Surface
Iron	µg/L	31/31	2 J	35	15	--	--
Lead	µg/L	30/31	0.003 J	0.312	0.020 J	Hardness Dep't[6]	None
Nickel	µg/L	1/31	0.38	27.7	1.69	Hardness Dep't[6]	27.7 (CTR = 18.8) Englebright Upper Reservoir--Surface
Silver	µg/L	28/31	0.002 J	< 0.020	0.019 J	Hardness Dep't[6]	<0.02(CTR = 0.01) Englebright Mid-reservoir--Surface
Zinc	µg/L	9/31	0.03 J	13.2	0.93	Hardness Dep't[6]	None
Methyl Mercury	ng/L	31/31	0.033 J	0.091	0.049 J	--	--

Key:
< = not detected at the laboratory reporting limit
B = analyte was observed in the associated laboratory method blank
J = Estimated value. Results are greater than method detection limit, but lower than reporting limit.
µg/L = micrograms per Liter
mg/L= milligrams per Liter
ng/L= nanograms per liter
< = less than the reporting limit for this analysis

[1] All data are provided in Attachment 2-3C.

[2] Twenty-eight (28) locations were sampled. Three samples were duplicates. Duplicates were collected at 166995-2-1, 166995-1-1B and 166995-2-9.

[3] For duplicate sample results, the highest concentration of the two samples was used for benchmark comparisons.

[4] The most protective standard, criterion, or benchmark of those given in Table 2.4-1 was used for this analysis. With few exceptions, aquatic life protective benchmarks were the most protective number.

[5] Minimum concentrations except where natural concentrations are less (Marshack 2008).

[6] See Attachment 2-3C, Table 2.3C-2 and Table 2.3C-3 for sample specific criteria. Ammonia criteria are temperature and pH dependent. Metals Criteria are hardness dependent for dissolved fractions of cadmium, copper, lead, silver, and zinc.

3.1.2 Summer 2012 Sample Results

Water chemistry data from samples collected between August 27 and 31, 2012, show that water quality in the Project Area is high. Most analytes are at non-detect levels to just above reporting limit concentrations and/or at concentrations that were consistent with CVRWQCB (1998) Basin Plan Water Quality Objectives (Table 3.1-2; Attachment 2-3C). In fact, of 48 constituents examined, only two-dissolved oxygen and dissolved copper-were detected in any sample at a concentration that is potentially inconsistent with the standards, criteria, and benchmarks of Table 2.4-1 (Table 3.1-2; Attachment 2-3C).

Table 3.1-2. Summary of Water Quality Element results - Summer 2012.

Analyte	Units	Results[1,2,3]				Standard, Criteria or Benchmark Comparison	
		Detection Frequency[2]	**Minimum**	**Maximum**	**Average**	**Standard, Criteria or Benchmark[3.4]**	**Location Exceedence(s)**
GENERAL CHEMISTRY - IN SITU							
Secchi	ft	--	--	--	--	--	--
Temperature	°C	31/31	6.74	23.27	14.88	--	See Water Temperature Monitoring Technical Memorandum
Specific Conductance	µSiemans/cm	31/31	60	188	95.71	900	None
pH	stnd units	31/31	6.75	8.49	7.64	6.5-8.5	None
Dissolved Oxygen	mg/L	31/31	5.14	12.1	9.12	7 mg/L (minimum)	5.14 New Bullards Bar Reservoir Near Madrone Cove—Bottom 6.16 New Bullards Bar Reservoir Near Dam—Bottom 6.79 Englebright Reservoir Mid-reservoir—Bottom
Turbidity	NTU	31/31	0	160	8.80	--	--
GENERAL CHEMISTRY AND NUTRIENTS - LABORATORY							
Alkalinity, Total (as CaCO3)	mg/L	30/31	24	76	42	20 (minimum)[5]	None
Ammonia (as N)	mg/L	0/30	0.1 ND	0.1 ND	0.1 ND	Temp & pH Dep't[6]	None
Calcium	mg/L	31/31	7.3	23.0	11.3	--	--
Carbon, Dissolved Organic	mg/L	31/31	4.3 B	9.1 B	5.8 B	--	--
Carbon, Total Organic	mg/L	31/31	3 B	8.4 B	5.1 B	--	--
Chloride	mg/L	31/31	0.53 J	2.5	0.96	230	None
Hardness, Total	mg/L	31/31	26	81	42	--	--
Magnesium	mg/L	30/31	2.09 B	8.99	3.55	--	--
Nitrate (as N)	mg/L	4/31	0.05 J	0.1 ND	0.10 ND	10	None
Nitrite (as N)	mg/L	0/31	0.1 ND	0.1 ND	0.10 ND	1	None
o-Phosphate (as P)	mg/L	1/31	0.039 J	0.1 ND	0.10 ND	--	--
Phosphorus, Total	mg/L	22/31	0.026 J	0.1 ND	0.06 J	--	--
Potassium	mg/L	31/31	0.23 J	1.44	0.51	--	--
Sodium	mg/L	31/31	1.69 J	6.18	3.09	20	None
Solids, Total Dissolved	mg/L	31/31	23	107	55.94	500	None
Solids, Total Suspended	mg/L	7/31	1 ND	1.9	1.08	--	--
Sulfate	mg/L	31/31	1.6	12	3.95	250	None
Sulfide, Total	mg/L	0/31	0.5 ND	0.5 ND	0.5 ND	--	--
Total Kjeldahl Nitrogen	mg/L	0/30	0.5 ND	0.5 ND	0.5 ND	--	--
METALS, TOTAL							
Aluminum	µg/L	31/31	6.3	190	36.51	87	
Arsenic	µg/L	31/31	0.33	5.71	1.37	10	--
Cadmium	µg/L	20/31	0.003 J	0.02 ND	0.01 J	5	None
Chromium	µg/L	31/31	0.14	0.44	0.25	50	None
Copper	µg/L	31/31	0.23	12.2	1.73	1000	None
Iron	µg/L	31/31	9	1760	95.52	300	None
Lead	µg/L	25/31	0.003 J	0.069	0.02 J	15	None
Mercury	ng/L	31/31	0.31 J	15.9	2.44	50	None

Table 3.1-2. (continued)

Analyte	Units	Results[1,2,3]				Standard, Criteria or Benchmark Comparison	
		Detection Frequency[2]	Minimum	Maximum	Average	Standard, Criteria or Benchmark[3.4]	Location Exceedence(s)
METALS, TOTAL (continued)							
Methyl Mercury	ng/L	17/31	0.05 ND	0.366	0.11	--	--
Nickel	µg/L	31/31	0.09	2.96	0.84	100	None
Selenium	µg/L	0/31	0.31 J	0.77	0.47	5	--
Silver	µg/L	7/31	0.002	0.041	0.02 ND	100	--
Zinc	µg/L	30/31	0.06 J	5.13	0.51	5000	--
METALS, DISSOLVED							
Aluminum	µg/L	31/31	0.8 J	10.4	3.47	--	--
Arsenic	µg/L	31/31	0.33	5.45	1.25	--	--
Cadmium	µg/L	16/31	0.003 J	0.02 ND	0.01 J	Hardness Dep't[6]	None
Chromium	µg/L	31/31	0.04 J	0.38	0.21	--	--
Copper	µg/L	31/31	0.2	9.13	1.51	Hardness Dep't[6]	9.13 (CTR=2.83) New Bullards Bar Reservoir Near Madrone Cove—Bottom 5.86 (CTR=2.93) New Bullards Bar Reservoir Mid-reservoir—Bottom 5.01 (CTR=3.11) New Bullards Bar Reservoir Near Dam—Bottom 5.32 (CTR=3.47) Englebright Reservoir Upper Reservoir—Bottom 7.57 (CTR=3.02) Englebright Reservoir Mid-reservoir—Bottom 3.84 (CTR=3.11) Englebright Reservoir Near Dam—Bottom
Iron	µg/L	31/31	0.7	194	14.28	--	--
Lead	µg/L	9/31	0.003	0.04	0.03	Hardness Dep't[6]	None
Methyl Mercury	ng/L	12/31	0.032 J	0.522	0.10	--	--

Table 3.1-2. (continued)

Analyte	Units	Results[1,2,3]				Standard, Criteria or Benchmark Comparison	
		Detection Frequency[2]	Minimum	Maximum	Average	Standard, Criteria or Benchmark[3.4]	Location Exceedence(s)
Nickel	µg/L	31/31	0.05	2.83	0.72	Hardness Dep't[6]	None
Silver	µg/L	9/31	0.002	0.062	0.02	Hardness Dep't[6]	None
Zinc	µg/L	27/31	0.06	1.32	0.31	Hardness Dep't[6]	None

Key:
< = not detected at the laboratory reporting limit
B = analyte was observed in the associated laboratory method blank
J = Estimated value. Results are greater than method detection limit, but lower than reporting limit.
µg/L = micrograms per Liter
mg/L= milligrams per Liter
ng/L= nanograms per liter

[1] All data are provided in Attachment 2-3C.

[2] Twenty-eight (28) locations were sampled. Three samples were duplicates. Duplicates were collected at 166995-2-1, 166995-1-2A and 166995-2-9.

[3] For duplicate sample results, the highest concentration of the two samples was used for benchmark comparisons.

[4] The most protective standard, criterion, or benchmark of those given in Table 2.4-1 was used for this analysis. With few exceptions, aquatic life protective benchmarks were the most protective number.

[5] Minimum concentrations except where natural concentrations are less (Marshack 2008).

[6] See Attachment 2-3C, Table 2.3C-2 and Table 2.3C-3 for sample specific criteria. Ammonia criteria are temperature and pH dependent. Metals Criteria are hardness dependent for dissolved fractions of cadmium, copper, lead, silver, and zinc.

3.1.3 Fall 2012 Sample Results

A single water sample was collected downstream of New Bullards Bar's fish release on December 3, 2012. Data show that water quality at this time is high. Most analytes are at non-detect levels to just above reporting limit concentrations and/or at concentrations that were consistent with CVRWQCB (1998) Basin Plan Water Quality Objectives (Table 3.1-3; Attachment 2-3C).

Table 3.1-3. Water Quality Element results - Fall 2012.

Analyte	Units	Result[1,2]		Standard, Criteria or Benchmark Comparison	
		Detection Frequency[2]	Concentration	Standard, Criteria or Benchmark[3]	Location of Exceedence(s)
GENERAL CHEMISTRY – IN SITU					
Stream Flow	cfs	--	8-10	--	--
Temperature	°C	--	9.2	--	See Water Temperature Monitoring Technical Memorandum
Specific Conductance	µSiemans/cm	1/1	62.8	900	None
pH	stnd units	1/1	7.5	6.5-8.5	None
Dissolved Oxygen	mg/L	0/1	10.0	< 7 mg/L	None
Turbidity	NTU	0/1	--[4]	--	--[4]
GENERAL CHEMISTRY AND NUTRIENTS - LABORATORY					
Alkalinity, Total (as CaCO3)	mg/L	1/1	58.0	20 (minimum)[5]	None
Ammonia (as N)	mg/L	0/1	< 0.10	4.4	--
Calcium	mg/L	1/1	8.28	--	--
Carbon, Dissolved Organic	mg/L	1/1	5.2 B	--	--
Carbon, Total Organic	mg/L	1/1	5.6	--	--
Chloride	mg/L	1/1	0.62 J	230	None
Hardness, Total	mg/L	1/1	32	--	--
Magnesium	mg/L	1/1	2.47	--	--
Nitrate (as N)	mg/L	1/1	0.10	10	None
Nitrite (as N)	mg/L	0/1	< 0.10	1	None
o-Phosphate (as P)	mg/L	0/1	< 0.10	--	--
Phosphorus, Total	mg/L	0/1	< 0.10	--	--
Potassium	mg/L	1/1	0.761	--	--
Sodium	mg/L	1/1	2.98	20	None
Solids, Total Dissolved	mg/L	1/1	43	500	None
Solids, Total Suspended	mg/L	0/1	< 1.0	--	--
Sulfate	mg/L	1/1	2.2	250	None
Sulfide, Total	mg/L	0/1	< 0.050	--	--
Total Kjeldahl Nitrogen	mg/L	0/1	< 0.50	--	--
METALS, TOTAL					
Aluminum	µg/L	1/1	56.7	87	None
Arsenic	µg/L	1/1	0.56 Q	10	None
Cadmium	µg/L	1/1	0.004 J	5	None
Chromium	µg/L	1/1	0.27	50	None
Copper	µg/L	1/1	0.57 Q	1000	None
Iron	µg/L	1/1	70	3.E+05	None
Lead	µg/L	1/1	0.048	15	None
Mercury	ng/L	1/1	0.95	50	None
Methyl Mercury	ng/L	0/1	< 0.050	--	--
Nickel	µg/L	1/1	0.49	100	None

Table 3.1-3. (continued)

Analyte	Units	Result[1,2]		Standard, Criteria or Benchmark Comparison	
		Detection Frequency[2]	Concentration	Standard, Criteria or Benchmark[3]	Location of Exceedence(s)
METALS, TOTAL (continued)					
Selenium	µg/L	1/1	0.52 J	5	None
Silver	µg/L	0/1	< 0.020 Q	100	None
Zinc	µg/L	1/1	0.80	5000	None
METALS, DISSOLVED					
Aluminum	µg/L	1/1	5.2	--	--
Arsenic	µg/L	1/1	0.59 Q	--	--
Cadmium	µg/L	1/1	0.003 J	Hardness Dep't[6]	--
Chromium	µg/L	1/1	0.22	--	--
Copper	µg/L	1/1	0.58 Q	Hardness Dep't[6]	--
Iron	µg/L	1/1	9 J	--	--
Lead	µg/L	1/1	0.005 J	Hardness Dep't[6]	--
Methyl Mercury	µg/L	0/1	< 0.050	--	--
Nickel	ng/L	1/1	0.40	Hardness Dep't[6]	--
Silver	µg/L	1/1	0.002 J,Q	Hardness Dep't[6]	--
Zinc	µg/L	1/1	0.48	Hardness Dep't[6]	--

Key:
< = not detected at the laboratory reporting limit
B = analyte was observed in the associated laboratory method blank
J = Estimated value. Results are greater than method detection limit, but lower than reporting limit.
Q = dissolved concentration is greater than total concentration.
µg/L = micrograms per Liter
mg/L= milligrams per Liter
ng/L= nanograms per liter

[1] All data are provided in Attachment 2-3C.

[2] A single sample was collected downstream of New Bullards Bar Dam.

[3] The most protective standard, criterion, or benchmark of those given in Table 2.4-1 was used for this analysis. With few exceptions, aquatic life protective benchmarks were the most protective number.

[4] Turbidity meter malfunctioned during sampling and no data were collected on this date.

[5] Minimum concentrations except where natural concentrations are less (Marshack 2008).

[6] See Attachment 2-3C, Table 2.3C-2 and Table 2.3C-3 for sample specific criteria. Ammonia criteria are temperature and pH dependent. Metals Criteria are hardness dependent for dissolved fractions of cadmium, copper, lead, silver, and zinc.

3.2 Recreation Element

Bacteria samples were collected in surface water adjacent to six recreation sites five times within 30 days, including one day of the Independence Day holiday weekend and one day of the Labor Day weekend in 2012 (See Figure 2 of Attachment 2-3A). The geometric mean was then calculated from the five results to allow comparison with the Water Quality Objective (fecal coliform) and benchmark (total coliform, *e. coli*). TPH samples and visual observations for oil and grease were also recorded. Results of these comparisons are shown in Table 3.2-1 for the 2012 Independence Day Holiday weekend.

3.2.1 Independence Day Holiday 2012 Results

Bacteria samples were collected in surface water adjacent to six recreation sites five times within 30 days, including one day of the Independence Day holiday weekend (See Figures 2 and 3 of Attachment 2-3A). The geometric mean was then calculated from the five results to allow comparison with the Water Quality Objective (fecal coliform) or benchmark (total coliform, *e. coli*). TPH samples and visual observations for oil and grease were also recorded. Results of these comparisons are shown in Table 3.2-1.

Table 3.2-1. Summary of Recreation Element results – 2012 Independence Day Holiday.

Sample Date	New Bullards Bar Reservoir				Our House Diversion Dam Impoundment	Log Cabin Diversion Dam Impoundment
	Emerald Cove Marina	Dark Day Cove Boat Ramp	Dark Day Cove Informal day use area	Moran Cove Day Use	Near Shore Upstream of Dam	Near Shore Upstream of Dam
	103410-3-1	**103410-3-2**	**103410-3-3**	**103410-3-4**	**103410-3-5**	**103410-3-6**
FECAL COLIFORM < 200 MPN per 100 mL (geometric mean)						
6/26/2012	2	< 2	2	< 2	4	2
	--	--	< 2	--	--	--
7/1/2012	< 2	2	< 2	5	22	170
	--	--	--	< 2	--	--
7/4/2012	6	2	6	< 2	8	21
	6	--	--	--	--	--
7/7/2012	< 2	< 2	< 2	< 2	30	17
	--	--	--	< 2	--	--
7/19/2012	50	8	< 2	2	8	8
	--	--	--	--	--	2
Geometric Mean	4.9	2.6	2.4	2.3	11.1	11.2
TOTAL COLIFORM < 240 MPN per 100 mL (geometric mean)						
6/26/2012	222.4	135.4	261.3	344.8	285.1	547.5
	--	146.7	--	--	--	--
7/1/2012	209.8	313.0	238.2	325.5	517.2	488.4
	--	--	--	261.3	--	--
7/4/2012	461.1	613.1	365.4	435.2	1,299.7	1,553.1
	461.1	--	--	--	--	--
7/7/2012	313.0	1,66.4	39.3	456.9	755.5	913.9
	--	--	--	344.1	--	--
7/19/2012	> 2,419.2	547.5	160.7	> 2,419.2	1,299.7	1,413.6
	--	--	--	--	--	1,046.2
Geometric Mean	**442.5**	**265.1**	170.4	**467.1**	**716.0**	**908.2**

Table 3.2-1. (continued)

Sample Date	New Bullards Bar Reservoir				Our House Diversion Dam Impoundment	Log Cabin Diversion Dam Impoundment
	Emerald Cove Marina	Dark Day Cove Boat Ramp	Dark Day Cove Informal day use area	Moran Cove Day Use	Near Shore Upstream of Dam	Near Shore Upstream of Dam
	103410-3-1	103410-3-2	103410-3-3	103410-3-4	103410-3-5	103410-3-6
ESCHERICHIA COLI **< 126 MPN per 100 mL (geometric mean)**						
6/26/2012	Absent	Absent	Absent	Absent	2.0	5.2
	--	Absent	--	--	--	--
7/1/2012	1.0	2.0	Absent	Absent	21.8	48.0
	--	--	--	Absent	--	--
7/4/2012	4.1	Absent	3.1	Absent	7.2	16.9
	3.0	--	--	--	--	--
7/7/2012	Absent	Absent	Absent	Absent	35.0	12.2
	--	--	--	Absent	--	--
7/19/2012	23.8	Absent	Absent	Absent	12.2	2.0
						4.1
Geometric Mean	4.1	2.0	3.1	Absent	10.6	8.7
OIL AND GREASE **Aesthetics – Present or absent by visual observation**						
6/26/2012	Absent	Absent	Absent	Absent	Absent	Absent
7/1/2012	Absent	Absent	Absent	Absent	Absent	Absent
7/4/2012	Absent	Absent	Absent	Absent	Absent	Absent
7/7/2012	Absent	Absent	Absent	Absent	Absent	Absent
7/9/2012	Absent	Absent	Absent	Absent	Absent	Absent
7/19/2012	Absent	Absent	Absent	Absent	Absent	Absent
TOTAL PETROLEUM HYDROCARBONS (μ/L) **Reporting Limit = 50 μ/L (micrograms per Liter)**						
7/4/2012	< 50	< 50	< 50	< 50	< 50	< 50
	< 50	--	--	--	--	--

-- No count performed for this location and time.

[1] Geometric mean values in **bold** were greater than the water quality objective or benchmark in Table 2.4-1.

For bacteria sampling, only fecal coliform has a numeric Basin Plan Water Quality Objective and all Independence Day Holiday weekend 2012 mean fecal coliform counts were less than the objective of less than 200 MPN per 100 mL (Table 3.2-1). Mean total coliform counts were found above the benchmark of greater than 240 MPN/100 mL (EPA 2003) at five of the six locations sampled: Emerald Cove Marina (442.5 MPN per 100 mL); Dark Day Cove Boat Ramp (265.1 MPN per 100 mL); Moran Cove Day Use Area (467.1 MPN per 100 mL); Our House Diversion Dam Impoundment (716.0 MPN per 100 mL); and Log Cabin Diversion Dam Impoundment (908.2 MPN per 100 mL). However, *E. coli* counts, which are considered a good predictor of human impacts and a component of total coliform, were less than it's' benchmark at all locations.

TPH was not detected during the study. Though boats, geese, and people were observed at different locations, no oily sheen or other water quality impairment was observed at any of the sites.

3.2.2 Labor Day Holiday 2012 Results

Bacteria samples were collected in surface water adjacent to six recreation sites five times within 30 days, including one day of the Labor Day holiday weekend (See Figures 2 and 3 of Attachment 2-3A). The geometric mean was then calculated from the five results to allow comparison with the Water Quality Objective (fecal coliform) or benchmark (total coliform, *E. coli*). TPH samples and visual observations for oil and grease were also recorded. Results of these comparisons are shown in Table 3.2-2.

Table 3.2-2. Summary of Recreation Element results – 2012 Labor Day Holiday.

Sample Date	New Bullards Bar Reservoir				Our House Diversion Dam Impoundment	Log Cabin Diversion Dam Impoundment
	Emerald Cove Marina	Dark Day Cove Boat Ramp	Dark Day Cove Informal day use area	Moran Cove Day Use	Near Shore Upstream of Dam	Near Shore Upstream of Dam
	103410-3-1	103410-3-2	103410-3-3	103410-3-4	103410-3-5	103410-3-6
FECAL COLIFORM < 200 MPN per 100 mL (geometric mean)						
8/20/2012	< 2	2	< 2	< 2	30	8
	< 2	--	--	--	--	--
8/24/2012	< 2	2	< 2	< 2	11	80
	--	--	< 2	--	--	--
9/3/2012	< 2	< 2	2	4	4	11
	--	--	--	2	--	--
9/14/2012	< 2	< 2	2	< 2	2	4
	--	--	--	--	--	4
9/17/2012	< 2	< 2	2	< 2	8	170
	--	< 2	--	--	--	--
Geometric Mean	< 2	< 2	2	2	7	16
TOTAL COLIFORM < 240 MPN per 100 mL (geometric mean)						
8/20/2012	365.4	866.4	1,413.6	1,413.6	> 2,419.2	2,419.2
	517.2	--	--	--	--	--
8/24/2012	387.3	387.3	285.1	410.6	> 2,419.2	1,986.3
	--	--	435.2	--	--	--
9/3/2012	410.6	770.1	547.5	235.9	> 2,419.2	920.8
	--	--	--	224.7	--	--
9/14/2012	1,732.9	209.8	648.8	198.9	> 2,419.2	631.1
	--	--	--	--	--	687.7
9/17/2012	1,299.7	344.8	770.1	275.5	2,419.2	727.0
	--	410.6	--	--	--	--
Geometric Mean	**638.4**	**444.1**	**602.8**	**345.0**	**2,419.2**	**1,057.2**
***ESCHERICHIA COLI* < 126 MPN per 100 mL (geometric mean)**						
8/20/2012	Absent	Absent	Absent	Absent	8.5	10.9
	Absent	--	--	--	--	--
8/24/2012	Absent	Absent	Absent	Absent	4.1	17.1
	--	--	Absent	--	--	--
9/3/2012	Absent	Absent	Absent	2.0	2.0	18.5
	--	--	--	Absent	--	--

Table 3.2-2. (continued)

Sample Date	New Bullards Bar Reservoir				Our House Diversion Dam Impoundment	Log Cabin Diversion Dam Impoundment
	Emerald Cove Marina	**Dark Day Cove Boat Ramp**	**Dark Day Cove Informal day use area**	**Moran Cove Day Use**	**Near Shore Upstream of Dam**	**Near Shore Upstream of Dam**
	103410-3-1	**103410-3-2**	**103410-3-3**	**103410-3-4**	**103410-3-5**	**103410-3-6**
***ESCHERICHIA COLI* (continued)** **< 126 MPN per 100 mL (geometric mean)**						
9/14/2012	Absent	1.0	Absent	Absent	2.0	48.0
	--	--	--	--	--	53.8
9/17/2012	Absent	Absent	Absent	Absent	2.0	13.5
	--	Absent	--	--	--	--
Geometric Mean	Absent	Absent	Absent	Absent	3.1	22.2
OIL AND GREASE **Aesthetics – Present or absent by visual observation**						
8/20/2012	Absent	Absent	Absent	Absent	Absent	Absent
8/24/2012	Absent	Absent	Absent	Absent	Absent	Absent
9/3/2012	Absent	Absent	Absent	Absent	Absent	Absent
9/14/2012	Absent	Absent	Absent	Absent	Absent	Absent
9/17/2012	Absent	Absent	Absent	Absent	Absent	Absent
TOTAL PETROLEUM HYDROCARBONS (µ/L) **Reporting Limit = 50 µ/L (micrograms per Liter)**						
9/3/2012	< 50	< 50	< 50	< 50	< 50	< 50
	--	--	--	--	--	--

-- No count performed for this location and time.

[1] Geometric mean values in **bold** were greater than the water quality objective or benchmark in Table 2.4-1.

For bacteria sampling, only fecal coliform has a numeric Basin Plan Water Quality Objective and all Labor Day Holiday weekend 2012 mean fecal coliform counts were less than the objective of less than 200 MPN per 100 mL (Table 3.2-2). Mean total coliform counts were found above the benchmark of greater than 240 MPN/100 mL (EPA 2003) all six locations sampled: Emerald Cove Marina (638.4 MPN per 100 mL); Dark Day Cove Boat Ramp (444.1 MPN per 100 mL); Dark Day Informal Day Use Area (602.8 MPN per 100 mL); Moran Cove Day Use Area (602.8 MPN per 100 mL); Our House Diversion Dam Impoundment (2419.2 MPN per 100 mL); and Log Cabin Diversion Dam Impoundment (1057.2 MPN per 100 mL). However, *E. coli* counts, which is considered a good predictor of human impacts and a component of total coliform, were less than it's' benchmark at all locations.

TPH was not detected during the field study. Though boats, geese, and people were observed at different locations, no oily sheen or other water quality impairment was observed at any of the sites.

3.3 Turbidity-associated Mercury Sample Element

Flows of 5,000 cfs or greater at the Smartsville Gage (gage YRS), located below Englebright Dam and Narrows No. 1 and No. 2 powerhouses, were observed on March 14, 2012, triggering this sample collection.[11] An initial set of samples was collected on Friday, March 16, and sent to MPSL-Cal Fish and Wildlife for Saturday delivery and preservation. Due to a shipping company error, samples were delayed getting to the laboratory and methylmercury samples were not preserved within the method's holding time. Hence, because the March 16 methylmercury sample results would be qualified, re-sampling occurred on Monday, March 19.

Both the March 16 and the March 19 results are shown in Table 3.3-1. Water samples were analyzed for turbidity, total suspended sediment, total dissolved sediment, total mercury and methylmercury. Observations made during the sampling events are provided below.

Table 3.3-1. Tailrace Sample Results

Analyte	Sample Location	Below Colgate Powerhouse		Below Narrows 2 Powerhouse		Fieldblank	
	Sample Depth	Surface		Surface			
	Powerhouse Flows	406	1159	3400	3500		
	Date	3/16/2012	3/19/2012	3/16/2012	3/19/2012	3/16/2012	3/19/2012
	units	Result	Result	Result	Result	Result	Result
Mercury	ng/L	7.20	0.689	9.66	19.4	<0.200	<0.200
Methyl Mercury	ng/L	0.023 HB	0.017 B	0.04 HB	0.072B	0.014 H	0.018
Solids, Total Dissolved	mg/L	68	54	67	60	<10	<10
Solids, Total Suspended	mg/L	86.79	<3.00 A	18.81	29.75	<3.00 A	<3.00 A

Key: < = not detected at the reporting limit
B = observed in fieldblank. Sample concentration is less than 5 times the blank concentration.
H = sample hold time exceeded A = entire sample was filtered, confirming the non-detect result.

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[11] The storm was large enough that Englebright Reservoir spilled; however New Bullards Bar reservoir did not. Between March 15 and 19, 2012, the Yuba River watershed received 10.9 inches of precipitation as measured at CDEC station CGT (Colgate Powerhouse). This event caused increased flows in Oregon Creek, Middle Yuba River and South Yuba River, eventually triggering a spill at Englebright Reservoir. The maximum flow observed during this event at the USGS Smartville gage (YRS) was 20,347 cfs, which occurred around 12:00 AM on March 17.

3.3.1 Below New Colgate Powerhouse Results

Methylmercury was detected in samples collected downstream of New Colgate Powerhouse on March 16 (0.023 ng/L) and March 19 (0.017 ng/L), as well as in their associated fieldblanks (0.014 ng/L and 0.018 ng/L; Table 3.3-1). The similarities of the sample and fieldblank results suggest that methylmercury was introduced from field conditions; methylmercury values are of the same order of magnitude and less than five times of the associated fieldblank. However, methylmercury concentrations measured in Spring 2012 are also similar, ranging from 0.029 J to 1.08 ng/L (average 0.083 ng/L), and concentrations may represent ambient conditions (Table 3.1-1). Mercury (total) concentrations were 7.20 ng/L and 0.689 ng/L, on the respective dates and mercury was not detected in either fieldblank. Mercury concentrations measured in Spring 2012 ranged between 0.27 J and 3.58 ng/L, suggesting that observed tailrace mercury concentrations also reflect ambient conditions (Table 3.1-1). Total dissolved solids were found at essentially equivalent concentrations on both dates at 68 mg/L and 54 mg/L, respectively, while total suspended solids were significantly different at 86.79 mg/L and <3.00 mg/L (qualified).

The differences in mercury (total) and total suspended solids results can be explained by the observed hydrology on each day. As described below, the March 19 sample appears to be more representative of water that had passed solely through the powerhouse turbines.

On March 16, 2012, the release from New Bullards Bar Dam was 12 cfs, the average daily flow through New Colgate Powerhouse was 406 cfs, and the average total flow below Colgate was 4,579 cfs.[12] Greater flows were observed through the powerhouse on March 19, although total streamflow was higher. Figure 3.3-1 shows the Yuba River looking upstream towards New Colgate Powerhouse from the sampling location, which were the conditions at the time of sample collection. *In situ* data collected using a HydroLab showed water temperature at approximately 8.6°C and turbidity readings between 80 and 100 NTU over a 5-minute period of monitoring.

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[12] The flow below New Colgate Powerhouse was estimated by adding the flows from the dam (12 cfs), the powerhouse (406 cfs), below Our House Diversion Dam (3,407 cfs), and below Log Cabin Diversion Dam (754 cfs).

Figure 3.3-1. Yuba River looking upstream from below New Colgate Powerhouse on March 16, 2012. The powerhouse is on river left.

On March 19, 2012, the release from the dam was 7 cfs, the average daily flow through New Colgate Powerhouse was 1,159 cfs, and the average total flow below New Colgate Powerhouse was 1,257 cfs.[13] The flow through New Colgate Powerhouse was higher on March 19 than on March 15 even though total streamflows were lower. Figure 3.3-2 shows the Yuba River looking downstream from the sampling location, and shows turbid water from above New Colgate Powerhouse and clear water from the powerhouse not mixing as they move downstream. Mixing was observed to occur in the large pool a few hundred yards downstream from the powerhouse near the Dobbins Creek confluence. Photo Figure 3.3-3 shows the clarity of the flowing through the powerhouse that, when sampled, had a turbidity of 0.0 NTU. There was no access to the downstream 'mixed' water.

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[13] The flow below Colgate was estimated by adding the flows from the dam (7 cfs), the powerhouse (1,159 cfs), below Our House Diversion Dam (70 cfs), and below Log Cabin Diversion Dam (21 cfs).

Figure 3.3-2. Yuba River looking downstream from New Colgate Powerhouse on March 19, 2012. Turbid water from upstream is not mixing with the New Colgate Powerhouse discharge.

Figure 3.3-3. Water in the Yuba River from New Colgate Powerhouse on March 19, 2012.

3.3.2 Below Narrows No. 2 Powerhouse Results

Methylmercury was detected in samples collected below Narrows 2 Powerhouse on March 16 (0.04 ng/L) and March 19 (0.072 ng/L), as well as in their associated fieldblanks (0.014 ng/L and 0.018 ng/L; Table 3.3-2). The similarity of the sample and fieldblank results suggests that methylmercury was introduced from field conditions; both methylmercury values are of the same order of magnitude and less than 5 times of the associated fieldblank.

On the other hand, methylmercury concentrations measured in Spring 2012 are also similar, ranging from 0.029 J to 1.08 ng/L (average 0.083 ng/L), and concentrations may represent ambient conditions (Table 3.1-1). Mercury (total) concentrations were 9.66 ng/L and 19.4 ng/L, on the respective dates and mercury was not detected in either fieldblank. Mercury concentrations measured in Spring 2012 ranged between 0.27 J and 3.58 ng/L, suggesting that observed tailrace mercury concentrations also reflect ambient conditions (Table 3.1-1). Total dissolved solids were found at essentially equivalent concentrations on both dates at 67 mg/L and 60 mg/L, while total suspended solids exhibited more difference at 18.81 mg/L and 29.75 mg/L.

The differences in mercury (total) and total suspended solids results can be explained by the observed hydrology on each day. As above, the March 19 sample appears to be more representative of water that had passed solely through the Narrows No. 1 and No. 2 powerhouses' turbines, and the sample exhibited greater turbidity than the March 16 sampling conditions.

On March 16, 2012, Englebright Reservoir was spilling and flows downstream of Narrows No. 1 and No. 2 powerhouses were about 12,788 cfs (YRS), with the powerhouses contributing about 4,000 cfs to that flow. Figure 3.3-4 shows the Yuba River looking upstream towards Narrows No. 1 and No. 2 powerhouses from the sampling location, and shows conditions at the time of sampling. *In situ* data collected using a HydroLab showed water temperature at approximately 9.3°C and turbidity readings between 37 and 45 NTU over a 5-minute period of monitoring.

Figure 3.3-4. Yuba River below Narrows No. 1 Powerhouse on March 16, 2012. The powerhouse is on river right and Englebright Reservoir, which is spilling, is in the background.

On March 19, 2012, Englebright Reservoir releases were controlled (not spilling) downstream of Narrows No. 1 and No. 2 powerhouses the flows were about 4,040 cfs (YRS), with the powerhouses contributing about 4,000 cfs to that flow. Figure 3.3-5 shows the Yuba River looking upstream towards Narrows No. 1 and No. 2 powerhouses from the sampling location, and shows conditions at the time of sampling. *In situ* data collected using a HydroLab showed water temperature at approximately 9.0°C. Like total mercury, turbidity readings were higher on March 19 than on March 16, with readings between 67 and 85 NTU over a 5-minute period of monitoring.

Figure 3.3-5. Yuba River below Narrows No. 1 Powerhouse on March 19, 2012. The powerhouse is on river right and Englebright Reservoir, which is not spilling, is in the background.

4.0 Discussion

Beneficial uses of surface water in the vicinity of the Project are designated by the CVRWQCB and listed in the Basin Plan (CVRWQCB 1998). The designated beneficial uses for the Project Area are Municipal and Domestic Supply, Agricultural Supply, Hydropower Generation, Water Contact and Non-Contact Recreation, Cold and Warm Freshwater Habitat, Migration of Aquatic Habitat, Spawning, and Wildlife Habitat.

To assess the consistency of analytical data with these beneficial uses, the Basin Plan's Water Quality Objectives were compared to data collected as part of the study. Basin Plan Water Quality Objectives and beneficial uses were linked to each other above in Table 2.4-1 where, for situations where the Basin Plan does not provide a numeric Water Quality Objective, a pertinent regulatory standard, criteria or benchmark was selected for this evaluation. Results of these comparisons are provided in Attachment 2-3C, summarized in the tables and text of Section 3, and discussed below.

Below is a summary of the 14 Basin Plan Water Quality Objectives that are applicable to the Project. Water Quality Objectives that do not apply, such as the Water Quality Objective for radioactivity, are excluded. Water temperature and mercury bioaccumulation by fish are not addressed in this Technical Memorandum, but in separate Relicensing Technical Memoranda.

4.1 Biostimulatory Substances

The Basin Plan requires that water shall not contain biostimulatory substances which promote aquatic growth in concentrations that cause nuisance or adversely affect designated beneficial uses.

In spring 2012, nitrate concentrations ranged between 0.04 J and 0.15 mg/L, while nitrite was not detectable (Table 3.1-1). Total Kjeldahl Nitrogen concentrations ranged between 0.49 J and 0.98 mg/L. Total phosphorous levels were similarly low, ranging between 0.09 J mg/L and 0.41 mg/L. Orthophosphate concentrations were only detected once during the Spring sampling (0.13 mg/L). In summer 2012, nitrate, nitrite, Total Kjeldahl Nitrogen, and orthophosphate concentrations were rarely detected below the reporting limit or not detectable (Table 3.1-2).

These low nutrient levels suggest that biostimulatory substances are not currently present in sufficient quantities to cause nuisance conditions related to algal blooms or decreased water clarity. YCWA is unaware of any instances where algal bloom or decreased water clarity has been reported as a nuisance.

4.2 Chemical Constituents

The Basin Plan requires that water shall not contain chemical constituents in concentrations that adversely affect designated beneficial uses. The Basin Plan requires that water designated for use as domestic or municipal supply shall not contain concentrations of chemical constituents in excess of the MCLs specified in the provisions of Title 22 of the California Code of Regulations (CDPH 2010).

MCLs are intended to be applied to finished tap water, but are applied to untreated water in our Relicensing studies (a very protective assumption). Samples collected in spring 2012 and summer 2012 had concentrations less than the primary MCLs for all analytes; water quality was found to be consistent with drinking water standards (See Attachment 2-3C). Analytes with secondary MCLs for tastes and odors are addressed in Section 4.7. Aquatic toxicity is discussed in Section 4.8.

4.3 Color

The Basin Plan includes a narrative Water Quality Objective regarding color.

The FERC-approved study did not require sampling for color. YCWA is unaware of any instances where the color of the water in the vicinity of the Project has been reported as a nuisance or has adversely affected designated beneficial uses.

4.4 pH

The Basin Plan requires that pH shall not be depressed below 6.5 nor raised above 8.5.

In spring 2012 and in summer 2012, all sample results were within the Basin Plan's Water Quality Objective for pH.

4.5 Pesticides

The Basin Plan includes extensive discussions related to Water Quality Objectives for pesticides. Significant pesticide use does not occur within the Project area, or in association with Project O&M. Further, YCWA is unaware of any instances where pesticide use in the vicinity of the Project has been reported to cause a nuisance or adversely affect designated beneficial uses.

4.6 Sediment and Settleable Solids

The Basin Plan requires that suspended sediment load and suspended sediment discharge of surface waters shall not be altered in such a manner as to cause a nuisance or adversely affect beneficial uses.

YCWA is unaware of any sediment discharges to surface water related to the Project, or that suspended sediment levels cause a nuisance or adversely affect designated beneficial uses.

4.7 Tastes and Odor

The Basin Plan requires that waters shall not contain taste- or odor-producing substances in concentrations that impart undesirable tastes or odors to domestic or municipal water supplies or to fish flesh or other edible products of aquatic origin, or that cause nuisance, or otherwise adversely affect beneficial uses.

Samples collected in spring 2012 and summer 2012 had concentrations less than the secondary MCLs for all analytes; water quality was found to be consistent with drinking water standards (See Attachment 2-3C). YCWA is unaware of any reports that taste or odor of water or fish caught in New Bullards Bar, the Projects diversion impoundments, or Project-affected reaches, cause a nuisance or otherwise adversely affect designated beneficial uses.

4.8 Toxicity

The Basin Plan requires that waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life.

The FERC-approved study states that study water quality data would be compared to the aquatic life protective benchmarks from the EPA (2000) CTR or benchmarks excerpted from Marshack (2008) A Compilation of Water Quality Goals. The low levels of hardness found throughout the study area are expected to increase the aquatic toxicity of some metals due to the greater proportion of free ions found in many trace metals. At the low hardness levels found in the study (i.e., 2.4 mg/L to 46 mg/L in spring and 26 mg/L to 81 mg/L in the summer), sample specific dissolved cadmium, copper, lead, silver, and zinc CTR criteria were calculated (Attachment 2-3C**)**. In spring 2012, dissolved copper, nickel, and silver concentrations were greater than each sample specific CTR in Englebright Reservoirs' surface samples. At the Englebright Reservoir's mid-reservoir location, copper was essentially equivalent[14] to the CTR criteria (0.39 µg/L; CTR= 0.37 µg/L) and the silver reporting limit was greater than the CTR criteria (<0.02 µg/L; CTR 0.01 µg/L). At Englebright Reservoir's upper-reservoir location, nickel was essentially equivalent to the CTR criteria (27.7 µg/L; CTR= 18.8 µg/L). In summer 2012, dissolved copper concentrations were greater than the CTR criteria in each of the six hypolimnion samples. Upstream to downstream, in New Bullards Bar, the dissolved copper hypolimnion concentrations were 9.13 µg/L (CTR=2.83 µg/L) , 5.86 µg/L (CTR=2.93 µg/L), and 5.01 µg/L (CTR=3.11 µg/L); while upstream to downstream in Englebright Reservoir, dissolved copper concentrations were 5.32 µg/L (CTR=3.47 µg/L), 7.57 µg/L (CTR=3.02 µg/L), and 3.84 µg/L (CTR=3.11 µg/L). YCWA is unaware of any Project O&M activity that may affect the trace levels of copper, nickel or silver in Englebright Reservoir.

4.8.1 Mercury and Methylmercury

The State Water Resources Control Board has identified as Clean Water Act Section (§) 303(d) State Impaired for mercury the following stream sections in the Project Vicinity[15] (SWRCB 2010): New Bullards Bar Reservoir; the Middle Yuba River from Bear Creek to the North Yuba River; the North Yuba River from New Bullards Bar Dam to the confluence with the Middle Yuba River; the Yuba River from the confluence of the North Yuba River and Middle Yuba River to the United States Army Corps of Engineer's (USACE) Englebright Reservoir; the South Yuba River from Lake Spaulding to Englebright Reservoir; Englebright Reservoir; and the Yuba River from Englebright Reservoir to the confluence of the Feather River.

Mercury in the Project vicinity is a legacy of the regions gold mining. Mercury can affect the nervous system of higher trophic organisms and is bioaccumulated and transferred to higher trophic organisms through the food-web.

Mercury was detected at all locations in the spring 2012 sampling at concentrations that ranged between 0.27 J and 3.58 nanograms per Liter (ng/L) and in the Summer 2012 sampling at concentrations that ranged between 0.31 J and 15.9 ng/L. These total mercury concentrations were far less than the MCL of 0.002 mg/L (2,000 ng/L) indicating that drinking water beneficial use is being met everywhere in the Project Area for mercury. Results were also below the CTR benchmark of 50 ng/L.

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[14] At the trace and low metals and hardness concentrations observed by this study, metals quantification and CTR criteria are highly uncertain. Comparisons between metals concentrations measured by EPA Method 1638 and CTR criteria account for the uncertainties in the both the laboratory method and the criteria. At the trace and low metals and hardness concentrations observed by this study, concentrations found of the same order of magnitude and within two times of each other were considered essentially equivalent.

[15] The Project Vicinity is defined as the area surrounding the Project on the order of a United States Geological Survey 1:24,000 topographic quadrangle.

Even in trace quantities, mercury is bioaccumulative in its methylated form and samples were also analyzed for methylmercury (total) and methylmercury (dissolved). In Spring 2012, methylmercury (total) was detected in 17 of 31[16] samples at concentrations that ranged between 0.029 J and 1.08 ng/L (average 0.083 ng/L), while methylmercury (dissolved) was detected in 31 of 31 samples at concentrations between 0.033 J and 0.091 ng/L (average 0.049 ng/L). In summer 2012, methylmercury (total) was detected in 17 of 31 samples at concentrations that ranged between 0.05 ND and 0.37 ng/L (average 0.11 ng/L), while methylmercury (dissolved) was detected in 12 of 31 samples at concentrations between 0.032 J and 0.522 ng/L (average 0.10 ng/L). Since Water Quality Objective for methylmercury are expressed in terms of fish tissue, no direct Basin Plan consistency evaluation can be made. However, bioaccumulation in fish tissue is assessed in Study 2-4 Bioaccumulation.

4.9 Turbidity

The Basin Plan requires that waters be free of changes in turbidity that cause nuisance or adversely affect beneficial uses. This objective is expressed in terms of changes in turbidity (NTU) in the receiving water body: where natural turbidity is 0 to 5 NTUs, increases shall not exceed 1 NTU; where 5 to 50 NTUs, increases shall not exceed 20 percent; where 50 to 100 NTUs, increases shall not exceed 10 NTUs; and where natural turbidity is greater than 100 NTUs, increase shall not exceed 10 percent.

Spatial upstream-to-downstream turbidity trends are best seen in the data as it is presented in Attachment 2-3C, which provides sample results by location. For spring 2012 sampling, these data show that turbidity was high in surface samples collected in Englebright Reservoir's upper reservoir sample (550 NTU) and New Bullards Bar Reservoir's Madrone Cove sample (335.6 NTU), but low everywhere else. Turbidity in the other 29 samples ranged from 0 to 46 NTU and the subset of samples collected from lower Yuba River, downstream of the Project, ranged from 0 to 11.9 NTU. For summer 2012 sampling, these data show that turbidity was high in surface samples collected in Englebright Reservoir's upper reservoir sample (159.6 NTU), but low everywhere else. Turbidity in the other 30 samples ranged from 0 to 20 NTU and the subset of samples collected from lower Yuba River, downstream of the Project, ranged from 0.3 to 20 NTU. YCWA is unaware of any reports that turbidity causes a nuisance or adversely affects beneficial uses in the study area or immediately downstream of the Project.

4.10 Bacteria

The Basin Plan includes a Water Quality Objective (< 200 MPN per 100 mL) for fecal coliform in waters designated for contact recreation (Table 3.2-1). In 2012, all six sites sampled had fecal coliform counts below the Water Quality Objective for the both the time surrounding and including Independence Day the time surrounding and including Labor Day.

For the two bacteria counts without Water Quality Objectives, over the Independence Day Holiday 2012 interval, 5 of 6 locations had mean total coliform counts above the EPA (2003) benchmark of 240 MPN/100 mL and over the Labor Day Holiday interval 6 out of 6 locations

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[16] Sample count includes duplicates.

had mean coliform counts about the benchmark. However, *E. coli* levels were below the recommended numeric criteria in all samples associated with each holiday. *E. coli* counts are thought to be better indicators of human impacts.

4.11 Floating Material

The Basin Plan includes a narrative Water Quality Objective regarding floating material that states water shall be free of floating material in amounts that cause nuisance or adversely affect beneficial uses.

4.12 Oil and Grease

The Basin Plan requires that the water not contain oils, greases, waxes or other material in concentrations that cause nuisance, result in visible film or coating on the surface of the water or on objects in the water, or otherwise adversely affect beneficial uses. In 2012, YCWA looked for oil and grease in the Project reservoirs and sampled for TPH at recreation sites on and around the Independence Day holiday. No oily sheen was observed and TPH was not detected at any of the sites.

4.13 Dissolved Oxygen

The general DO Water Quality Objective of 7.0 mg/L applies to the Yuba River and its tributaries. (CVRWQCB 1998).

As documented in YCWA's Pre-application Document and elsewhere, both New Bullards Bar and Englebright reservoirs stratify in the Summer months, which oftentimes results in low DO conditions at the bottom of reservoirs (YCWA 2010). Dissolved oxygen concentrations measured in spring 2012 ranged from 6.90 to 13.1 mg/L in the 31 samples collected and only two of the sites had concentrations less than the Water Quality Objective of 7.0 mg/L. New Bullards Bar Reservoir near Madrone had a DO concentration of 6.96 mg/L in its surface sample, which could be consistent with the objective, as it is within the sonde's measurement error of ± 0.5 mg/L. The New Bullards Bar Reservoir near the dam had a DO concentration of 6.90 mg/L in the hypolimnion, which could also be consistent with the objective, as it is within the sonde's measurement error of ± 0.5 mg/L.

Dissolved oxygen concentrations measured in summer 2012 ranged from 5.14 to 12.1 mg/L in the 31 samples collected and only three of the samples had concentrations less than the Water Quality Objective of 7.0 mg/L. New Bullards Bar Reservoir near Madrone had a DO concentration of 5.14 mg/L in its hypolimnion sample. New Bullards Bar Reservoir near the dam had a DO concentration of 6.16 mg/L in its hypolimnion sample. Englebright Reservoir mid-reservoir had a concentration of 6.79 mg/L in its hypolimnion sample. These results were not unexpected, since large, deep reservoirs/lakes generally form strong thermoclines with oxygen poor hypolimnions in the late summer/fall period (See Temperature Monitoring Study).

Along with temperature profiles, DO profiles have been collected in New Bullards Bar Reservoir near the dam each month since November 2010 (Table 4.13-1). As shown in Table 4.13-1, almost all DO measurements are greater than 7.00 mg/L. However, in July and August 2012, DO concentration was observed at concentrations less than the Basin Plan Objective of 7.0 mg/L. During each of these months, a strong thermocline was observed from 40 to 60 ft, and the lower DO concentrations were observed well into the hypolimnion from 70 to 300 feet.

Table 4.13-1. Monthly minimum, average and maximum dissolved oxygen (DO) concentrations (mg/L) in New Bullards Bar Reservoir near the Dam from November 2010 through August 2012.

Month	Minimum DO (mg/L)	Average DO (mg/L)	Maximum DO (mg/L)
2010			
November	8.22	8.93	9.34
December	8.37	9.51	10.19
2011			
January	8.66	9.55	10.22
February	9.42	9.96	10.65
March	9.97	10.43	11.30
April	10.16	10.43	11.05
May	9.91	10.33	11.23
June	8.67	10.24	11.16
July	8.32	10.03	10.45
August	8.20	9.84	10.30
September	8.24	9.44	10.01
October	8.01	9.19	9.79
November	8.39	9.11	9.59
December	8.57	9.14	9.64
2012			
January	8.28	9.20	10.16
February	8.24	9.41	10.54
March	8.17	9.36	10.51
April	9.46	9.98	10.73
May	9.00	9.74	10.49
June	8.70	9.59	10.25
July	6.99	8.16	8.85
August	6.79	8.01	8.64

Key: DO = Dissolved Oxygen mg/L = milligram per Liter

Along with temperature profiles, DO profiles have been collected in Englebright Reservoir near the dam each month since November 2010 (Table 4.13-2) and mid-reservoir since April 2011 (Table 4.13-3). As with New Bullards Bar, there are only a few cases where DO concentrations were inconsistent with the Water Quality Objective. In November 2010, DO level was observed at concentrations less than the Basin Plan Objective of 7.0 mg/L near the dam. During this month, a strong thermocline was observed from 10 to 30 ft, and the lower DO concentrations were observed well into the hypolimnion from 40 to 100 feet. Profiles collected from the middle of Englebright Reservoir since April 2011 was all consistent with the Basin Plan Objective.

Table 4.13-2. Monthly minimum, average and maximum dissolved oxygen (DO) concentrations (mg/L) in Englebright Reservoir near the dam from November 2010 through August 2012.

Month	Minimum DO (mg/L)	Average DO (mg/L)	Maximum DO (mg/L)
2010			
November	6.52	9.21	10.38
December	10.33	10.45	10.55
2011			
January	10.36	10.93	11.44
February	11.27	11.58	11.84

Table 4.13-2. (continued)

Month	Minimum DO (mg/L)	Average DO (mg/L)	Maximum DO (mg/L)
2011 (continued)			
March	11.82	12.00	12.16
April	11.66	11.87	12.06
May	11.36	11.59	11.85
June	10.84	11.41	11.89
July	9.94	11.00	11.72
August	9.80	10.98	11.92
September	9.38	10.25	11.01
October	9.41	9.88	10.37
November	8.02	9.45	10.85
December	10.74	10.96	11.38
2012			
January	10.86	11.26	11.96
February	9.25	10.45	11.89
March	11.06	11.43	11.67
April	10.66	11.25	11.55
May	9.67	10.79	11.24
June	9.97	10.62	11.01
July	8.46	9.33	10.00
August	7.97	8.97	9.98

Key: DO = Dissolved Oxygen mg/L = milligram per Liter

Table 4.13-3. Monthly minimum, average and maximum dissolved oxygen (DO) concentrations (mg/L) in Englebright Reservoir about 3.3 miles upstream of the dam from November 2010 through August 2012.

Month	Minimum DO (mg/L)	Average DO (mg/L)	Maximum DO (mg/L)
2011			
April	11.49	11.97	12.40
May	11.08	11.64	11.86
June	10.77	11.41	11.81
July	9.77	11.40	12.44
August	10.48	11.38	12.00
September	9.31	10.29	10.89
October	7.11	9.83	10.53
November	10.62	10.86	11.06
December	11.00	11.17	11.43
2012			
January	10.49	11.19	11.42
February	9.44	10.42	11.44
March	11.44	11.78	11.85
April	10.71	11.40	11.65
May	10.20	11.25	11.72
June	9.87	10.82	11.22
July	7.87	9.22	10.12
August	8.70	9.95	10.39

Key: DO = Dissolved Oxygen mg/L = milligram per Liter

5.0 Study-Specific Consultation

This study required three study-specific consultations, each of which is discussed below.

5.1 Additional Bacteria Sampling

The FERC-approved study states:

> If YCWA and Relicensing Participants collaboratively identify additional locations of concern regarding Project-related bacteria during the Recreation Use and Visitor Surveys Study (Study 8.1), additional recreation-related bacteria sampling will be performed at the locations (Step 2). In particular, YCWA and the Forest Service have agreed that YCWA will perform recreation surveys at Oregon Creek Day Use Area during the Relicensing Recreation Use and Visitor Surveys Study (Study 8.1). If the surveys indicate a Project nexus, YCWA will perform additional data collection, which could include general water quality and bacteria sampling at the day use area.

YCWA interviewed Recreation Study staff on August 13, 2012, and were informed that nothing has been observed to date that would require any further water quality testing.

5.2 Additional Bacteria Sampling

The FERC-approved study states:

> YCWA will make a good faith effort to keep Relicensing Participants informed of the study's progress and preliminary findings from verified and/or validated data following data QA/QC (Step 3).

YCWA made Relicensing Participants informed of study results by issuance of the October 2012 Interim Technical Memorandum, which provides the quality reviewed results of the 2012 spring and summer 2012 sampling and the 2012 Independence Day Holiday and Labor Day Holiday weekends sampling.

5.3 Additional Water Quality Sampling

The FERC-approved study states:

> YCWA will collaborate with Relicensing Participants regarding need for a focused second year study (Step 8).

YCWA issued an Interim Technical Memorandum 2-3, Water Quality, which included all data collected through October 2012, and met with Relicensing Participants on November 8, 2012 to discus the need for focused second year studies. Based on study results through October 2012, YCWA and Relicensing Participants agreed focused second year studies were not warranted. However, YCWA and Relicensing Participants agreed the fall 2012 water quality sampling, which was not available for the November 8 meeting could suggest some focused studies are needed. Therefore, YCWA and Relicensing Participants agreed to meet on January 30, 2013 to review the results of the fall 2012 water quality sampling. YCWA and the Relicensing Participants met on January 30, 2013 to collaborate regarding the need for a second year study. YCWA and Relicensing Participants collaboratively agreed that additional data gathering needs, based on the results of the study, were not warranted.

6.0 Variances from FERC-Approved Study

The study was conducted in conformance to the FERC-approved Water Quality Study (Study 2-3), with one variance. The FERC-approved study required collection of single samples below Englebright Dam and Narrows No. 1 and No. 2 powerhouses, as soon as possible after flows of 5,000 cfs or greater were observed at USGS' Smartsville gage (YRS). The required flows were observed on March 14, 2012 and samples were collected on Friday, March 16, 2012. However, the shipping company did not complete the Saturday delivery and methylmercury samples did not get preserved. Hence, because the March 16 methylmercury sample results would be qualified, re-sampling occurred on Monday, March 19, which were then delivered to the laboratory and preserved within the required holding time. Both sets of results were presented herein.

7.0 Attachments to This Technical Memorandum

The Technical Memorandum includes the following three attachments:

• Attachment 2-3A	Water Quality Sample Locations – Yuba River Development Project [1 Adobe pdf file: 497 KB; 4 pages: 4 pages formatted to print double sided on 8 ½ x 11 paper]
• Attachment 2-3B	Quality Assurance – Yuba River Development Project [1 Adobe pdf file: 1.2 MB; 82 pages formatted to print double sided on 8 ½ x 11 paper]
• Attachment 2-3C	Chemical Data – Yuba River Development Project [4 Excel files totaling 241 kB]

8.0 References Cited

American Public Health Association, American Water Works Association, and Water Environment Federation. 2010. Standard Methods for the Examination of Water and Wastewater. 21st edition. Washington, D.C. Available at: http://www.standardmethods.org/.

California Department of Public Health (CDPH). 2010. California Code of Regulations, Title 22, Division 4, Chapter 15, Domestic Water Quality and Monitoring Regulations. Available online at: <http://www.cdph.ca.gov/certlic/drinkingwater/Pages/Lawbook.aspx>.

Central Valley Regional Water Quality Control Board (CVRWQCB). 1998. The Water Quality Control Plan (Basin Plan) for the Sacramento River Basin and the San Joaquin River Basin. 4th ed. California Regional Water Quality Control Board, Central Valley Region. Revised in September 2009 with the Approved Amendments. Available online at: <http://www. waterboards.ca.gov/centralvalley/water_issues/basin_plans/>.

_____. 2002. Amendment to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for Bacteria. Staff Report and Functional Equivalent Document. Final Report. State of California Regional Water Quality Control Board, Central Valley Region. R5-2002-0150. September.

Marshack, J. 2008. A Compilation of Water Quality Goals. California Regional Water Quality Control Board, Central Valley Region, Rancho Cordova, California. Available online at: <http://www.swrcb.ca.gov/centralvalley/water_issues/water_quality_standards_limits/ water_quality_goals/index.html>.

State Water Resources Control Board (SWRCB). 2010. 2010 Integrated Report Clean Water Act Sections 303(d) and 305(b). Approved August 4, 2010. Board Resolution No. 2010-0040. Sacramento, California. Available online at: <http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml>.

——. 2011. 2010 Final California 2010 Integrated Report (303(d) List/305(b) Report. Staff Report. Approved by SWRCB: August 4, 2010. Approved by USEPA on November 10, 2010 and October 11, 2011. Available online:

<http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml>

United States Environmental Protection Agency (EPA). 1996. Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. EPA 821-R-95-034. U.S. Environmental Protection Agency, Washington, DC. July 1996. Available online at: <http://www.ecy.wa.gov/programs/ wq/wastewater/method_1669.pdf>.

——. 2000. Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California. 40 CFR 131, pages 31682-31711. Federal Register May 18. Available online at: <http://www.epa.gov/fedrgstr/EPA-WATER/2000/May/Day-18/w11106.pdf>.

——. 2003. Bacterial Water Quality Standards for Recreational Waters (Freshwater and Marine Waters). Office of Water Report No. EPA-823-R-03-008. June. Available online at: <http://www.epa.gov/waterscience/beaches/local/sum2.html>.

——. 2010. Clean Water Act Analytical Methods. Available online at: <http://water.epa.gov/scitech/ swguidance/methods/index.cfm>.

Yuba County Water Agency. 2010. Yuba River Development Project Pre-Application Document. FERC Project No. 2246. November 10, 2010.

Technical Memorandum 2-3

Water Quality

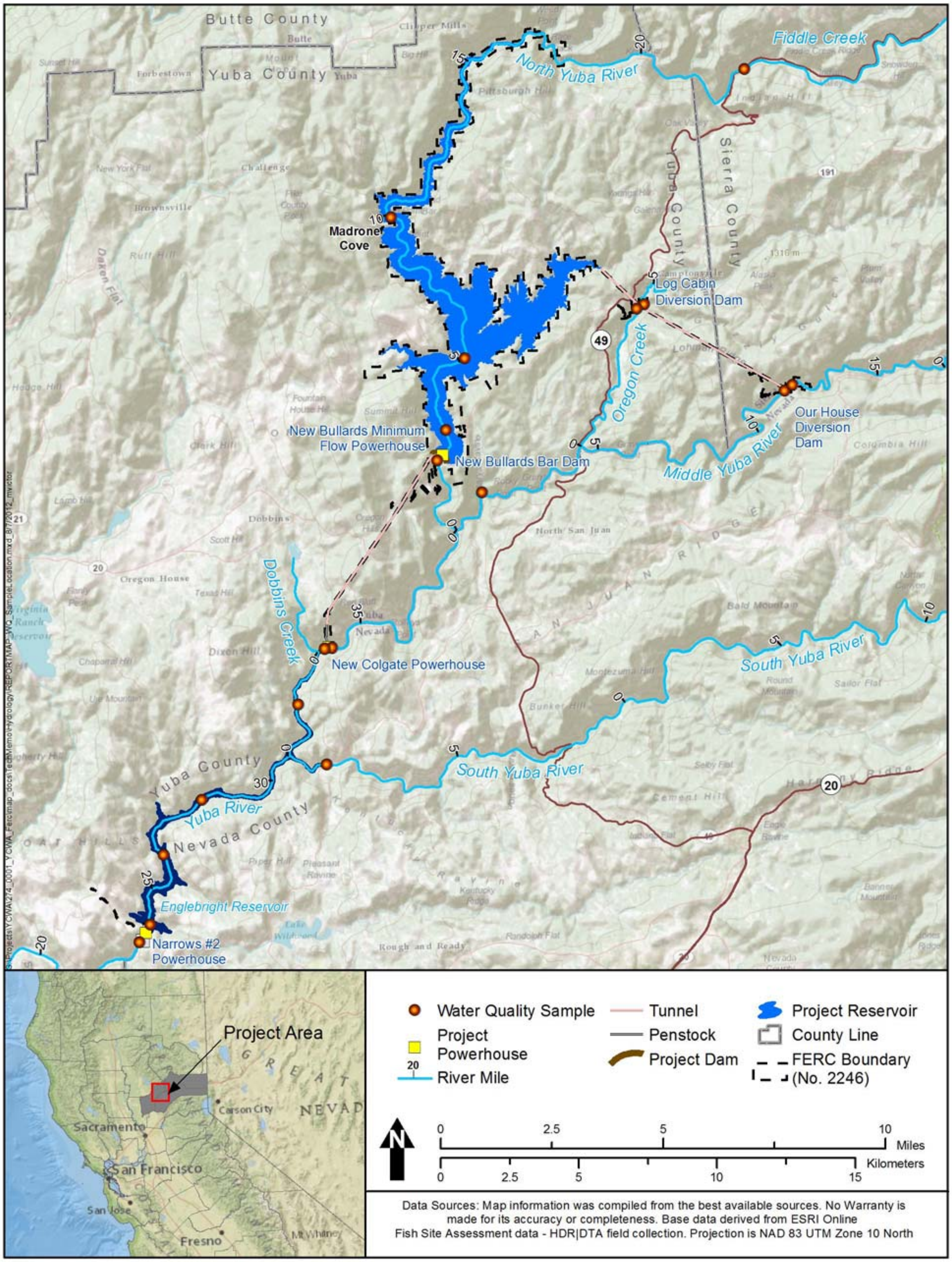
Attachment 2-3A

Water Quality Sample Locations

Yuba River Development Project

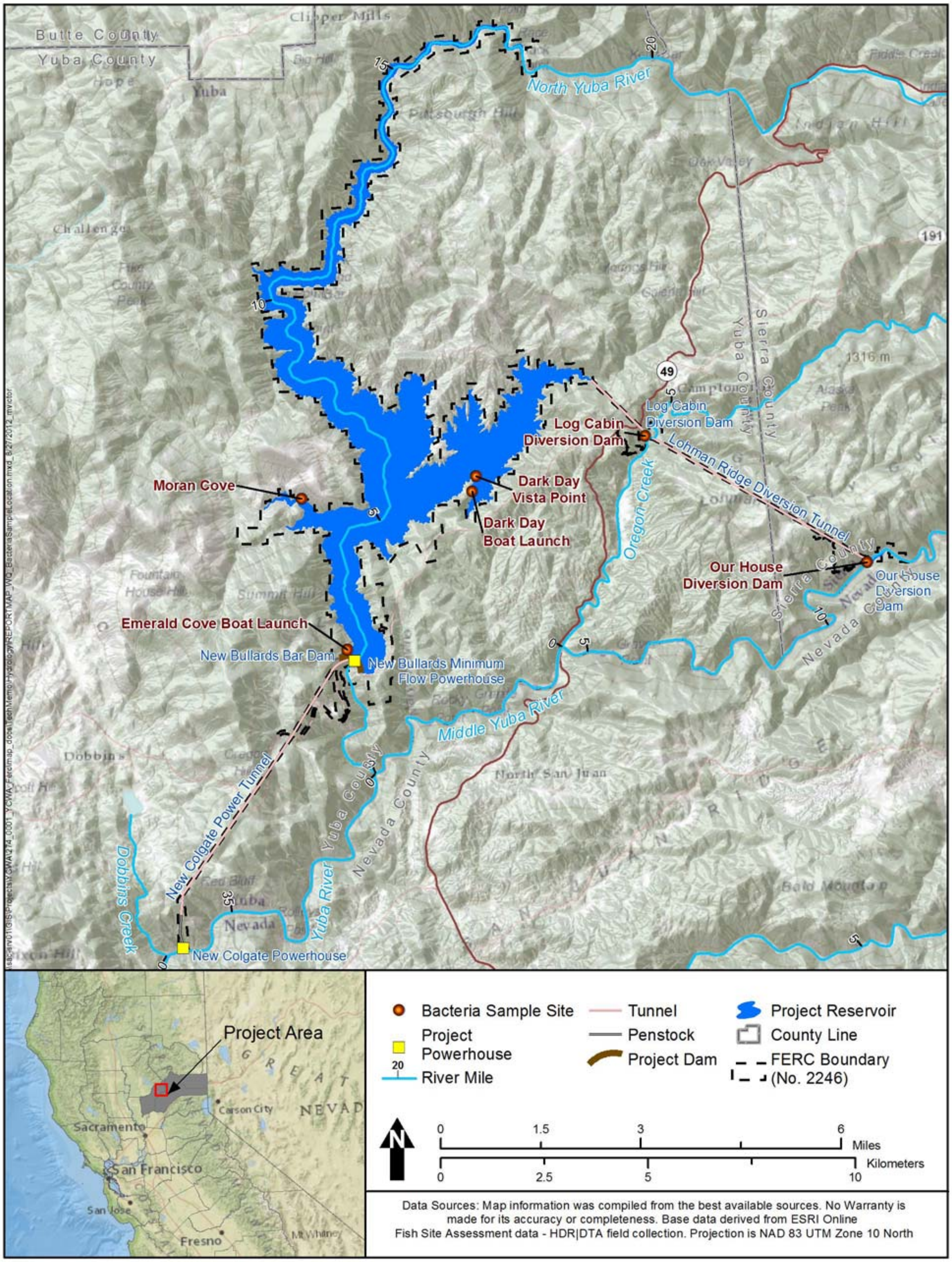
FERC Project No. 2246

February 2013



Data Sources: Map information was compiled from the best available sources. No Warranty is made for its accuracy or completeness. Base data derived from ESRI Online Fish Site Assessment data - HDR|DTA field collection. Projection is NAD 83 UTM Zone 10 North

Figure 1. Water Quality Element Sample Locations



Data Sources: Map information was compiled from the best available sources. No Warranty is made for its accuracy or completeness. Base data derived from ESRI Online Fish Site Assessment data - HDR|DTA field collection. Projection is NAD 83 UTM Zone 10 North

Figure 2. Recreation Element Sample Locations

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Water Quality

Attachment 2-3B

Quality Assurance

Yuba River Development Project

FERC Project No. 2246

February 2013

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Technical Memorandum 2-3

Water Quality

Attachment 2-3B
Part 1

Quality Assurance Project Plan

Yuba River Development Project
FERC Project No. 2246

February 2013

Quality Assurance Project Plan
Yuba County Water Agency
Yuba River Development Project

Version 1.0

FERC Project No. 2246

Prepared for
Yuba County Water Agency
1220 F Street
Marysville, CA 95901

Prepared by
HDR Engineering, Hydropower Services
2379 Gateway Oaks, Suite 200
Sacramento, CA 95833

November 2012

GROUP A ELEMENTS: PROJECT MANAGEMENT

1.0 TITLE SHEET

This Quality Assurance Program Plan (QAPP) is to be used by HDR, Inc. when implementing Study 2.3 Water Quality, the Federal Energy Regulatory Commission (FERC) approved water quality study developed to support the relicensing of Yuba County Water Agency's (YCWA's) Yuba River Development Project (Project), FERC Project No. 2246.

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APPENDIX B	Data Review and Verification Checklist

LIST OF ACRONYMS

ASTM	American Society for Testing and Materials
CVRWQCB	Central Valley Regional Water Quality Control Board
DO	dissolved oxygen
DQO	data quality objective
EPA	United States Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
GPS	Global Positioning System
ID	identification number
mg/L	milligrams per liter
NTU	nephelometric turbidity unit
PARCC	precision, accuracy, representativeness, completeness, and comparability
QA	quality assurance
QA/QC	quality assurance/quality control
QAPP	Quality Assurance Project Plan
QC	quality control
RPD	relative percent difference
TRL	Target Reporting Limit
USACE	United States Army Corps of Engineers
YCWA	Yuba County Water Agency

3.0 DISTRIBUTION LIST

This document will be distributed to the key personnel listed in Table 3.0-1 and will be provided as an attachment to relevant reports and upon request.

Table 3.0-1. Personnel Responsibilities.

Name	Affiliation	Title	Contact Information
James Lynch	HDR	Project Manager	2379 Gateway Oaks, Suite 200 Sacramento, CA 95833 916-564-4214
Carin Loy	HDR	Study Lead	2379 Gateway Oaks, Suite 200 Sacramento, CA 95833 916-564-4214
Fred Holzmer	HDR	QA Officer	2379 Gateway Oaks, Suite 200 Sacramento, CA 95833 916-564-4214
Chuck Vertucci	HDR	Field Coordinator	2379 Gateway Oaks, Suite 200 Sacramento, CA 95833 916-564-4214
Don Burley	CalScience	Laboratory Project Manager	7440 Lincoln Way Garden Grove, CA 92841-1427 (714) 895-5494
Kate Haney	Frontier Global Sciences Inc	Laboratory Project Manager	11720 North Creek Parkway N. Suite 400 Bothell, WA 98011 425-686-1996, ext. 1526
Antonia Powers	Cranmer Engineering, Inc.	Laboratory Director	1188 East Main Street Grass Valley, CA 95945 530-273-7284

4.0 PROJECT/TASK ORGANIZATION

4.1 Involved Parties and Roles

This QAPP has been prepared for the water quality investigation component(s) of the Project's FERC-approved relicensing studies. Within this QAPP are descriptions of methods, procedures, and practices that will be used to assure and control the quality of chemical data.

Key personnel who will be involved in the project are listed above in Table 3.0-1. Under contract to YCWA, HDR will be responsible for all aspects of the water quality study(ies) including the organization of field staff, scheduling of sampling days, field quality assurance/quality control (QA/QC), coordination with the off-site laboratory, and reporting. Laboratory analytical services will be provided by a California certified laboratory.

The Study Lead is responsible for monitoring and verifying implementation of the QA/QC procedures found in this QAPP. Key personnel assigned to the project will have reviewed the QAPP and will be instructed by the Study Lead regarding the requirements of the QA/QC program. The Study Lead will work directly with the Field Coordinator or other designee and

Laboratory Project Managers to ensure that QAPP objectives are being met. All members of the team will continually assess the effectiveness of the QA/QC program and recommend modifications, as needed.

4.2 Quality Assurance Officer Role

The QA Officer is familiar with the study, but not involved in day-to-day implementation. The QA officer is versed in HDR policies, water quality field sampling, and laboratory procedures. The QA officer will review the study's intermediate and final products, and work with the Study Lead to ensure they are of high quality when complete.

4.3 Persons Responsible for QAPP Update and Maintenance

The Study Lead is responsible for keeping the QAPP up-to-date. Modifications may be instigated by any member of the study team—the Study Lead, the Field Coordinator, the QA Officer, the laboratory project manager, or others. Exceptions to the content of this document will be formalized in the Revision Log following the title page. New versions of the QAPP will be available to project personnel and attached to subsequent reports. Variances and non-conformances with the QAPP will be documented in applicable project reports.

4.4 Organizational Chart and Responsibilities

The organizational chart for implementation of the water quality investigation component of the Project relicensing is presented in Figure 1.

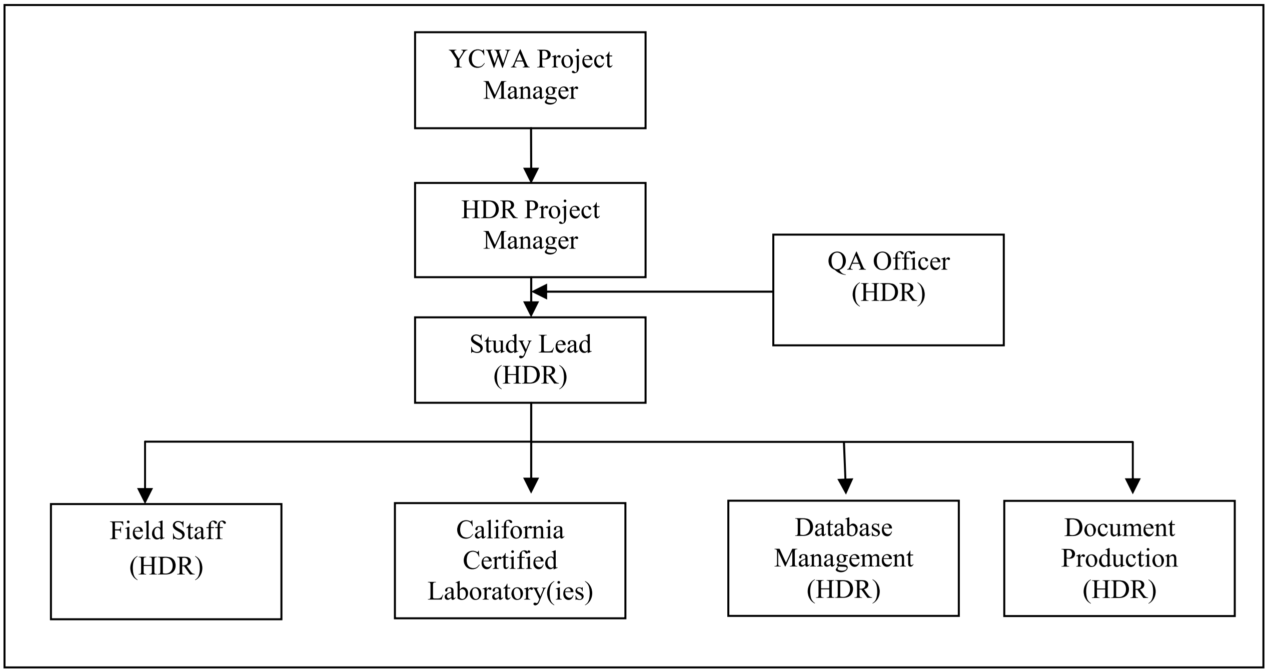

Figure 4.4-1. Organizational Chart

5.0 PROBLEM DEFINITION/BACKGROUND

5.1 Problem Statement

This QAPP has been developed to provide guidance and quality assurance for water quality sampling and analyses conducted to implement the FERC-approved water quality study plan(s) developed to support the Project's FERC relicensing.

5.2 Decisions or Outcomes

The collected data will provide one or more "snap-shots" of the physical and/or chemical state of surface water in the study area, defined in the study plan. The data will be filed with FERC in the Initial Study Report and in other relicensing documents, as needed, and will be suitable to compare to applicable regulatory standards and criteria. The data may be integrated with other information or data and used for trend analyses or for modeling. Additional information regarding study objectives, methods and reporting can be found in the FERC-approved study plan(s).

5.3 Water Quality Regulatory Criteria

Water quality objectives for Project reservoirs and Project affected stream reaches are established in Central Valley Regional Water Quality Control Board's (CVRWQCB) Water Quality Control Plan (Basin Plan) for the Sacramento and San Joaquin Rivers, the fourth edition of which was initially adopted in 1998 and most recently revised in 2011 (CVRWQCB 1998). The standards are composed of designated existing and potential beneficial uses and water quality objectives to protect the beneficial uses. Additional information and detail can be found in the FERC-approved study plan(s).

6.0 PROJECT/TASK DESCRIPTION

6.1 General Work Statement

Each FERC-approved study plan details the scope of the water quality investigation. Chemical constituents and characteristics of surface water will be measured both in the field and through collection of water quality samples for off-site analyses by a California certified laboratory. Examples of in situ water field measurements that may be performed include pH, specific conductivity, instantaneous water temperature, dissolved oxygen (DO), DO percent saturation, turbidity, and Secchi disk. Examples of analyses that may be performed on samples sent to an off-site California certified laboratory are trace metals, hardness, bacteria, sediment, nutrients, minerals, chlorophyll, pesticides, total petroleum hydrocarbons or other organics.

Refer to the "Group B Element: Data Generation and Acquisition" section of this QAPP for quality assurance practices associated with sample collection, instrument calibration, and so forth.

6.2 Project Schedule

The study schedule is specified in the FERC-approved study plan.

6.3 Geographical Setting

Located in California's Sierra Nevada, the study area includes 1) the Middle Yuba River from and including Our House Diversion Dam Impoundment to the confluence with the North Yuba River, 2) Oregon Creek from and including the Log Cabin Diversion Dam Impoundment to the confluence with the Middle Yuba River, 3) the North Yuba River from and including New Bullards Bar Dam Reservoir to the confluence with the Middle Yuba River, and 4) the portion of the Yuba River from the confluence of the North and Middle Yuba rivers to the Feather River, including USACE's Englebright Reservoir.

6.4 Constraints

Water quality sample collection will occur at elevations ranging from 44 to 2239 feet above sea level and may occur over a wide range of weather conditions (rain, snow, sun, wind, high heat, and cold weather). Stream flows may be high or low. Reservoir sampling may require the use of a boat and occur at different stages of Reservoir surface elevation. Remote sites may require access via 4-wheel drive vehicles or long hikes carrying heavy bottles and equipment. Permission must be received from landowners prior to any work on private lands. Due to the distances covered, only five to nine locations may be visited in a single day and still meet the laboratory's hours of operation or shipping deadlines.

Many of the watersheds where HDR works on FERC relicensing projects have extremely low naturally occurring levels of trace metals and waters are free or nearly free of contaminants. Hence, samples are highly susceptible to contamination during sampling and handling activities by both the field personnel and the analytical laboratory and the lowest possible method detection limits and reporting limits are required.

7.0 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Data quality objectives (DQOs) are a set of performance or acceptance criteria that the collected data should achieve in order to minimize the possibility of either making a decision error or failing to keep uncertainty in estimates to within acceptable levels. DQOs are defined in terms of five parameters: precision, accuracy, representativeness, completeness, and comparability (PARCC) and differ with different measurement techniques.

DQOs for FERC relicensing water quality studies are presented in Table 7.0-1.

Table 7.0-1. Data Quality Objectives, by Measurement Type and Sampling Event

Precision	Accuracy	Representativeness	Completeness	Comparability
FIELD MEASUREMENTS (e.g. pH, specific conductivity, temperature, dissolved oxygen)				
--	Instrument calibration meets manufacturers' requirements	Sample locations, sampling frequency and analytical methods follow study plan.	90%	Meets Target Reporting Limits provided in the study plan.
ANALYTICAL LABORATORY ANALYSES (e.g. metals, nutrients)				
Field duplicates within10%; Laboratory QA/QC meets method requirements.	Laboratory QA/QC meets method requirements.	Sample locations, sampling frequency and analytical methods follow study plan.	90%	Meets Target Reporting Limits provided in the study plan.
BACTERIA ANALYSES (e.g. fecal coliform, total coliform, e. coli)				
Field duplicates within 10%; Laboratory QA/QC meets method requirements.	Laboratory QA/QC meets method requirements.	Sample locations, sampling frequency and analytical methods follow study plan.	100%	Meets Target Reporting Limits provided in the study plan.

-- not applicable

Precision is a measure of the reproducibility of analyses under a given set of conditions. In other words, precision describes how well repeated measurements agree. Precision is typically evaluated by comparing analytical results from duplicate samples and calculating the relative percent difference (RPD), where RPD is defined as:

$$RPD = \left(\frac{|C_1 - C_2|}{\left(\frac{C_1 + C_2}{2} \right)} \right) \times 100$$, where C_1 and C_2 are the analyte's concentrations in each duplicate

Precision will be determined through the use of field duplicates, laboratory matrix spike/matrix spike duplicates and laboratory duplicate quality control samples.

Accuracy is a measure of the bias that exists in a measurement system. In other words, accuracy describes how close an analytical measurement is to its "true" value. For analytical samples, accuracy is typically measured by analyzing a sample of known concentration (prepared using analytical-grade standards) and comparing the analytical result with the known concentration. For bacteria samples, accuracy is evaluated by comparing results to a laboratory reference sample.

Representativeness is the degree that sampling data accurately and precisely depict selected characteristics. The representativeness of the data is mainly dependent on the sample design, such as locations (spatial), sampling frequency (temporal), and sample collection procedures, as well as analytical constituents and methods. The FERC-approved study plan presents the study design.

Completeness, which is expressed as a percentage, is calculated by subtracting the number of rejected and unreported results from the total planned results and dividing by the total number of planned results. Estimated results do not count against completeness because they are considered usable as long as any limitations are identified. Results rejected because of out-of-control analytical conditions, severe matrix effects, broken or spilled samples, or samples that could not be analyzed for any other reason are subtracted from the total planned number of results to calculate completeness. Though regulations currently do not require a specific percentage of data completeness, it is expected that the measurement techniques selected for use in this project are capable of generating data that is of 90% of more completeness for field and laboratory analyses.

Comparability is the degree of confidence with which one data set can be compared to another. A broad spectrum of analytical constituents has been selected to characterize water quality and the use of approved/documented analytical methods will ensure that analytical results adequately represent the true concentrations of constituents within these samples. In addition, Target Reporting Limits (TRLs) have been selected for each analyte, where appropriate, to ensure that the analytical methods used are of adequate sensitivity to generate useful data for the purposes of this project. Presented in the FERC-approved study plan, selection of appropriate TRLs was based on a review the CVWRCB’s numeric and narrative water quality objectives and other regulatory standards, criteria and benchmarks, as well as the capabilities of commercial laboratories.

8.0 SPECIAL TRAINING NEEDS/CERTIFICATION

Proper training of field and laboratory personnel represents a critical aspect of quality control.

All field personnel that participate in water quality monitoring will have reviewed this QAPP. Field personnel will have also been trained in water quality sample collection (including QA/QC, grab sampling techniques, flow measurement techniques, completing laboratory chain-of-custody forms, ordering correct laboratory analyses, and proper handling of water samples), field analysis (including instrument calibration, data recording procedures, and interpretation of collected data), and Global Positioning System (GPS) use. All samplers will be provided hands-on training in the “clean hands-dirty hands” technique by the QA Officer or his designee when trace metals are constituents of interest (See Section 11). The QA Officer or his designee will provide training to field personnel. Documentation of training will be maintained in the project file.

All laboratories utilized to perform analytical services will be certified by the State of California, The certification includes requirements that laboratory personnel will be certified and trained. Certification and training is documented in the laboratory's quality assurance manual and verified during the State visit[1].

9.0 DOCUMENTS AND RECORDS

9.1 Project Documents, Records, and Electronic Files

The documents and records that will be used or generated during this project include the following:

Study Plan. The FERC-approved study plan contains information regarding sampling locations, frequencies, sample collection methods, analytical methods, target reporting limits, and water quality objectives.

Quality Assurance Project Plan. The QAPP (this document) contains details on the quality assurance and quality control procedures that will be implemented throughout the water quality study(ies).

Field records. The Study Lead or designee will maintain all field records, including field data sheets documenting results of field analyses and QC samples, equipment maintenance and calibration documentation, and sample collection and handling documentation (copies of chain-of-custody forms, shipping receipts, etc.).

Laboratory records. The analytical laboratory will generate records for sample receipt and storage, instrument calibration, analytical QC, and reporting. Lab reports summarizing analytical results and QC results will be provided to HDR both in hard-copy and electronic formats. The information contained within and the format of the data report package will include at a minimum the sample identification number (ID), sampling date/time, test method, extraction date/time, analysis date/time, analytical result, QA sample results, instrument and equipment calibration information, and a description of any corrective action taken to resolve data quality issues.

Data verification records. Field data sheets, field QC results, chain-of-custody forms, and lab reports from each sampling event will be reviewed by the Study Lead and documented for the project file.

Project database. Microsoft Excel spreadsheets will be used to store all water quality data gathered during this project.

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[1] http://www.cdph.ca.gov/certlic/labs/Pages/ELAP-CAInformation.aspx

9.2 Retention of Project Documentation

Throughout the relicensing, the original field notebooks and forms, equipment maintenance and calibration documentation, chain-of-custody forms, laboratory reports, and data verification records will be stored at the HDR office at 2379 Gateway Oaks Drive, Suite 200, Sacramento, CA 95833. Records will be transferred to YCWA upon license receipt or earlier, at YCWA's discretion.

9.3 Electronic File Back-up

All electronic files will be stored on HDR network servers and will be backed-up on a regular basis by the HDR information technology staff

9.4 Distribution of QAPP Revisions

Revisions that occur after the original QAPP is approved will be indicated by "Version No." on the QAPP title page and documented in the Revision Log, and will be distributed in subsequent deliverables and upon request.

GROUP B ELEMENTS: DATA GENERATION AND ACQUISITION

10.0 SAMPLING PROCESS DESIGN

The FERC-approved study plan presents the study design, including sample locations, frequency of sample collection, analytical parameters, and laboratory methods.

11.0 SAMPLING METHODS

Data will be obtained in the field and in the laboratory.

The field sampler will maintain a field notebook and will note relevant conditions during each sampling event on the field data sheet. At a minimum, the following information pertaining to each sample will be recorded: date, time, weather conditions, name(s) of people collecting samples, units of measurements, depth, GPS coordinates for sample site, and river flow or reservoir water level.

Gloves and other appropriate personal protective equipment will be worn during sample and data collection activities. Observations of any field conditions that could affect sample results will be recorded in the field notebook, such as the concentrated presence of domestic animals or wildlife. Digital photo documentation of sampling conditions may also be performed. All field notes will be clearly written in a format that can be reproduced (i.e. scanned (pdf)) and entered into electronic format (Word or Excel).

11.1 Field Data Collection

The field measurement equipment that may be used during this project includes the following:

- Handheld multi-parameter meter (Hydrolab^{TM} DataSonde 5) or equivalent. A sonde will be used to measure water temperature (±0.1°C), dissolved oxygen (±0.2 mg/L), pH (±0.2 standard unit, or su), specific conductance (±0.001 µmhos/cm), turbidity (±1 NTU) and depth.

Prior to each use, the instrument will be calibrated using manufacturer’s recommended calibration methods (See Section 16). Any variances will be noted on the field data sheet and final report. If necessary to obtain a complete dataset, re-sampling within the FERC-approved study window will be performed. Non-disposable sampling equipment will be thoroughly cleaned between sampling sites.

Any field collected data that are not already in electronic format (Excel) will be hand entered into an electronic format and checked by a second-party.

11.2 Analytical Sample Collection

Surface samples will be collected using a grab sampling technique. Hypolimnetic samples will be collected using a Kemmerer bottle or equivalent. Each laboratory sample will be collected using laboratory-supplied clean containers, certified to meet the reporting limits specified in the study plan. Water samples to be analyzed for metals will be collected using "clean hands-dirty hands" method[2] consistent with the EPA Method 1669 sampling protocol as described in *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels* (EPA 1996; Appendix A).

Samples requiring filtration before metals analysis will be filtered in accordance with standard protocols. Whether filtering is done in the field or the laboratory, samples will be filtered with a 0.45 micrometer (µm) diameter pore-membrane filter, prior to preservation. Filters used in the field will be disposable and certified clean at the desired reporting limits, as specified in the study plan.

As part of the field quality assurance program, field blanks and equipment rinsates will also be collected and submitted to the laboratory for analysis (See Section 14). While still in the field, full sample containers will be labeled, placed in re-sealable plastic bags (e.g. Ziploc®), and stored in a cooler on ice to maintain a temperature of approximately 4º C.

12.0 SAMPLE HANDLING AND CUSTODY

A chain-of-custody record will be maintained with the laboratory samples at all times.

A chain-of-custody form that identifies the sample bottles, date and time of sample collection, and analyses requested will be initiated at the time of sample collection and prior to sample shipment or release. Identification information for each sample will be consistent with the information entered in the field notebook. The samples will be transported or shipped to the analytical lab in insulated containers within the appropriate holding time and will be accompanied by the chain-of-custody form. If shipment is needed, the samples will be packaged and shipped in accordance with U.S. Department of Transportation standards. The original chain-of-custody will be given to the lab with the samples and HDR will retain a copy for their records.

Once received by the laboratory, a sample receipt and storage record will be generated. The laboratory will perform all analyses within the constituent- or method-specific holding times.

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[2] One member of a two-person sampling team is designated as "dirty hands"; the second member is designated as "clean hands." All operations involving contact with the sample bottle and transfer of the sample from the sample collection device to the sample bottle are handled by the individual designated as "clean hands." "Dirty hands" is all other activities that do not involve direct contact with the sample.

After analyses, all samples will be disposed of in accordance with federal, state, and local requirements.

13.0 ANALYTICAL METHODS

The FERC-approved study plan presents the laboratory methods that will be employed. Containers, preservatives, holding times, and QA/QC requirements are specified in the analytical methods and/or in the laboratory's own standard operating procedures. Analytical methods are preferentially U.S. Environmental Protection Agency (EPA) or American Society for Testing and Materials (ASTM) methods and are detailed in the laboratory's own quality assurance manual.

For each analyte, the laboratory must be able to achieve target reporting limits and method detection limits that will allow consistency with the Basin Plan's Water Quality Objectives to be assessed. Because many of the watersheds where HDR works are free or nearly free of contaminants, low method detection limits and reporting limits are often required. Though not preferred, it may be necessary for the commercial laboratory to report estimated or "J-flagged" data to meet target reporting limits for some analytes.

14.0 QUALITY CONTROL

14.1 In Situ Data Collection

Projects that require pH and DO sampling also require a method of back-up or corrective action for inconsistent or questionable measurements collected in the field. For example, if pH is measured at less than 6 or greater than 8.5 in the field, a second measurement must be taken to verify the value. The second measurement could consist of ensuring that pH is included in the analyses of grab samples submitted to the California-certified laboratory, recalibrating the probe and re-measuring in the field, or returning to the site with a calibrated probe within the study window specified within the FERC-approved study plan. This information must be recorded in the field notes as well with explanations for the activity.

Projects that require DO sampling also require methods for back-up or corrective action measurements. For example, if a DO reading of less than 7 mg/L, for waters designated as COLD in the Basin Plan, is measured; then the instrument should be recalibrated and the sample collected again. If the reading is still questionable, then a sample must be analyzed on-site using the Indigo Carmine Colorimetric method (ASTM D888-87) to verify the DO content of the water. Accurate field notes must be kept for any additional or back-up monitoring required in the field.

14.2 Sample Collection

QA/QC activities for sampling processes include the collection of field duplicates for bacterial and chemical testing, and the preparation of field blanks and/or equipment blanks as necessary. The number of duplicates should be one per every ten stations sampled or one per field visit.

Blanks will be prepared by pouring water known to be free of the substance of interest into a sample collection container then subsampling into the appropriate number of replicate sample containers. Ultrapure certified metals-free water will be used for hardness and metals.

14.3 Analytical Laboratory

All laboratories providing analytical support for this project will have the appropriate facilities to store, prepare, and process samples and appropriate instrumentation and staff to provide data of the required quality within the time period dictated by the project. The California certified laboratory will have a quality assurance plan in place and will adhere to standard protocols for accuracy, precision, instrument bias, and analytical bias.

The laboratory's deliverable (i.e. data package) will include information documenting their ability to conduct the analyses with the required level of data quality. Such information may include results from inter-laboratory calibration studies, control charts, and summary data from internal QA/QC checks, and results from analyses of certified reference materials. Additionally, the laboratory will report any inconsistencies or problems associated with any sample run(s) to HDR, who will document the situation as a variance or non-conformance, as appropriate (e.g., contaminated reagents, equipment malfunction, lost or broken sample bottles upon receipt, etc.).

15.0 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

15.1 Field Equipment

The field measurement equipment that may be used during this project includes the following:

- Handheld multi-parameter meter (Hydrolab DataSonde 5). This sonde will be used to measure dissolved oxygen, temperature, pH, and conductivity in the field.

Prior to each field visit, the sonde will be rented from and calibrated by the manufacturer. Upon receipt of the Hydrolab and prior to leaving for the field, the Field Lead or his designee will confirm the probe is working. Written documentation of calibration will be maintained in the project file, attached to relevant reports, and provided upon request.

In the event that the sonde shows signs of malfunction or drift in readings during fieldwork, basic diagnostics will be performed. At a minimum, the following will be checked: batteries, computer connection, and software. The probes will be examined for obstructions, such as algae, or physical damage. The Hydrolab user manual will be taken into the field that includes some basic trouble shooting procedures. If basic trouble shooting is not successful, the sampling team will order a replacement rental unit and return to sample the site in a few days and within the sample period specified in the FERC-approved Study Plan.

15.2 Laboratory Equipment

All laboratories utilized to perform analytical services will be certified by the State of California. The certification includes requirements that the laboratory maintain their analytical equipment in accordance with manufactures instructions and analytical method requirements. Instrument testing, inspection and maintenance procedures are documented in the laboratory's quality assurance manual and verified during the State's visit.[3] Records will be kept at the laboratory and available upon request.

16.0 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Field instruments will be calibrated according to manufacturer's instructions immediately before use in the field. Sondes will be rented from and calibrated by the manufacturer immediately before use in the field. Documentation of calibration prior to each field visit will be maintained in the project file.

17.0 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Project supplies and consumables that may directly or indirectly affect the quality of results include filters, samplers, gloves, bottles and more. To avoid contaminating samples through supplies, supply selection will be made the meet the needs of the study plan. Supplies will be examined for damage as they are received and consumables will be replaced no later than the date recommended in the manufacturer's instructions.

The California-certified laboratory will provide all bottles used for sample collection and cleanliness certification will be provided. Specifically, all equipment used for trace metals sample collection will be certified clean and double-bagged, allowing for the measurement at the concentrations required for the study plan using the clean hands-dirty hands technique described in EPA Method 1669 (Appendix A).

A small inventory of critical spare parts for field equipment (DO membranes, o-rings, and temperature and conductivity probes) will be kept by HDR and brought in the field if needed;

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[3] http://www.cdph.ca.gov/certlic/labs/Pages/ELAP-CAInformation.aspx

however, perishable supplies or expensive parts may not be kept on hand, and will need to be ordered when needed. All spare parts and supplies will be obtained through the equipment manufacturer or other reputable sources.

18.0 NON-DIRECT MEASUREMENTS (EXISTING DATA)

Water quality data has been previously collected in the study area. Though it is unknown at this time what existing data may be incorporated into relicensing documents, if any, the level of review of all incorporated existing data will be disclosed.

19.0 DATA MANAGEMENT

Field and laboratory data will be entered and maintained in Excel spreadsheets. The contract laboratory will provide an electronic data deliverable and an electronic narrative that includes, at a minimum, Level II documentation.

Throughout the relicensing, the original field notebooks and forms, equipment maintenance and calibration documentation, chain-of-custody forms, laboratory reports, and data verification records will be stored at the HDR office at 2379 Gateway Oaks Drive, Suite 200, Sacramento, CA 95833. Records will be transferred to YCWA upon YCWA's direction.

GROUP C ELEMENTS: ASSESSMENT AND OVERSIGHT

20.0 ASSESSMENTS AND RESPONSE ACTIONS

Periodic assessments will be conducted to ensure that data collection is conducted according to requirements presented in this QAPP. The Study Lead will have the primary responsibility for assessing compliance with the QAPP requirements pertaining to sample collection and handling procedures, field analytical procedures, laboratory analytical procedures, and communicating project status to the QA Officer and Project Manager. The QA Officer or his designee will conduct reviews of field sampling and analysis procedures at the beginning of each field season. The reviews may be performed at a demonstration site or involve accompanying sampling personnel to determine whether sampling activities are being conducted in accordance with the QAPP and Study Plan. Laboratory analyses will be assessed through evaluating results of QC samples and compliance with DQOs.

If a non-conformance is identified, the QA Officer and/or Study Lead will notify the Project Manager immediately. The Project Manager, QA Officer, and Study Lead will discuss the observed discrepancy with the appropriate person responsible for the activity to determine whether the information collected can still be considered accurate, what the cause(s) were leading to the deviation, how the deviation might impact data quality, and what corrective actions might be considered. The QA Officer and Study Lead will then follow up to ensure that corrective actions have been implemented.

21.0 REPORTS TO MANAGEMENT

The study schedule is specified in the FERC-approved study plan. As described in the study plan, the primary deliverable will be a technical memorandum, transmitting the data collected.

GROUP D ELEMENTS: DATA VALIDATION AND USABILITY

22.0 DATA REVIEW, VERIFICATION, AND VALIDATION REQUIREMENTS

Data review, verification and validation are steps in the transition between data collection via sampling and analysis and data use and interpretation. Although data review, verification and data validation are commonly used terms, they are defined and applied differently in various organizations and quality systems. For the purposes of relicensing, the terms will be generally defined as follows:

- Data review ensures the data have been recorded, transmitted, and processed correctly. That includes, ensuring the data are sensible and checking for data entry, transcription, calculation, reduction, and transcription errors.
- Data verification is the process for evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual specifications (EPA 2002).
- Data validation is an analyte and sample specific process that extends the evaluation of data beyond method, procedure, or contractual compliance to determine the quality of a specific data set relative to the end use (EPA 2002). Data validation begins with the output from data verification.

23.0 VERIFICATION AND VALIDATION METHODS

Documentation of review, verification, and/or validation will be maintained in the project file.

For the relicensing, all data will be reviewed and verified. In brief, following the field sampling and laboratory analyses, which includes the laboratories' own QA/QC analyses, HDR will subject all data to QA/QC procedures including, but not limited to: spot-checks of transcription; review of electronic data submissions for completeness; comparison of results to field blank and rinsate results; and, identification of any data that seem inconsistent. If any inconsistencies are found, HDR will consult with the laboratory to identify any potential sources of error before concluding that the data is correct.

All verified chemical detections, including data whose results are "J" qualified, will be used for this assessment. Should the laboratory need to re-extract samples and re-run the sample under different calibration conditions, the data identified by the laboratory, as the most certain, will be used. If field-sampling conditions, as measured by the field blank and the rinsate sample results, indicate that samples have been corrupted, HDR will identify the data accordingly.

24.0 RECONCILIATION WITH USER REQUIREMENTS

To fulfill YCWA's data needs, it is important that the data collected during this project are accurate, precise, representative, and complete, and can therefore be used to characterize water quality within the YCWA Project area. These data requirements will be assessed by ensuring that DQOs are met throughout the project.

After each discrete sampling event, the Study Lead will evaluate if the data quality objectives (DQOs) of Table 7.0-1 have been met. Results of the evaluation will be documented on the Data Review and Verification Form provided in Appendix B. If the impact of the QC failure on data quality is minimal, the data will be flagged and included in the database. If a greater impact is found, the Study Lead will work with the QA Officer to determine the next steps. Data that does not meet the DQOs listed in Section 7 will be evaluated to 1) determine the cause of the problem; 2) determine whether corrective actions can be implemented so that DQOs are met in the future; and/or 3) determine if re-sampling is necessary to meet completeness or other PARCC objectives.

At the end of the monitoring program, the data generated under this project will be given to the YCWA.

25.0 REFERENCES

Central Valley Regional Water Quality Control Board (CVRWQCB). 1998. Water Quality Control Plan (Basin Plan) for the Sacramento River and the San Joaquin River Basins. Fourth Edition. California Regional Water Quality Control Board, Central Valley Region. Revised in September 2011 with Approved Amendments. Available online: <http://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/>

_______. 2003. A Compilation of Water Quality Goals. California Environmental Protection Agency. Regional Water Quality Control Board, Central Valley Region. August 2003.

_______. 2005. Draft Monitoring and Reporting Program Order No. R5-2005-XXXX for Water Districts enrolled as Individual Dischargers under Resolution No. R5-2003-0105, Conditional Waiver of Waste Discharge Requirements for Discharges from Irrigated Lands. California Regional Water Quality Control Board, Central Valley Region.

United States Environmental Protection Agency (EPA). 1996. Method 1669: Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels. EPA, Office of Water. July 1996.

_______. 1999. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA 540/R-99/008. United States Environmental Protection Agency Office of Emergency and Remedial Response. October 1999

_______. 2000. U.S. Environmental Protection Agency, 2000. ECOTOX database. http://www.epa.gov/ecotox/

_______. 2002. United States Environmental Protection Agency. 2002. Guidance on Environmental Data Verification and Data Validation (EPA QA/G-8), November 2002.

_______. 2004. U.S. Environmental Protection Agency Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA 540-R-04-004. Office of Superfund Remediation and Technology Innovation (OSRTI), United States Environmental Protection Agency. October 2004.

Standard Methods. 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition, 1998. American Public Health Association, American Water Works Association, and Water Environment Federation.

State Water Resources Control Board. 2004. Electronic template for SWAMP-Compatible Quality Assurance Project Plans, March 2004. Version 1.0, State Water Resources Control Board.

QUALITY ASSURANCE PROJECT PLAN

APPENDIX A

SAMPLING AMBIENT WATERS FOR TRACE METALS AT EPA WATER QUALITY LEVELS

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Method 1669

Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels

July 1996

U.S. Environmental Protection Agency
Office of Water
Engineering and Analysis Division (4303)
401 M Street S.W.
Washington, D.C. 20460

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This version of the method was prepared after observations of sampling teams from the University of California at Santa Cruz, the Wisconsin Department of Natural Resources, the U.S. Geological Survey, and Battelle Ocean Sciences. The assistance of personnel demonstrating the sampling techniques used by these institutions is gratefully acknowledged.

Disclaimer

This sampling method has been reviewed and approved for publication by the Analytical Methods Staff within the Engineering and Analysis Division of the U.S. Environmental Protection Agency. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Further Information

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Introduction

This sampling method was designed to support water quality monitoring programs authorized under the Clean Water Act. Section 304(a) of the Clean Water Act requires EPA to publish water quality criteria that reflect the latest scientific knowledge concerning the physical fate (e.g., concentration and dispersal) of pollutants, the effects of pollutants on ecological and human health, and the effect of pollutants on biological community diversity, productivity, and stability.

Section 303 of the Clean Water Act requires states to set a water quality standard for each body of water within its boundaries. A state water quality standard consists of a designated use or uses of a waterbody or a segment of a waterbody, the water quality criteria that are necessary to protect the designated use or uses, and an antidegradation policy. These water quality standards serve two purposes: (1) they establish the water quality goals for a specific waterbody, and (2) they are the basis for establishing water quality-based treatment controls and strategies beyond the technology-based controls required by Sections 301(b) and 306 of the Clean Water Act.

In defining water quality standards, the state may use narrative criteria, numeric criteria, or both. However, the 1987 amendments to the Clean Water Act required states to adopt numeric criteria for toxic pollutants (designated in Section 307(a) of the Act) based on EPA Section 304(a) criteria or other scientific data, when the discharge or presence of those toxic pollutants could reasonably be expected to interfere with designated uses.

In some cases, these water quality criteria are as much as 280 times lower than those achievable using existing EPA methods and required to support technology-based permits. Therefore, this sampling method, and the analytical methods referenced in Table 1 of this document, were developed by EPA to specifically address state needs for measuring toxic metals at water quality criteria levels, when such measurements are necessary to protect designated uses in state water quality standards. The latest criteria published by EPA are those listed in the National Toxics Rule (57 *FR* 60848) and the Stay of Federal Water Quality Criteria for Metals (60 *FR* 22228). These rules include water quality criteria for 13 metals, and it is these criteria on which this sampling method and the referenced analytical methods are based.

In developing these methods, EPA found that one of the greatest difficulties in measuring pollutants at these levels was precluding sample contamination during collection, transport, and analysis. The degree of difficulty, however, is highly dependent on the metal and site-specific conditions. This method, therefore, is designed to provide the level of protection necessary to preclude contamination in nearly all situations. It is also designed to provide the procedures necessary to produce reliable results at the lowest possible water quality criteria published by EPA. In recognition of the variety of situations to which this method may be applied, and in recognition of continuing technological advances, the method is performance-based. Alternative procedures may be used, so long as those procedures are demonstrated to yield reliable results.

Requests for additional copies of this method should be directed to:

U.S. EPA NCEPI
11029 Kenwood Road
Cincinnati, OH 45242
513/489–8190

Note: This document is intended as guidance only. Use of the terms "must," "may," and "should" are included to mean that EPA believes that these procedures must, may, or should be followed in order to produce the desired results when using this guidance. In addition, the guidance is intended to be performance-based, in that the use of less stringent procedures may be used so long as neither samples nor blanks are contaminated when following those modified procedures. Because the only way to measure the performance of the modified procedures is through the collection and analysis of uncontaminated blank samples in accordance with this guidance and the referenced methods, it is highly recommended that any modifications be thoroughly evaluated and demonstrated to be effective before field samples are collected.

Method 1669

Sampling Ambient Water for Determination of Metals at EPA Water Quality Criteria Levels

1.0 Scope and Application

1.1 This method is for the collection and filtration of ambient water samples for subsequent determination of total and dissolved metals at the levels listed in Table 1. It is designed to support the implementation of water quality monitoring and permitting programs administered under the Clean Water Act.

1.2 This method is applicable to the metals listed below and other metals, metals species, and elements amenable to determination at trace levels.

Analyte	Symbol	Chemical Abstract Services Registry Number (CASRN)
Antimony	(Sb)	7440-36-0
Arsenic	(As)	7440-38-2
Cadmium	(Cd)	7440-43-9
Chromium (III)	Cr^{+3}	16065-83-1
Chromium (VI)	Cr^{+6}	18540-29-9
Copper	(Cu)	7440-50-8
Lead	(Pb)	7439-92-1
Mercury	(Hg)	7439-97-6
Nickel	(Ni)	7440-02-0
Selenium	(Se)	7782-49-2
Silver	(Ag)	7440-22-4
Thallium	(Tl)	7440-28-0
Zinc	(Zn)	7440-66-6

1.3 This method is accompanied by the 1600 series methods listed in Table 1. These methods include the sample handling, analysis, and quality control procedures necessary for reliable determination of trace metals in aqueous samples.

1.4 This method is not intended for determination of metals at concentrations normally found in treated and untreated discharges from industrial facilities. Existing regulations (40 *CFR* Parts 400-500) typically limit concentrations in industrial discharges to the mid to high part-per-billion (ppb) range, whereas ambient metals concentrations are normally in the low part-per-trillion (ppt) to low ppb range. This guidance is therefore directed at the collection of samples to be measured at or near the levels listed in Table 1. Actual concentration ranges to which this guidance is applicable will be dependent on the sample matrix, dilution levels, and other laboratory operating conditions.

1.5 The ease of contaminating ambient water samples with the metal(s) of interest and interfering substances cannot be overemphasized. This method includes sampling techniques that should maximize the ability of the sampling team to collect samples reliably and eliminate sample contamination. These techniques are given in Section 8.0 and are based on findings of researchers performing trace metals analyses (References 1-9).

1.6 Clean and Ultraclean—The terms "clean" and "ultraclean" have been used in other Agency guidance to describe the techniques needed to reduce or eliminate contamination in trace metals determinations. These terms are not used in this sampling method due to a lack of exact definitions. However, the information provided in this method is consistent with summary guidance on clean and ultraclean techniques (Reference 10).

1.7 This sampling method follows the EPA Environmental Methods Management Council's "Format for Method Documentation" (Reference 11).

1.8 Method 1669 is "performance-based"; i.e., an alternate sampling procedure or technique may be used, so long as neither samples nor blanks are contaminated when following the alternate procedures. Because the only way to measure the performance of the alternate procedures is through the collection and analysis of uncontaminated blank samples in accordance with this guidance and the methods referenced in Table 1, it is highly recommended that any modifications be thoroughly evaluated and demonstrated to be effective before field samples are collected. Section 9.2 provides additional details on the tests and documentation required to support equivalent performance.

1.9 For dissolved metal determinations, samples must be filtered through a 0.45 µm capsule filter at the field site. The filtering procedures are described in this method. The filtered samples may be preserved in the field or transported to the laboratory for preservation. Procedures for field preservation are detailed in this sampling method; procedures for laboratory preservation are provided in the methods referenced in Table 1. Preservation requirements are summarized in Table 2.

1.10 The procedures in this method are for use only by personnel thoroughly trained in the collection of samples for determination of metals at ambient water quality control levels.

2.0 Summary of Method

2.1 Before samples are collected, all sampling equipment and sample containers are cleaned in a laboratory or cleaning facility using detergent, mineral acids, and reagent water as described in the methods referenced in Table 1. The laboratory or cleaning facility is responsible for generating an acceptable equipment blank to demonstrate that the sampling equipment and containers are free from trace metals contamination before they are shipped to the field sampling team. An acceptable blank is one that is free from contamination below the minimum level (ML) specified in the referenced analytical method (Section 9.3).

2.2 After cleaning, sample containers are filled with weak acid solution, individually double-bagged, and shipped to the sampling site. All sampling equipment is also bagged for storage or shipment.

NOTE: *EPA has found that, in some cases, it may be possible to empty the weak acid solution from the bottle immediately prior to transport to the field site. In this case, the bottle should be refilled with reagent water (Section 7.1).*

2.3 The laboratory or cleaning facility must prepare a large carboy or other appropriate clean container filled with reagent water (Section 7.1) for use with collection of field blanks during sampling activities. The reagent-water-filled container should be shipped to the field site and handled as all other sample containers and sampling equipment. At least one field blank should be processed per site, or one per every ten samples, whichever is more frequent (Section 9.4). If samples are to be collected for determination of trivalent chromium, the sampling team processes additional QC aliquots are processed as described in Section 9.6.

2.4 Upon arrival at the sampling site, one member of the two-person sampling team is designated as "dirty hands"; the second member is designated as "clean hands." All operations involving contact with the sample bottle and transfer of the sample from the sample collection device to the sample bottle are handled by the individual designated as "clean hands." "Dirty hands" is responsible for preparation of the sampler (except the sample container itself), operation of any machinery, and for all other activities that do not involve direct contact with the sample.

2.5 All sampling equipment and sample containers used for metals determinations at or near the levels listed in Table 1 must be nonmetallic and free from any material that may contain metals.

2.6 Sampling personnel are required to wear clean, nontalc gloves at all times when handling sampling equipment and sample containers.

2.7 In addition to processing field blanks at each site, a field duplicate must be collected at each sampling site, or one field duplicate per every 10 samples, whichever is more frequent (Section 9.5). Section 9.0 gives a complete description of quality control requirements.

2.8 Sampling

2.8.1 Whenever possible, samples are collected facing upstream and upwind to minimize introduction of contamination.

2.8.2 Samples may be collected while working from a boat or while on land.

2.8.3 Surface samples are collected using a grab sampling technique. The principle of the grab technique is to fill a sample bottle by rapid immersion in water and capping to minimize exposure to airborne particulate matter.

2.8.4 Subsurface samples are collected by suction of the sample into an immersed sample bottle or by pumping the sample to the surface.

2.9 Samples for dissolved metals are filtered through a 0.45 µm capsule filter at the field site. After filtering, the samples are double-bagged and iced immediately. Sample containers are shipped to the analytical laboratory. The sampling equipment is shipped to the laboratory or cleaning facility for recleaning.

2.10 Acid preservation of samples is performed in the field or in the laboratory. Field preservation is necessary for determinations of trivalent chromium. It has also been shown that field preservation can increase sample holding times for hexavalent chromium to 30 days; therefore it is recommended that preservation of samples for hexavalent chromium be performed in the field. For other metals, however, the sampling team may prefer to utilize laboratory preservation of samples to expedite field operations and to minimize the potential for sample contamination.

2.11 Sampling activities must be documented through paper or computerized sample tracking systems.

3.0 Definitions

3.1 Apparatus—Throughout this method, the sample containers, sampling devices, instrumentation, and all other materials and devices used in sample collection, sample processing, and sample analysis activities will be referred to collectively as the Apparatus.

3.2 Definitions of other terms are given in the Glossary (Section 15.0) at the end of this method.

4.0 Contamination and Interferences

4.1 Contamination Problems in Trace Metals Analysis

4.1.1 Preventing ambient water samples from becoming contaminated during the sampling and analytical process is the greatest challenge faced in trace metals determinations. In recent years, it has been shown that much of the historical trace metals data collected in ambient water are erroneously high because the concentrations reflect contamination from sampling and analysis rather than ambient levels (Reference 12). Therefore, it is imperative that extreme care be taken to avoid contamination when collecting and analyzing ambient water samples for trace metals.

4.1.2 There are numerous routes by which samples may become contaminated. Potential sources of trace metals contamination during sampling include metallic or metal-containing sampling equipment, containers, labware (e.g. talc gloves that contain high levels of zinc), reagents, and deionized water; improperly cleaned and stored equipment, labware, and reagents; and atmospheric inputs such as dirt and dust from automobile exhaust, cigarette smoke, nearby roads, bridges, wires, and poles. Even human contact can be a source of trace metals contamination. For example, it has been demonstrated that dental work (e.g., mercury amalgam fillings) in the mouths of laboratory personnel can contaminate samples that are directly exposed to exhalation (Reference 3).

4.2 Contamination Control

4.2.1 Philosophy—The philosophy behind contamination control is to ensure that any object or substance that contacts the sample is nonmetallic and free from any material that may contain metals of concern.

4.2.1.1 The integrity of the results produced cannot be compromised by contamination of samples. Requirements and suggestions for controlling sample contamination are given in this sampling method and in the analytical methods referenced in Table 1.

4.2.1.2 Substances in a sample or in the surrounding environment cannot be allowed to contaminate the Apparatus used to collect samples for trace metals measurements. Requirements and suggestions for protecting the

Apparatus are given in this sampling method and in the methods referenced in Table 1.

4.2.1.3 While contamination control is essential, personnel health and safety remain the highest priority. Requirements and suggestions for personnel safety are given in Section 5 of this sampling method and in the methods referenced in Table 1.

4.2.2 Avoiding contamination—The best way to control contamination is to completely avoid exposure of the sample and Apparatus to contamination in the first place. Avoiding exposure means performing operations in an area known to be free from contamination. Two of the most important factors in avoiding/reducing sample contamination are (1) an awareness of potential sources of contamination and (2) strict attention to work being performed. Therefore, it is imperative that the procedures described in this method be carried out by well trained, experienced personnel. Documentation of training should be kept on file and readily available for review.

4.2.2.1 Minimize exposure—The Apparatus that will contact samples or blanks should only be opened or exposed in a clean room, clean bench, glove box, or clean plastic bag, so that exposure to atmospheric inputs is minimized. When not being used, the Apparatus should be covered with clean plastic wrap, stored in the clean bench or in a plastic box or glove box, or bagged in clean, colorless zip-type bags. Minimizing the time between cleaning and use will also reduce contamination.

4.2.2.2 Wear gloves—Sampling personnel must wear clean, nontalc gloves (Section 6.7) during all operations involving handling of the Apparatus, samples, and blanks. Only clean gloves may touch the Apparatus. If another object or substance is touched, the glove(s) must be changed before again handling the Apparatus. If it is even suspected that gloves have become contaminated, work must be halted, the contaminated gloves removed, and a new pair of clean gloves put on. Wearing multiple layers of clean gloves will allow the old pair to be quickly stripped with minimal disruption to the work activity.

4.2.2.3 Use metal-free Apparatus—All Apparatus used for metals determinations at the levels listed in Table 1 must be nonmetallic and free of material that may contain metals. When it is not possible to obtain equipment that is completely free of the metal(s) of interest, the sample should not come into direct contact with the equipment.

4.2.2.3.1 Construction materials—Only the following materials should come in contact with samples: fluoropolymer (FEP, PTFE), conventional or linear polyethylene, polycarbonate, polysulfone, polypropylene, or ultrapure quartz. PTFE is less desirable than FEP because the sintered material in PTFE may contain contaminants and is susceptible to serious memory effects (Reference 6). Fluoropolymer or glass containers should be used for samples that will be analyzed for mercury because mercury vapors can diffuse in or out of other materials, resulting either in contamination or low-biased results (Reference 3). Metal must not be used under any circumstance. Regardless of construction, all materials that will directly or indirectly contact the sample must be cleaned using the procedures described in the referenced analytical methods (see Table 1) and must be known to be clean and metal-free before proceeding.

4.2.2.3.2 The following materials have been found to contain trace metals and must not be used to hold liquids that come in contact with the sample or must not contact the sample, unless these materials have been shown to be free of the metals of interest at the desired level: Pyrex, Kimax, methacrylate, polyvinylchloride, nylon, and Vycor (Reference 6). In addition, highly colored plastics, paper cap liners, pigments used to mark increments on plastics, and rubber all contain trace levels of metals and must be avoided (Reference 13).

4.2.2.3.3 Serialization—Serial numbers should be indelibly marked or etched on each piece of Apparatus so that contamination can be traced, and logbooks should be maintained to track the sample from the container through the sampling process to shipment to the laboratory. Chain-of-custody procedures may also be used if warranted so that contamination can be traced to particular handling procedures or lab personnel.

4.2.2.3.4 The Apparatus should be clean when the sampling team receives it. If there are any indications that the Apparatus is not clean (e.g., a ripped storage bag), an assessment of the likelihood of contamination must be made. Sampling must not proceed if it is possible that the Apparatus is contaminated. If the Apparatus is contaminated, it must be returned to the laboratory or cleaning facility for proper cleaning before any sampling activity resumes.

4.2.2.3.5 Details for recleaning the Apparatus between collection of individual samples are provided in Section 10.0.

4.2.2.4 Avoid sources of contamination—Avoid contamination by being aware of potential sources and routes of contamination.

4.2.2.4.1 Contamination by carryover—Contamination may occur when a sample containing low concentrations of metals is processed immediately after a sample containing relatively high concentrations of these metals. At sites where more than one sample will be collected, the sample known or expected to contain the lowest concentration of metals should be collected first with the sample containing the highest levels collected last (Section 8.1.4). This will help minimize carryover of metals from high- concentration samples to low- concentration samples. If the sampling team does not have prior knowledge of the waterbody, or when necessary, the sample collection system should be rinsed with dilute acid and reagent water between samples and followed by collection of a field blank (Section 10.3).

4.2.2.4.2 Contamination by samples—Significant contamination of the Apparatus may result when untreated effluents, in-process waters, landfill leachates, and other samples containing mid- to high-level concentrations of inorganic substances are processed. As stated in Section 1.0, this sampling method is not intended for application to these samples, and samples containing high concentrations of metals must not be collected, processed, or shipped at the same time as samples being collected for trace metals determinations.

4.2.2.4.3 Contamination by indirect contact—Apparatus that may not directly contact samples may still be a source of contamination. For example, clean tubing placed in a dirty plastic bag may pick up contamination from the bag and subsequently transfer the contamination to the sample. Therefore, it is imperative that every piece of the Apparatus that is directly or indirectly used in the collection of ambient water samples be cleaned as specified in the analytical method(s) referenced in Table 1.

4.2.2.4.4 Contamination by airborne particulate matter—Less obvious substances capable of contaminating samples include airborne particles. Samples may be contaminated by airborne dust, dirt, particulate matter, or vapors from automobile exhaust; cigarette smoke; nearby corroded or rusted bridges, pipes, poles, or wires; nearby roads; and even human breath (Section 4.1.2). Whenever possible, the sampling activity should occur as far as possible from sources of airborne contamination (Section 8.1.3). Areas where nearby soil is bare and subject to wind erosion should be avoided.

4.3 Interferences—Interferences resulting from samples will vary considerably from source to source, depending on the diversity of the site being sampled. If a sample is suspected of containing substances that may interfere in the determination of trace metals, sufficient sample should be collected to allow the laboratory to identify and overcome interference problems.

5.0 Safety

5.1 The toxicity or carcinogenicity of the chemicals used in this method has not been precisely determined; however, these chemicals should be treated as a potential health hazard. Exposure should be reduced to the lowest possible level. Sampling teams are responsible for maintaining a current awareness file of OSHA regulations for the safe handling of the chemicals specified in this method. A reference file of Material Safety Data Sheets should also be made available to all personnel involved in sampling. It is also suggested that the organization responsible perform personal hygiene monitoring of each sampling team member who uses this method and that the results of this monitoring be made available to the member.

5.2 Operating in and around waterbodies carries the inherent risk of drowning. Life jackets must be worn when operating from a boat, when sampling in more than a few feet of water, or when sampling in swift currents.

5.3 Collecting samples in cold weather, especially around cold water bodies, carries the risk of hypothermia, and collecting samples in extremely hot and humid weather carries the risk of dehydration and heat stroke. Sampling team members should wear adequate clothing for protection in cold weather and should carry an adequate supply of water or other liquids for protection against dehydration in hot weather.

6.0 Apparatus and Materials

NOTE: *Brand names, suppliers, and part numbers are for illustration only and no endorsement is implied. Equivalent performance may be achieved using apparatus and materials other than those specified here. Meeting the performance requirements of this method is the responsibility of the sampling team and laboratory.*

6.1 All sampling equipment and sample containers must be precleaned in a laboratory or cleaning facility, as described in the methods referenced in Table 1, before they are shipped to the field site. Performance criteria for equipment cleaning is described in the referenced methods. To minimize difficulties in sampling, the equipment should be packaged and arranged to minimize field preparation.

6.2 Materials such as gloves (Section 6.7), storage bags (Section 6.8), and plastic wrap (Section 6.9), may be used new without additional cleaning unless the results of the equipment blank pinpoint any of these materials as a source of contamination. In this case, either a different supplier must be obtained or the materials must be cleaned.

6.3 Sample Bottles—Fluoropolymer (FEP, PTFE), conventional or linear polyethylene, polycarbonate, or polypropylene; 500 mL or 1 L with lids. If mercury is a target analyte, fluoropolymer or glass bottles should be used. Refer to the methods referenced in Table 1 for bottle cleaning procedures.

6.3.1 Cleaned sample bottles should be filled with 0.1% HCl (v/v). In some cases, it may be possible to empty the weak acid solution from the sample bottle immediately prior to transport to the field site. In this case, the bottle should be refilled with reagent water (Section 7.1).

6.3.2 Whenever possible, sampling devices should be cleaned and prepared for field use in a class 100 clean room. Preparation of the devices in the field should be done within the glove bag (Section 6.6). Regardless of design, sampling devices must be constructed of nonmetallic material (Section 4.2.2.3.1) and free from material that contains metals. Fluoropolymer or other material shown not to adsorb or contribute mercury must be used if mercury is a target analyte; otherwise, polyethylene, polycarbonate, or polypropylene are acceptable. Commercially available sampling devices may be used provided that any metallic or metal-containing parts are replaced with parts constructed of nonmetallic material.

6.4 Surface Sampling Devices—Surface samples are collected using a grab sampling technique. Samples may be collected manually by direct submersion of the bottle into the water or by using a grab sampling device. Examples of grab samplers are shown in Figures 1 and 2 and may be used at sites where depth profiling is neither practical nor necessary.

6.4.1 The grab sampler in Figure 1 consists of a heavy fluoropolymer collar fastened to the end of a 2-m-long polyethylene pole, which serves to remove the sampling personnel from the immediate vicinity of the sampling point. The collar holds the sample bottle. A fluoropolymer closing mechanism, threaded onto the bottle, enables the sampler to open and close the bottle under water, thereby avoiding surface microlayer contamination (Reference 14). Polyethylene, polycarbonate, and polypropylene are also acceptable construction materials unless mercury is a target analyte. Assembly of the cleaned sampling device is as follows (refer to Figure 1):

6.4.1.1 Thread the pull cord (with the closing mechanism attached) through the guides and secure the pull ring with a simple knot. Screw a sample bottle onto the closing device and insert the bottle into the collar. Cock the closing plate so that the plate is pushed away from the operator.

6.4.1.2 The cleaned and assembled sampling device should be stored in a double layer of large, clean zip-type polyethylene bags or wrapped in two layers of clean polyethylene wrap if it will not be used immediately.

6.4.2 An alternate grab sampler design is shown in Figure 2. This grab sampler is used for discrete water samples and is constructed so that a capped clean bottle can be submerged, the cap removed, sample collected, and bottle recapped at a selected depth. This device eliminates sample contact with conventional samplers (e.g., Niskin bottles), thereby reducing the risk of extraneous contamination. Because a fresh bottle is used for each sample, carryover from previous samples is eliminated (Reference 15).

6.5 Subsurface Sampling Devices—Subsurface sample collection may be appropriate in lakes and sluggish deep river environments or where depth profiling is determined to be necessary. Subsurface samples are collected by pumping the sample into a sample bottle. Examples of subsurface collection systems include the jar system device shown in Figure 3 and described in Section 6.5.1 or the continuous-flow apparatus shown in Figure 4 and described in Section 6.5.2.

6.5.1 Jar sampler (Reference 14)—The jar sampler (Figure 3) is comprised of a heavy fluoropolymer 1-L jar with a fluoropolymer lid equipped with two 1/4 in. fluoropolymer fittings. Sample enters the jar through a short length of fluoropolymer tubing inserted into one fitting. Sample is pulled into the jar by pumping on fluoropolymer tubing attached to the other fitting. A thick fluoropolymer plate supports the jar and provides attachment points for a fluoropolymer safety line and fluoropolymer torpedo counterweight.

6.5.1.1 Advantages of the jar sampler for depth sampling are (1) all wetted surfaces are fluoropolymer and can be rigorously cleaned; (2) the sample is collected into a sample jar from which the sample is readily recovered, and the jar can be easily recleaned; (3) the suction device (a peristaltic or rotary vacuum pump, Section 6.15) is located in the boat, isolated from the sampling jar; (4) the sampling jar can be continuously flushed with sample, at sampling depth, to equilibrate the system; and (5) the sample does not travel through long lengths of tubing that are more difficult to clean and keep clean (Reference 14). In addition, the device is designed to eliminate atmospheric contact with the sample during collection.

6.5.1.2 To assemble the cleaned jar sampler, screw the torpedo weight onto the machined bolt attached to the support plate of the jar sampler. Attach a section of the 1/4 in. o.d. tubing to the jar by inserting the tubing into the fitting on the lid and pushing down into the jar until approximately 8 cm from the bottom. Tighten the fitting nut securely. Attach the solid safety line to the jar sampler using a bowline knot to the loop affixed to the support plate.

6.5.1.3 For the tubing connecting the pump to the sampler, tubing lengths of up to 12 m have been used successfully (Reference 14).

6.5.2 Continuous-flow sampler (References 16-17)—This sampling system, shown in Figure 4, consists of a peristaltic or submersible pump and one or more lengths of precleaned fluoropolymer or styrene/ethylene/butylene/ silicone (SEBS) tubing. A filter is added to the sampling train when sampling for dissolved metals.

6.5.2.1 Advantages of this sampling system include (1) all wetted surfaces are fluoropolymer or SEBS and can be readily cleaned; (2) the suction device is located in the boat, isolated from the sample bottle; (3) the sample does not travel through long lengths of tubing that are difficult to clean and keep clean; and (4) in-line filtration is possible, minimizing field handling requirements for dissolved metals samples.

6.5.2.2 The sampling team assembles the system in the field as described in Section 8.2.8. System components include an optional polyethylene pole to remove sampling personnel from the immediate vicinity of the sampling point and the pump, tubing, filter, and filter holder listed in Sections 6.14 and 6.15.

6.6 Field-Portable Glove Bag—I2R, Model R-37-37H (nontalc), or equivalent. Alternately, a portable glove box may be constructed with a nonmetallic (PVC pipe or other suitable material) frame and a frame cover made of an inexpensive, disposable, nonmetallic material (e.g., a thin-walled polyethylene bag) (Reference 7).

6.7 Gloves—Clean, nontalc polyethylene, latex, vinyl, or PVC; various lengths. Shoulder-length gloves are needed if samples are to be collected by direct submersion of the sample bottle into the water or when sampling for mercury.

6.7.1 Gloves, shoulder-length polyethylene—Associated Bag Co., Milwaukee, WI, 66-3-301, or equivalent.

6.7.2 Gloves, PVC—Fisher Scientific Part No. 11-394-100B, or equivalent.

6.8 Storage Bags—Clean, zip-type, nonvented, colorless polyethylene (various sizes).

6.9 Plastic Wrap—Clean, colorless polyethylene.

6.10 Cooler—Clean, nonmetallic, with white interior for shipping samples.

6.11 Ice or Chemical Refrigerant Packs—To keep samples chilled in the cooler during shipment.

6.12 Wind Suit—Pamida, or equivalent.

NOTE: *This equipment is necessary only for collection of metals, such as mercury, that are known to have elevated atmospheric concentrations.*

6.12.1 An unlined, long-sleeved wind suit consisting of pants and jacket and constructed of nylon or other synthetic fiber is worn when sampling for mercury to prevent mercury adsorbed onto cotton or other clothing materials from contaminating samples.

6.12.2 Washing and drying—The wind suit is washed by itself or with other wind suits only in a home or commercial washing machine and dried in a clothes dryer. The clothes dryer must be thoroughly vacuumed, including the lint filter, to remove all traces of lint before drying. After drying, the wind suit is folded and stored in a clean polyethylene bag for shipment to the sample site.

6.13 Boat

6.13.1 For most situations (e.g., most metals under most conditions), the use of an existing, available boat is acceptable. A flat-bottom, Boston Whaler-type boat is preferred because sampling materials can be stored with reduced chance of tipping.

6.13.1.1 Immediately before use, the boat should be washed with water from the sampling site away from any sampling points to remove any dust or dirt accumulation.

6.13.1.2 Samples should be collected upstream of boat movement.

6.13.2 For mercury, and for situations in which the presence of contaminants cannot otherwise be controlled below detectable levels, the following equipment and precautions may be necessary:

6.13.2.1 A metal-free (e.g., fiberglass) boat, along with wooden or fiberglass oars. Gasoline- or diesel-fueled boat motors should be avoided when possible because the exhaust can be a source of contamination. If the body of water is large enough to require use of a boat motor, the engine should be shut off at a distance far enough from the sampling point to avoid contamination, and the sampling team should manually propel the boat to the sampling point. Samples should be collected upstream of boat movement.

6.13.2.2 Before first use, the boat should be cleaned and stored in an area that minimizes exposure to dust and atmospheric particles. For example, cleaned boats should not be stored in an area that would allow exposure to automobile exhaust or industrial pollution.

6.13.2.3 The boat should be frequently visually inspected for possible contamination.

6.13.2.4 After sampling, the boat should be returned to the laboratory or cleaning facility, cleaned as necessary, and stored away from any sources of contamination until next use.

6.14 Filtration Apparatus—Required when collecting samples for dissolved metals determinations.

6.14.1 Filter—0.45 µm, 15 mm diameter or larger, tortuous-path capsule filters (Reference 18), Gelman Supor 12175, or equivalent.

6.14.2 Filter holder—For mounting filter to the gunwale of the boat. Rod or pipe made from plastic material and mounted with plastic clamps.

NOTE: *A filter holder may not be required if one or a few samples are to be collected. For these cases, it may only be necessary to attach the filter to the outlet of the tubing connected to the pump.*

6.15 Pump and Pump Apparatus—Required for use with the jar sampling system (Section 6.5.1) or the continuous-flow system (Section 6.5.2). Peristaltic pump; 115 V a.c., 12 V d.c., internal battery, variable-speed, single-head, Cole-Parmer, portable, "Masterflex L/S," Catalog No. H-07570-10 drive with Quick Load pump head, Catalog No. H-07021-24, or equivalent.

NOTE: *Equivalent pumps may include rotary vacuum, submersible, or other pumps free from metals and suitable to meet the site-specific depth sampling needs.*

6.15.1 Cleaning—Peristaltic pump modules do not require cleaning. However, nearly all peristaltic pumps contain a metal head and metal controls. Touching the head or controls necessitates changing of gloves before touching the Apparatus. If a submersible pump is used, a large volume of sample should be pumped to clean the stainless steel shaft (hidden behind the impeller) that comes in contact with the sample. Pumps with metal impellers should not be used.

6.15.2 Tubing—For use with peristaltic pump. SEBS resin, approximately 3/8 in. i.d. by approximately 3 ft, Cole-Parmer size 18, Cat. No. G-06464-18, or approximately 1/4 in. i.d., Cole-Parmer size 17, Catalog No. G-06464-17, or equivalent. Tubing is cleaned by soaking in 5-10% HCl solution for 8-24 hours, rinsing with reagent water in a clean bench in a clean room, and drying in the clean bench by purging with mercury-free air or nitrogen. After drying, the tubing is double-bagged in clear polyethylene bags, serialized with a unique number, and stored until use.

6.15.3 Tubing—For connection to peristaltic pump tubing. Fluoropolymer, 3/8 or 1/4 in. o.d., in lengths as required to reach the point of sampling. If sampling will be at some depth from the end of a boom extended from a boat, sufficient tubing to extend to the end of the boom and to the depth will be required. Cleaning of the fluoropolymer can be the same as cleaning the tubing for the rotary vacuum pump (Section 6.15.1.2). If necessary, more aggressive cleaning (e.g., concentrated nitric acid) may be used.

6.15.4 Batteries to operate submersible pump—12 V, 2.6 amp, gel cell, YUASA NP2.6-12, or equivalent. A 2 amp fuse connected at the positive battery terminal is strongly recommended to prevent short circuits from overheating the battery. A 12 V, lead-acid automobile or marine battery may be more suitable for extensive pumping.

6.15.5 Tubing connectors—Appropriately sized PVC, clear polyethylene, or fluoropolymer "barbed" straight connectors cleaned as the tubing above. Used to connect multiple lengths of tubing.

6.16 Carboy—For collection and storage of dilute waste acids used to store bottles.

6.17 Apparatus—For field preservation of aliquots for trivalent chromium determinations.

6.17.1 Fluoropolymer forceps—1 L fluoropolymer jar, and 30 mL fluoropolymer vials with screw-caps (one vial per sample and blank). It is recommended that 1 mL of ultrapure nitric acid (Section 7.3) be added to each vial prior to transport to the field to simplify field handling activities (See Section 8.4.4.6).

6.17.2 Filters—0.4 µm, 47 mm polycarbonate Nuclepore (or equivalent). Filters are cleaned as follows. Fill a 1 L fluoropolymer jar approximately two-thirds full with 1 N nitric acid. Using fluoropolymer forceps, place individual filters in the fluoropolymer jar. Allow the filters to soak for 48 hours. Discard the acid, and rinse five times with reagent water. Fill the jar with reagent water, and soak the filters for 24 hours. Remove the filters when ready for use, and using fluoropolymer forceps, place them on the filter apparatus (Section 6.17.3).

6.17.3 Vacuum filtration apparatus—Millipore 47 mm size, or equivalent, vacuum pump and power source (and extension cords, if necessary) to operate the pump.

6.17.4 Eppendorf auto pipet and colorless pipet tips (100-1000 µL)

6.17.5 Wrist-action shaker—Burrel or equivalent.

6.17.6 Fluoropolymer wash bottles—One filled with reagent water (Section 7.1) and one filled with high- purity 10% HCl (Section 7.4.4), for use in rinsing forceps and pipet tips.

7.0 Reagents and Standards

7.1 Reagent Water—Water in which the analytes of interest and potentially interfering substances are not detected at the Method Detection Limit (MDL) of the analytical method used for analysis of samples. Prepared by distillation, deionization, reverse osmosis, anodic/cathodic stripping voltammetry, or other techniques that remove the metal(s) and potential interferent(s). A large carboy or other appropriate container filled with reagent water must be available for the collection of field blanks.

7.2 Nitric Acid—Dilute, trace-metal grade, shipped with sampling kit for cleaning equipment between samples.

7.3 Sodium Hydroxide—Concentrated, 50% solution for use when field-preserving samples for hexavalent chromium determinations (Section 8.4.5).

7.4 Reagents—For field-processing aliquots for trivalent chromium determinations

7.4.1 Nitric Acid, Ultrapure—For use when field-preserving samples for trivalent chromium determinations (Sections 6.17 and 8.4.4).

7.4.2 Ammonium Iron (II) Sulfate Solution (0.01M)—Used to prepare the chromium (III) extraction solution (Section 7.4.3) necessary for field preservation of samples for trivalent chromium (Section 8.4.4). Prepare the ammonium iron (II) sulfate solution by adding 3.92 g ammonium iron (II) sulfate (ultrapure grade) to a 1 L volumetric flask. Bring to volume with reagent water. Store in a clean polyethylene bottle.

7.4.3 Chromium (III) extraction solution—For use when field-preserving samples for trivalent chromium determinations (Section 8.4.4). Prepare this solution by adding 100 mL of ammonium iron (II) sulfate solution (Section 7.4.2) to a 125 mL polyethylene bottle. Adjust pH to 8 with approximately 2 mL of ammonium hydroxide solution. Cap and shake on a wrist-action shaker for 24 hours. This iron (III) hydroxide solution is stable for 30 days.

7.4.4 Hydrochloric acid—High-purity, 10% solution, shipped with sampling kit in fluoropolymer wash bottles for cleaning trivalent chromium sample preservation equipment between samples.

7.4.5 Chromium stock standard solution (1000 µg/mL)—Prepared by adding 3.1 g anhydrous chromium chloride to a 1 L flask and diluting to volume with 1% hydrochloric acid. Store in polyethylene bottle. A commercially available standard solution may be substituted.

7.4.6 Standard chromium spike solution (1000 µg/L)—Used to spike sample aliquots for matrix spike/matrix spike duplicate (MS/MSD) analysis and to prepare ongoing precision and recovery standards. Prepared by spiking 1 mL of the chromium stock standard solution (Section 7.4.5) into a 1 L flask. Dilute to volume with 1% HCl. Store in a polyethylene bottle.

7.4.7 Ongoing precision and recovery (OPR) standard (25 µg/L)—Prepared by spiking 2.5 mL of the standard chromium spike solution (Section 7.4.6) into a 100 mL flask. Dilute to volume with 1% HCl. One OPR is required for every 10 samples.

8.0 Sample Collection, Filtration, and Handling

8.1 Site Selection

8.1.1 Selection of a representative site for surface water sampling is based on many factors including: study objectives, water use, point source discharges, non-point source discharges, tributaries, changes in stream characteristics, types of stream bed, stream depth, turbulence, and the presence of structures (bridges, dams, etc.). When collecting samples to determine ambient levels of trace metals, the presence of potential sources of metal contamination are of extreme importance in site selection.

8.1.2 Ideally, the selected sampling site will exhibit a high degree of cross-sectional homogeneity. It may be possible to use previously collected data to identify locations for samples that are well mixed or are vertically or horizontally stratified. Since mixing is principally governed by turbulence and water velocity, the selection of a site immediately downstream of a riffle area will ensure good vertical mixing. Horizontal mixing occurs in constrictions in the channel. In the absence of turbulent areas, the selection of a site that is clear of immediate point sources, such as industrial effluents, is preferred for the collection of ambient water samples (Reference 19).

8.1.3 To minimize contamination from trace metals in the atmosphere, ambient water samples should be collected from sites that are as far as possible (e.g., at least several hundred feet) from any metal supports, bridges, wires or poles. Similarly, samples should be collected as far as possible from regularly or heavily traveled roads. If it is not possible to avoid collection near roadways, it is advisable to study traffic patterns and plan sampling events during lowest traffic flow (Reference 7).

8.1.4 The sampling activity should be planned to collect samples known or suspected to contain the lowest concentrations of trace metals first, finishing with the samples known or suspected to contain the highest concentrations. For example, if samples are collected from a flowing river or stream near an industrial or municipal discharge, the upstream sample should be collected first, the downstream sample collected second, and the sample nearest the discharge collected last. If the concentrations of pollutants is not known and cannot be estimated, it is necessary to use precleaned sampling equipment at each sampling location.

8.2 Sample Collection Procedure—Before collecting ambient water samples, consideration should be given to the type of sample to be collected, the amount of sample needed, and the devices to be used (grab, surface, or subsurface samplers). Sufficient sample volume should be collected to allow for necessary quality control analyses, such as matrix spike/matrix spike duplicate analyses.

8.2.1 Four sampling procedures are described:

8.2.1.1 Section 8.2.5 describes a procedure for collecting samples directly into the sample container. This procedure is the simplest and provides the least potential for contamination because it requires the least amount of equipment and handling.

8.2.1.2 Section 8.2.6 describes a procedure for using a grab sampling device to collect samples.

8.2.1.3 Section 8.2.7 describes a procedure for depth sampling with a jar sampler. The size of sample container used is dependent on the amount of sample needed by the analytical laboratory.

8.2.1.4 Section 8.2.8 describes a procedure for continuous-flow sampling using a submersible or peristaltic pump.

8.2.2 The sampling team should ideally approach the site from down current and downwind to prevent contamination of the sample by particles sloughing off the boat or equipment. If it is not possible to approach from both, the site should be approached from down current if sampling from a boat or approached from downwind if sampling on foot. When sampling from a boat, the bow of the boat should be oriented into the current (the boat will be pointed upstream). All sampling activity should occur from the bow.

If the samples are being collected from a boat, it is recommended that the sampling team create a stable workstation by arranging the cooler or shipping container as a work table on the upwind side of the boat, covering this worktable and the upwind gunnel with plastic wrap or a plastic tablecloth, and draping the wrap or cloth over the gunnel. If necessary, duct tape is used to hold the wrap or cloth in place.

8.2.3 All operations involving contact with the sample bottle and with transfer of the sample from the sample collection device to the sample bottle (if the sample is not directly collected in the bottle) are handled by the individual designated as "clean hands." "Dirty hands" is responsible for all activities that do not involve direct contact with the sample.

Although the duties of "clean hands" and "dirty hands" would appear to be a logical separation of responsibilities, in fact, the completion of the entire protocol may require a good deal of coordination and practice. For example, "dirty hands" must open the box or cooler containing the sample bottle and unzip the outer bag; clean hands must reach into the outer bag, open the inner bag, remove the bottle, collect the sample, replace the bottle lid, put the bottle back into the inner bag, and zip the inner bag. "Dirty hands" must close the outer bag and place it in a cooler.

To minimize unnecessary confusion, it is recommended that a third team member be available to complete the necessary sample documentation (e.g., to document sampling location, time, sample number, etc). Otherwise, "dirty hands" must perform the sample documentation activity (Reference 7).

8.2.4 Extreme care must be taken during all sampling operations to minimize exposure of the sample to human, atmospheric, and other sources of contamination. Care must be taken to avoid breathing directly on the sample, and whenever possible, the sample bottle should be opened, filled, and closed while submerged.

8.2.5 Manual collection of surface samples directly into the sample bottle.

8.2.5.1 At the site, all sampling personnel must put on clean gloves (Section 6.7) before commencing sample collection activity, with "clean hands" donning shoulder-length gloves. If samples are to be analyzed for mercury, the sampling team must also put their precleaned wind suits on at this time. Note that "clean hands" should put on the shoulder-length polyethylene gloves (Section 6.7.1) and both "clean hands" and "dirty hands" should put on the PVC gloves (Section 6.7.2).

8.2.5.2 "Dirty hands" must open the cooler or storage container, remove the double-bagged sample bottle from storage, and unzip the outer bag.

8.2.5.3 Next, "clean hands" opens the inside bag containing the sample bottle, removes the bottle, and reseals the inside bag. "Dirty hands" then reseals the outer bag.

8.2.5.4 "Clean hands" unscrews the cap and, while holding the cap upside down, discards the dilute acid solution from the bottle into a carboy for wastes (Section 6.16) or discards the reagent water directly into the water body.

8.2.5.5 "Clean hands" then submerges the sample bottle, and allows the bottle to partially fill with sample. "Clean hands" screws the cap on the bottle, shakes the bottle several times, and empties the rinsate away from the site. After two more rinsings, "clean hands" holds the bottle under water and allows bottle to fill with sample. After the bottle has filled (i.e., when no more bubbles appear), and while the bottle is still inverted so that the mouth of the bottle is underwater, "clean hands" replaces the cap of the bottle. In this way, the sample has never contacted the air.

8.2.5.6 Once the bottle lid has been replaced, "dirty hands" reopens the outer plastic bag, and "clean hands" opens the inside bag, places the bottle inside it, and zips the inner bag.

8.2.5.7 "Dirty hands" zips the outer bag.

8.2.5.8 Documentation—After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

8.2.5.9 If the sample is to be analyzed for dissolved metals, it is filtered in accordance with the procedure described in Section 8.3.

8.2.6 Sample collection with grab sampling device—The following steps detail sample collection using the grab sampling device shown in Figure 1 and described in Section 6.4.1. The procedure is indicative of the "clean hands/dirty hands" technique that must be used with alternative grab sampling devices such as that shown in Figure 2 and described in Section 6.4.2.

8.2.6.1 The sampling team puts on gloves (and wind suits, if applicable). Ideally, a sample bottle will have been preattached to the sampling device in the class 100 clean room at the laboratory. If it is necessary to attach a bottle to the device in the field, "clean hands" performs this operation, described in Section 6.4.2, inside the field-portable glove bag (Section 6.6).

8.2.6.2 "Dirty hands" removes the sampling device from its storage container and opens the outer polyethylene bag.

8.2.6.3 "Clean hands" opens the inside polyethylene bag and removes the sampling device.

8.2.6.4 "Clean hands" changes gloves.

8.2.6.5 "Dirty hands" submerges the sampling device to the desired depth and pulls the fluoropolymer pull cord to bring the seal plate into the middle position so that water can enter the bottle.

8.2.6.6 When the bottle is full (i.e., when no more bubbles appear), "dirty hands" pulls the fluoropolymer cord to the final stop position to seal off the sample and removes the sampling device from the water.

8.2.6.7 "Dirty hands" returns the sampling device to its large inner plastic bag, "clean hands" pulls the bottle out of the collar, unscrews the bottle from the sealing device, and caps the bottle. "Clean hands" and "dirty hands" then return the bottle to its double-bagged storage as described in Sections 8.2.5.6 through 8.2.5.7.

8.2.6.8 Closing mechanism—"Clean hands" removes the closing mechanism from the body of the grab sampler, rinses the device with reagent water (Section 7.1), places it inside a new clean plastic bag, zips the bag, and places the bag inside an outer bag held by "dirty hands." "Dirty hands" zips the outer bag and places the double-bagged closing mechanism in the equipment storage box.

8.2.6.9 Sampling device—"Clean hands" seals the large inside bag containing the collar, pole, and cord and places the bag into a large outer bag held by "dirty hands." "Dirty hands" seals the outside bag and places the double-bagged sampling device into the equipment storage box.

8.2.6.10 Documentation—After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

8.2.6.11 If the sample is to be analyzed for dissolved metals, it is filtered in accordance with the procedures described in Section 8.3.

8.2.7 Depth sampling using a jar sampling device (Figure 3 and Section 6.5.1)

8.2.7.1 The sampling team puts on gloves (and wind suits, if applicable) and handles bottles as with manual collection (Sections 8.2.5.1 through 8.2.5.4 and 8.2.5.6 through 8.2.5.7).

8.2.7.2 "Dirty hands" removes the jar sampling device from its storage container and opens the outer polyethylene bag.

8.2.7.3 "Clean hands" opens the inside polyethylene bag and removes the jar sampling apparatus. Ideally, the sampling device will have been preassembled in a class 100 clean room at the laboratory. If, however, it is necessary to assemble the device in the field, "clean hands" must perform this operation, described in Section 6.5.2, inside a field-portable glove bag (Section 6.6).

8.2.7.4 While "dirty hands" is holding the jar sampling apparatus, "clean hands" connects the pump to the to the 1/4 in. o.d. flush line.

8.2.7.5 "Dirty hands" lowers the weighted sampler to the desired depth.

8.2.7.6 "Dirty hands" turns on the pump allowing a large volume (>2 L) of water to pass through the system.

8.2.7.7 After stopping the pump, "dirty hands" pulls up the line, tubing, and device and places them into either a field-portable glove bag or a large, clean plastic bag as they emerge.

8.2.7.8 Both "clean hands" and "dirty hands" change gloves.

8.2.7.9 Using the technique described in Sections 8.2.5.2 through 8.2.5.4, the sampling team removes a sample bottle from storage, and "clean hands" places the bottle into the glove bag.

8.2.7.10 "Clean hands" tips the sampling jar and dispenses the sample through the short length of fluoropolymer tubing into the sample bottle.

8.2.7.11 Once the bottle is filled, "clean hands" replaces the cap of the bottle, returns the bottle to the inside polyethylene bag, and zips the bag. "Clean hands" returns the zipped bag to the outside polyethylene bag held by "dirty hands."

8.2.7.12 "Dirty hands" zips the outside bag. If the sample is to be analyzed for dissolved metals, it is filtered as described in Section 8.3.

8.2.7.13 Documentation—After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

8.2.8 Continuous-flow sampling (Figure 4 and Section 6.5.2)—The continuous-flow sampling system uses peristaltic pump (Section 6.15) to pump sample to the boat or to shore through the SEBS-resin or PTFE tubing.

8.2.8.1 Before putting on wind suits or gloves, the sampling team removes the bags containing the pump (Section 6.15), SEBS-resin tubing (Section 6.15.2), batteries (Section 6.15.4), gloves (Section 6.7), plastic wrap (Section 6.9), wind suits (Section 6.12), and, if samples are to be filtered, the filtration apparatus (Section 6.14) from the coolers or storage containers in which they are packed.

8.2.8.2 "Clean hands" and "dirty hands" put on the wind suits and PVC gloves (Section 6.7.2).

8.2.8.3 "Dirty hands" removes the pump from its storage bag, and opens the bag containing the SEBS-resin tubing.

8.2.8.4 "Clean hands" installs the tubing while "dirty hands" holds the pump. "Clean hands" immerses the inlet end of the tubing in the sample stream.

8.2.8.5 Both "clean hands" and "dirty hands" change gloves. "Clean hands" also puts on shoulder length polyethylene gloves (Section 6.7.1).

8.2.8.6 "Dirty hands" turns the pump on and allows the pump to run for 5-10 minutes or longer to purge the pump and tubing.

8.2.8.7 If the sample is to be filtered, "clean hands" installs the filter at the end of the tubing, and "dirty hands" sets up the filter holder on the gunwale as shown in Figure 4.

NOTE: *The filtration apparatus is not attached until immediately before sampling to prevent buildup of particulates from clogging the filter.*

8.2.8.8 The sample is collected by rinsing the sample bottle and cap three times and collecting the sample from the flowing stream.

8.2.8.9 Documentation—After each sample is collected, the sample number is documented in the sampling log, and any unusual observations concerning the sample and the sampling are documented.

8.3 Sample Filtration—The filtration procedure described below is used for samples collected using the manual (Section 8.2.5), grab (Section 8.2.6), or jar (Section 8.2.7) collection systems (Reference 7). In-line filtration using the continuous-flow approach is described in Section 8.2.8.7. Because of the risk of contamination, it is recommended that samples for mercury be shipped unfiltered by overnight courier and filtered when received at the laboratory.

8.3.1 Set up the filtration system inside the glove bag, using the shortest piece of pump tubing as is practicable. Place the peristaltic pump immediately outside of the glove bag and poke a small hole in the glove bag for passage of the tubing. Also, attach a short length of tubing to the outlet of the capsule filter.

8.3.2 "Clean hands" removes the water sample from the inner storage bag using the technique described in Sections 8.2.5.2 through 8.2.5.4 and places the sample inside the glove bag. "Clean hands" also places two clean empty sample bottles, a bottle containing reagent water, and a bottle for waste in the glove bag.

8.3.3 "Clean hands" removes the lid of the reagent water bottle and places the end of the pump tubing in the bottle.

8.3.4 "Dirty hands" starts the pump and passes approximately 200 mL of reagent water through the tubing and filter into the waste bottle. "Clean hands" then moves the outlet tubing to a clean bottle and collects the remaining reagent water as a blank. "Dirty hands" stops the pump.

8.3.5 "Clean hands" removes the lid of the sample bottle and places the intake end of the tubing in the bottle.

8.3.6 "Dirty hands" starts the pump and passes approximately 50 mL through the tubing and filter into the remaining clean sample bottle and then stops the pump. "Clean hands" uses the filtrate to rinse the bottle, discards the waste sample, and returns the outlet tube to the sample bottle.

8.3.7 "Dirty hands" starts the pump and the remaining sample is processed through the filter and collected in the sample bottle. If preservation is required, the sample is acidified at this point (Section 8.4).

8.3.8 "Clean hands" replaces the lid on the bottle, returns the bottle to the inside bag, and zips the bag. "Clean hands" then places the zipped bag into the outer bag held by "dirty hands."

8.3.9 "Dirty hands" zips the outer bag, and places the double-bagged sample bottle into a clean, ice-filled cooler for immediate shipment to the laboratory.

NOTE: *It is not advisable to reclean and reuse filters. The difficulty and risk associated with failing to properly clean these devices far outweighs the cost of purchasing a new filter.*

8.4 Preservation

8.4.1 Field preservation is not necessary for dissolved metals, except for trivalent and hexavalent chromium, provided that the sample is preserved in the laboratory and allowed to stand for at least two days to allow the metals adsorbed to the container walls to redissolve. Field preservation is advised for hexavalent chromium in order to provide sample stability for up to 30 days. Mercury samples should be shipped by overnight courier and preserved when received at the laboratory.

8.4.2 If field preservation is required, preservation must be performed in the glove bag or in a designated clean area, with gloved hands, as rapidly as possible to preclude particulates from contaminating the sample. For preservation of trivalent chromium, the glove bag or designated clean area must be large enough to accommodate the vacuum filtration apparatus (Section 6.17.3), and an area should be available for setting up the wrist-action shaker (Section 6.17.5). It is also advisable to set up a work area that contains a "clean" cooler for storage of clean equipment, a "dirty" cooler for storage of "dirty" equipment, and a third cooler to store samples for shipment to the laboratory.

8.4.3 Preservation of aliquots for metals other than trivalent and hexavalent chromium—Using a disposable, precleaned, plastic pipet, add 5 mL of a 10% solution of ultrapure nitric acid in reagent water per liter of sample. This will be sufficient to preserve a neutral sample to pH <2.

8.4.4 Preservation of aliquots for trivalent chromium (References 8-9).

8.4.4.1 Decant 100 mL of the sample into a clean polyethylene bottle.

8.4.4.2 Clean an Eppendorf pipet by pipeting 1 mL of 10% HCl (Section (7.4.4) followed by 1 mL of reagent water into an acid waste container. Use the rinsed pipet to add 1 mL of chromium (III) extraction solution (Section 7.4.3) to each sample and blank.

8.4.4.3 Cap each bottle tightly, place in a clean polyethylene bag, and shake on a wrist action shaker (Section 6.17.5) for one hour.

8.4.4.4 Vacuum-filter the precipitate through a 0.4 µm pretreated filter membrane (Section 6.17.2), using fluoropolymer forceps (Section 6.17.1) to handle the membrane, and a 47 mm vacuum filtration apparatus with a precleaned filter holder (Section 6.17.3). After all sample has filtered, rinse the inside of the filter holder with approximately 15 mL of reagent water.

8.4.4.5 Using the fluoropolymer forceps, fold the membrane in half and then in quarters, taking care to avoid touching the side containing the filtrate to any surface. (Folding is done while the membrane is sitting on the filter holder and allows easy placement of the membrane into the sample vial). Transfer the filter to a 30 mL fluoropolymer vial. If the fluoropolymer vial was not pre-equipped with the ultrapure nitric acid (Section 7.4.1), rinse the pipet by drawing and discharging 1 mL of 10% HCl followed by 1 mL of reagent water into a waste container, and add 1 mL of ultrapure nitric acid to the sample vial.

8.4.4.6 Cap the vial and double-bag it for shipment to the laboratory.

8.4.4.7 Repeat Steps 8.4.4.4-8.4.4.6 for each sample, rinsing the fluoropolymer forceps and the pipet with 10% high-purity HCl followed by reagent water between samples.

8.4.5 Preservation of aliquots for hexavalent chromium (Reference 20).

8.4.5.1 Decant 125 mL of sample into a clean polyethylene bottle.

8.4.5.2 Prepare an Eppendorf pipet by pipeting 1 mL of 10% HCl (Section 7.4.4) followed by 1 mL of reagent water into an acid waste container. Use the rinsed pipet to add 1 mL NaOH to each 125 mL sample and blank aliquot.

8.4.5.3 Cap the vial(s) and double-bag for shipment to the laboratory.

9.0 Quality Assurance/Quality Control

9.1 The sampling team shall employ a strict quality assurance/ quality control (QA/QC) program. The minimum requirements of this program include the collection of equipment blanks, field blanks, and field replicates. It is also desirable to include blind QC samples as part of the program. If samples will be processed for trivalent chromium determinations, the sampling team shall also prepare method blank, OPR, and MS/MSD samples as described in Section 9.6.

9.2 The sampling team is permitted to modify the sampling techniques described in this method to improve performance or reduce sampling costs, provided that reliable analyses of samples are obtained and that samples and blanks are not contaminated. Each time a modification is made to the procedures, the sampling team is required to demonstrate that the modification does not result in contamination of field and equipment blanks. The requirements for modification are given in Sections 9.3 and 9.4. Because the acceptability of a modification is based on the results obtained with the modification, the sampling team must work with an analytical laboratory capable of making trace metals determinations to demonstrate equivalence.

9.3 Equipment Blanks

9.3.1 Before using any sampling equipment at a given site, the laboratory or equipment cleaning contractor is required to generate equipment blanks to demonstrate that the equipment is free from contamination. Two types of equipment blanks are required: bottle blanks and sampling equipment blanks.

9.3.2 Equipment blanks must be run on all equipment that will be used in the field. If, for example, samples are to be collected using both a grab sampling device and the jar sampling device, then an equipment blank must be run on both pieces of equipment.

9.3.3 Equipment blanks are generated in the laboratory or at the equipment cleaning contractor's facility by processing reagent water through the equipment using the same procedures that are used in the field (Section 8.0). Therefore, the "clean hands/dirty hands" technique used during field sampling should be followed when preparing equipment blanks at the laboratory or cleaning facility. In addition, training programs must require must require sampling personnel to collect a clean equipment blank before performing on-site field activities.

9.3.4 Detailed procedures for collecting equipment blanks are given in the analytical methods referenced in Table 1.

9.3.5 The equipment blank must be analyzed using the procedures detailed in the referenced analytical method (see Table 1). If any metal(s) of interest or any potentially interfering substance is detected in the equipment blank at the minimum level specified in the referenced method, the source of contamination/interference must be identified and removed. The equipment must be demonstrated to be free from the metal(s) of interest before the equipment may be used in the field.

9.4 Field Blank

9.4.1 To demonstrate that sample contamination has not occurred during field sampling and sample processing, at least one field blank must be generated for every 10 samples that are collected at a given site. Field blanks are collected before sample collection.

9.4.2 Field blanks are generated by filling a large carboy or other appropriate container with reagent water (Section 7.1) in the laboratory, transporting the filled container to the sampling site, processing the water through each of the sample processing steps and equipment (e.g., tubing, sampling devices, filters, etc.) that will be used in the field, collecting the field blank in one of the sample bottles, and shipping the bottle to the laboratory for analysis in accordance with the method(s) referenced in Table 1. For example, manual grab sampler field blanks are collected by directly submerging a sample bottle into the water, filling the bottle, and capping. Subsurface sampler field blanks are collected by immersing the tubing into the water and pumping water into a sample container.

9.4.3 Filter the field blanks using the procedures described in Section 8.3.

9.4.4 If it is necessary to acid clean the sampling equipment between samples (Section 10.0), a field blank should be collected after the cleaning procedures but before the next sample is collected.

9.4.5 If trivalent chromium aliquots are processed, a separate field blank must be collected and processed through the sample preparation steps given in Sections 8.4.4.1 through 8.4.4.6.

9.5 Field Duplicate

9.5.1 To assess the precision of the field sampling and analytical processes, at least one field duplicate sample must be collected for every 10 samples that are collected at a given site.

9.5.2 The field duplicate is collected either by splitting a larger volume into two aliquots in the glove box, by using a sampler with dual inlets that allows simultaneous collection of two samples, or by collecting two samples in rapid succession.

9.5.3 Field duplicates for dissolved metals determinations must be processed using the procedures in Section 8.3. Field duplicates for trivalent chromium must be processed through the sample preparation steps given in Sections 8.4.4.1 through 8.4.4.6.

9.6 Additional QC for Collection of Trivalent Chromium Aliquots

9.6.1 Method blank—The sampling team must prepare one method blank for every ten or fewer field samples. Each method blank is prepared using the steps in Sections 8.4.4.1 through 8.4.4.6 on a 100 mL aliquot of reagent water (Section 7.1). Do not use the procedures in Section 8.3 to process the method blank through the 0.45 µm filter (Section 6.14.1), even if samples are being collected for dissolved metals determinations.

9.6.2 Ongoing precision and recovery (OPR)—The sampling team must prepare one OPR for every ten or fewer field samples. The OPR is prepared using the steps in Sections 8.4.4.1 through 8.4.4.6 on the OPR standard (Section 7.4.7). Do not use the procedures in Section 8.3 to process the OPR through the 0.45 µm filter (Section 6.14.1), even if samples are being collected for dissolved metals determinations.

9.6.3 MS/MSD—The sampling team must prepare one MS and one MSD for every ten or fewer field samples.

9.6.3.1 If, through historical data, the background concentration of the sample can be estimated, the MS and MSD samples should be spiked at a level of one to five times the background concentration.

9.6.3.2 For samples in which the background concentration is unknown, the MS and MSD samples should be spiked at a concentration of 25 µg/L.

9.6.3.3 Prepare the matrix spike sample by spiking a 100-mL aliquot of sample with 2.5 mL of the standard chromium spike solution (Section 7.4.6), and processing the MS through the steps in Sections 8.4.4.1 through 8.4.4.6.

9.6.3.4 Prepare the matrix spike duplicate sample by spiking a second 100-mL aliquot of the same sample with 2.5 mL of the standard chromium spike solution, and processing the MSD through the steps in Sections 8.4.4.1 through 8.4.4.6.

9.6.3.5 If field samples are collected for dissolved metals determinations, it is necessary to process an MS and an MSD through the 0.45 µm filter as described in Section 8.3.

10.0 Recleaning the Apparatus Between Samples

10.1 Sampling activity should be planned so that samples known or suspected to contain the lowest concentrations of trace metals are collected first with the samples known or suspected to contain the highest concentrations of trace metals collected last. In this manner, cleaning of the sampling equipment between samples in unnecessary. If it is not possible to plan sampling activity in this manner, dedicated sampling equipment should be provided for each sampling event.

10.2 If samples are collected from adjacent sites (e.g., immediately upstream or downstream), rinsing of the sampling Apparatus with water that is to be sampled should be sufficient.

10.3 If it is necessary to cross a gradient (i.e., going from a high-concentration sample to a low-concentration sample), such as might occur when collecting at a second site, the following procedure may be used to clean the sampling equipment between samples:

10.3.1 In the glove bag, and using the "clean hands/dirty hands" procedure in Section 8.2.5, process the dilute nitric acid solution (Section 7.2) through the Apparatus.

10.3.2 Dump the spent dilute acid in the waste carboy or in the waterbody away from the sampling point.

10.3.3 Process 1 L of reagent water through the Apparatus to rinse the equipment and discard the spent water.

10.3.4 Collect a field blank as described in Section 9.4.

10.3.5 Rinse the Apparatus with copious amounts of the ambient water sample and proceed with sample collection.

10.4 Procedures for recleaning trivalent chromium preservation equipment between samples are described in Section 8.4.4.

11.0 Method Performance

Samples were collected in the Great Lakes during September–October 1994 using the procedures in this sampling method.

12.0 Pollution Prevention

12.1 The only materials used in this method that could be considered pollutants are the acids used in the cleaning of the Apparatus, the boat, and related materials. These acids are used in dilute solutions in small amounts and pose little threat to the environment when managed properly.

12.2 Cleaning solutions containing acids should be prepared in volumes consistent with use to minimize the disposal of excessive volumes of acid.

12.3 To the extent possible, the Apparatus used to collect samples should be cleaned and reused to minimize the generation of solid waste.

13.0 Waste Management

13.1 It is the sampling team's responsibility to comply with all federal, state, and local regulations governing waste management, particularly the discharge regulations, hazardous waste identification rules, and land disposal restrictions; and to protect the air, water, and land by minimizing and controlling all releases from field operations.

13.2 For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* and *Less is Better—Laboratory Chemical Management for Waste Reduction*, available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street NW, Washington, DC 20036.

14.0 References

1. Adeloju, S.B. and Bond, A.M. "Influence of Laboratory Environment on the Precision and Accuracy of Trace Element Analysis," *Anal. Chem.* **1985**, *57*, 1728.

2. Berman, S.S. and Yeats, P.A. "Sampling of Seawater for Trace Metals," *CRC Reviews in Analytical Chemistry* **1985**, *16*.

3. Bloom, N.S. "Ultra-Clean Sampling, Storage, and Analytical Strategies for the Accurate Determination of Trace Metals in Natural Waters." Presented at the 16th Annual EPA Conference on the Analysis of Pollutants in the Environment, Norfolk, VA, May 5, 1993.

4. Bruland, K.W. "Trace Elements in Seawater," *Chemical Oceanography* **1983**, *8*, 157.

5. Nriagu, J.O., Larson, G., Wong, H.K.T., and Azcue, J.M. "A Protocol for Minimizing Contamination in the Analysis of Trace Metals in Great Lakes Waters," *J. Great Lakes Research* **1993**, *19*, 175.

6. Patterson, C.C. and Settle, D.M. "Accuracy in Trace Analysis," in *National Bureau of Standards Special Publication 422*; LaFleur, P.D., Ed., U.S. Government Printing Office, Washington, DC, 1976.

7. "A Protocol for the Collection and Processing of Surface-Water Samples for Subsequent Determination of Trace Elements, Nutrients, and Major Ions in Filtered Water"; Office of Water Quality Technical Memorandum 94.09, Office of Water Quality, Water Resources Division, U.S. Geological Survey, Reston, VA, Jan. 28, 1994.

8. Standard Operating Procedure No. 4-54, Revision 01, *SOP for Concentration and Analysis of Chromium Species in Whole Seawater;* Prepared by Battelle Ocean Sciences, Duxbury, MA for the U.S. Environmental Protection Agency Office of Marine Environmental Protection, Ocean Incineration Research Program, 1987.

9. Cranston, R.E. and Murray, J.W. "The Determination of Chromium Species in Natural Waters," *Anal. Chem. Acta* **1978**, *99*, 275.

10. Prothro, M.G. "Office of Water Policy and Technical Guidance on Interpretation and Implementation of Aquatic Life Metals Criteria"; EPA Memorandum to Regional Water Management and Environmental Services Division Directors, Oct. 1, 1993.

11. "Format for Method Documentation"; Distributed by the EPA Environmental Monitoring Management Council, Washington, DC, Nov. 18, 1993.

12. Windom, H.L., Byrd, J.T., Smith, R.G., Jr., and Huan, F. "Inadequacy of NASQAN Data for Assessing Metal Trends in the Nation's Rivers," *Environ. Sci. Technol.* **1991**, *25*, 1137.

13. Zief, M. and Mitchell, J.W. "Contamination Control in Trace Metals Analysis," *Chemical Analysis* **1976**, *47*, Chapter 6.

14. Phillips, H., Shafer, M., Dean, P., Walker, M., and Armstrong, D. "Recommendations for Trace Metals Analysis of Natural Waters"; Wisconsin Department of Natural Resources: Madison, WI, May 1992.

15. Hunt, C.D. In *Manual of Biological and Geochemical Techniques in Coastal Areas,* 2nd ed.; Lambert, C.E. and Oviatt, C.A., Eds.; Marine Ecosystems Research Laboratory; Graduate School of Oceanography; The University of Rhode Island: Narragansett, RI, MERL Series, Report No. 1, Chapter IV.

16. Flegal, R. Summer 1994 San Francisco Bay Cruise, apparatus and procedures witnessed and videotaped by W. Telliard and T. Fieldsend, Sept. 15-16, 1994.

17. Watras, C. Wisconsin DNR procedures for mercury sampling in pristine lakes in Wisconsin, witnessed and videotaped by D. Rushneck and L. Riddick, Sept. 9-10, 1994.

18. Horowitz, A.J., Kent A.E., and Colberg, M.R. "The Effect of Membrane Filtration Artifacts on Dissolved Trace Element Concentrations," *Wat. Res.* **1992**, *26,* 53.

19. *Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual: 1986;* U.S. Environmental Protection Agency. Region IV. Environmental Services Division: Athens, GA.

20. Grohse, P. Research Triangle Institute, Institute Drive, Building 6, Research Triangle Park, NC.

21. Methods 1624 and 1625, 40 *CFR* Part 136, Appendix A.

15.0 Glossary of Definitions and Purposes

These definitions and purposes are specific to this sampling method but have been conformed to common usage as much as possible.

15.1 Ambient Water—Waters in the natural environment (e.g., rivers, lakes, streams, and other receiving waters), as opposed to effluent discharges.

15.2 Apparatus—The sample container and other containers, filters, filter holders, labware, tubing, pipets, and other materials and devices used for sample collection or sample preparation, and that will contact samples, blanks, or analytical standards.

15.3 Equipment Blank—An aliquot of reagent water that is subjected in the laboratory to all aspects of sample collection and analysis, including contact with all sampling devices and apparatus. The purpose of the equipment blank is to determine if the sampling devices and apparatus for sample collection have been adequately cleaned before they are shipped to the field site. An acceptable equipment blank must be achieved before the sampling devices and Apparatus are used for sample collection.

15.4 Field Blank—An aliquot of reagent water that is placed in a sample container in the laboratory, shipped to the field, and treated as a sample in all respects, including contact with the sampling devices and exposure to sampling site conditions, filtration, storage, preservation, and all analytical procedures. The purpose of the field blank is to determine whether the field or sample transporting procedures and environments have contaminated the sample.

15.5 Field Duplicates (FD1 and FD2)—Two identical aliquots of a sample collected in separate sample bottles at the same time and place under identical circumstances using a duel inlet sampler or by splitting a larger aliquot and treated exactly the same throughout field and laboratory procedures. Analyses of FD1 and FD2 give a measure of the precision associated with sample collection, preservation, and storage, as well as with laboratory procedures.

15.6 Matrix Spike (MS) and Matrix Spike Duplicate (MSD)—Aliquots of an environmental sample to which known quantities of the analytes are added in the laboratory. The MS and MSD are analyzed exactly like a sample. Their purpose is to quantify the bias and precision caused by the sample matrix. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS and MSD corrected for background concentrations.

15.7 May—This action, activity, or procedural step is optional.

15.8 May Not—This action, activity, or procedural step is prohibited.

15.9 Minimum Level (ML)—The lowest level at which the entire analytical system gives a recognizable signal and acceptable calibration point (Reference 21).

15.10 Must—This action, activity, or procedural step is required.

15.11 Reagent Water—Water demonstrated to be free from the metal(s) of interest and potentially interfering substances at the MDL for that metal in the referenced method or additional method.

15.12 Should—This action, activity, or procedural step is suggested but not required.

15.13 Trace-Metal Grade—Reagents that have been demonstrated to be free from the metal(s) of interest at the method detection limit (MDL) of the analytical method to be used for determination of this metal(s).

The term "trace-metal grade" has been used in place of "reagent grade" or "reagent" because acids and other materials labeled "reagent grade" have been shown to contain concentrations of metals that will interfere in the determination of trace metals at levels listed in Table 1.

TABLE 1. ANALYTICAL METHODS, METALS, AND CONCENTRATION LEVELS APPLICABLE TO METHOD 1669

Method	Technique	Metal	MDL (µg/L) [1]	ML (µg/L) [2]
1631	Oxidation/Purge & Trap/CVAFS	Mercury	0.0002	0.0005
1632	Hydride AA	Arsenic	0.003	0.01
1636	Ion Chromatography	Hexavalent Chromium	0.23	0.5
1637	CC/STGFAA	Cadmium	0.0075	0.02
		Lead	0.036	0.1
1638	ICP/MS	Antimony	0.0097	0.02
		Cadmium	0.013	0.1
		Copper	0.087	0.2
		Lead	0.015	0.05
		Nickel	0.33	1
		Selenium	0.45	1
		Silver	0.029	0.1
		Thallium	0.0079	0.02
		Zinc	0.14	0.5
1639	STGFAA	Antimony	1.9	5
		Cadmium	0.023	0.05
		Trivalent Chromium	0.10	0.2
		Nickel	0.65	2
		Selenium	0.83	2
		Zinc	0.14	0.5
1640	CC/ICP/MS	Cadmium	0.0024	0.01
		Copper	0.024	0.1
		Lead	0.0081	0.02
		Nickel	0.029	0.1

[1] Method Detection Limit as determined by 40 *CFR* Part 136, Appendix B.

[2] Minimum Level (ML) calculated by multiplying laboratory-determined MDL by 3.18 and rounding result to nearest multiple of 1, 2, 5, 10, 20, 50, etc., in accordance with procedures used by EAD and described in the EPA *Draft National Guidance for the Permitting, Monitoring, and Enforcement of Water Quality-Based Effluent Limitations Set Below Analytical Detection/Quantitation Levels*, March 22, 1994.

TABLE 2. ANALYTES, PRESERVATION REQUIREMENTS, AND CONTAINERS

Metal	Preservation Requirements	Acceptable Containers
Antimony Arsenic Cadmium Copper Lead Nickel Selenium Silver Thallium Zinc	Add 5 mL of 10% $HN0_3$ to 1-L sample; preserve on-site or immediately upon laboratory receipt.	500 mL or 1 L fluoropolymer, conventional or linear polyethylene, polycarbonate, or polypropylene containers with lid
Chromium (III)	Add 1 mL chromium (III) extraction solution to 100 mL aliquot, vacuum filter through 0.4 µm membrane, add 1 mL 10% $HN0_3$; preserve on-site immediately after collection.	500 mL or 1 L fluoropolymer, conventional or linear polyethylene, polycarbonate, or polypropylene containers with lid
Chromium (IV)	Add 50% NaOH; preserve immediately after sample collection.	500 mL or 1 L fluoropolymer, conventional or linear polyethylene, polycarbonate, or polypropylene containers with lid
Mercury	Total: Add 0.5% high-purity HCl or 0.5% BrCl to pH < 2; Total & Methyl: Add 0.5% high-purity HCL; preserve on-site or immediately upon laboratory receipt	Fluoropolymer or borosilicate glass bottles with fluoropolymer or fluoropolymer-lined caps

Figure 1 - Grab Sampling Device

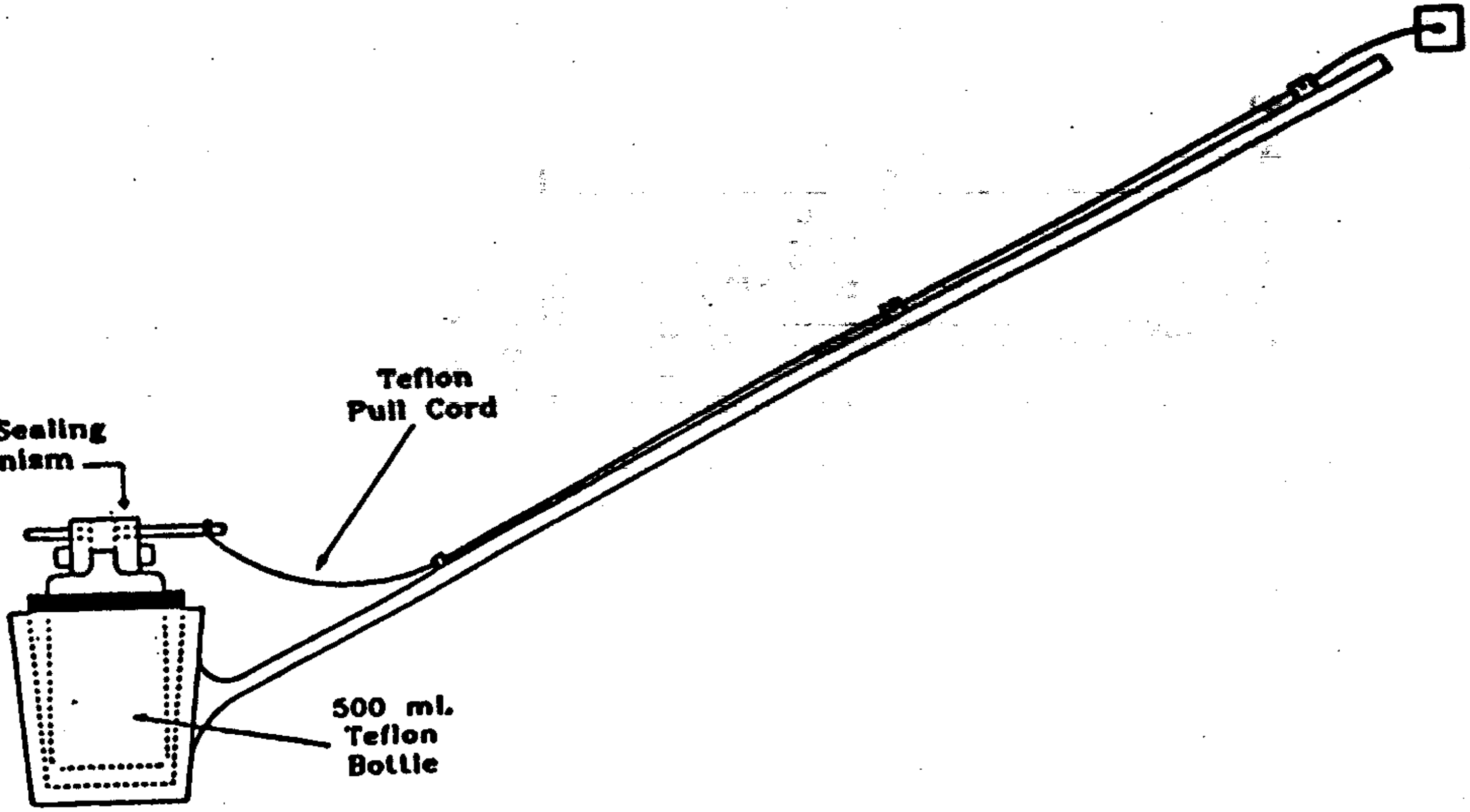


Figure 2 - Grab Sampling Device

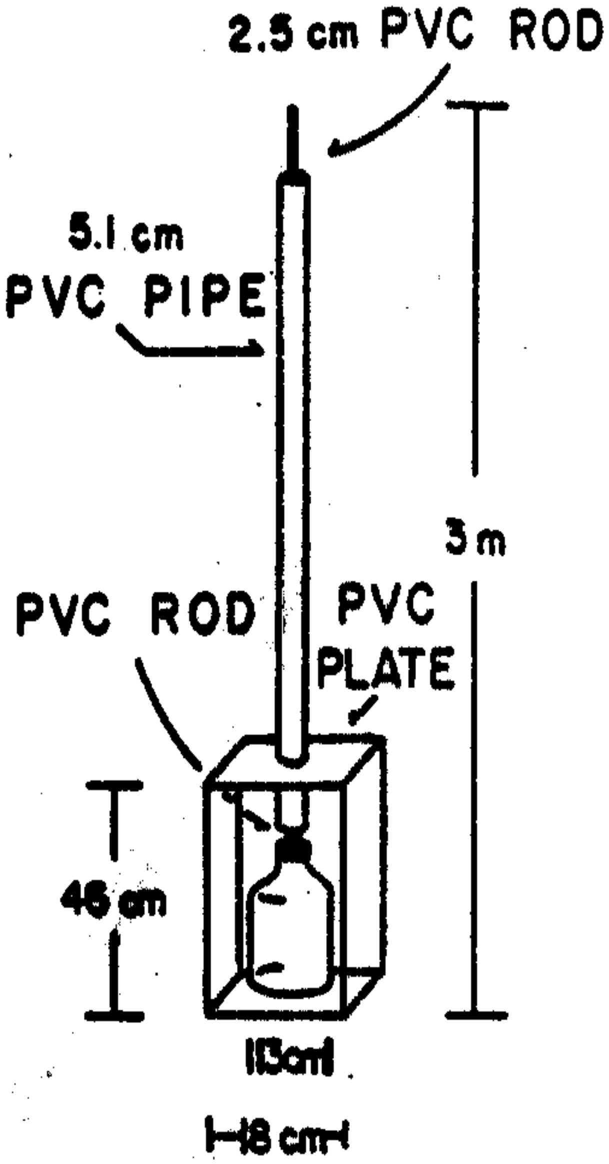


Figure 3 - Jar Sampling Device

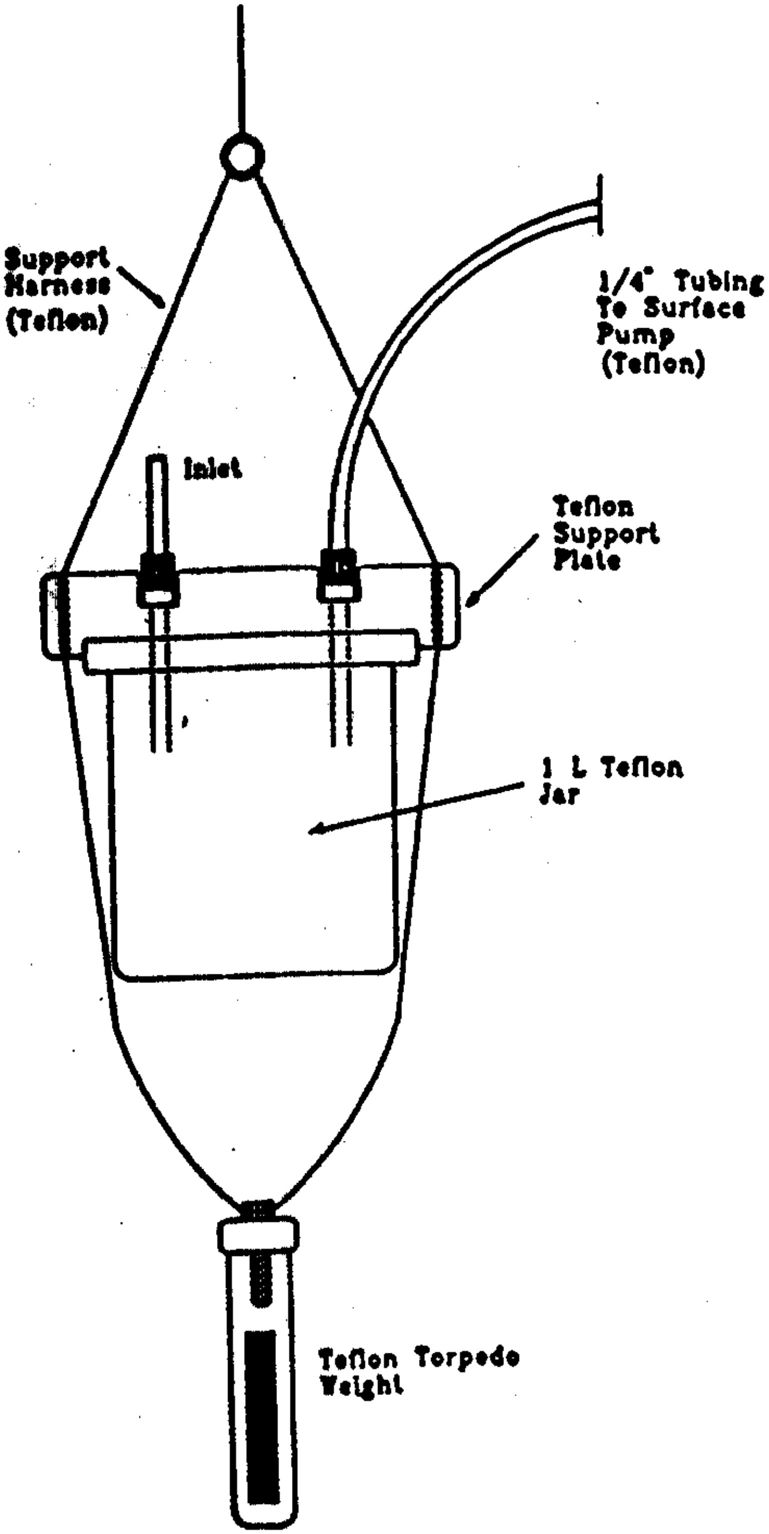
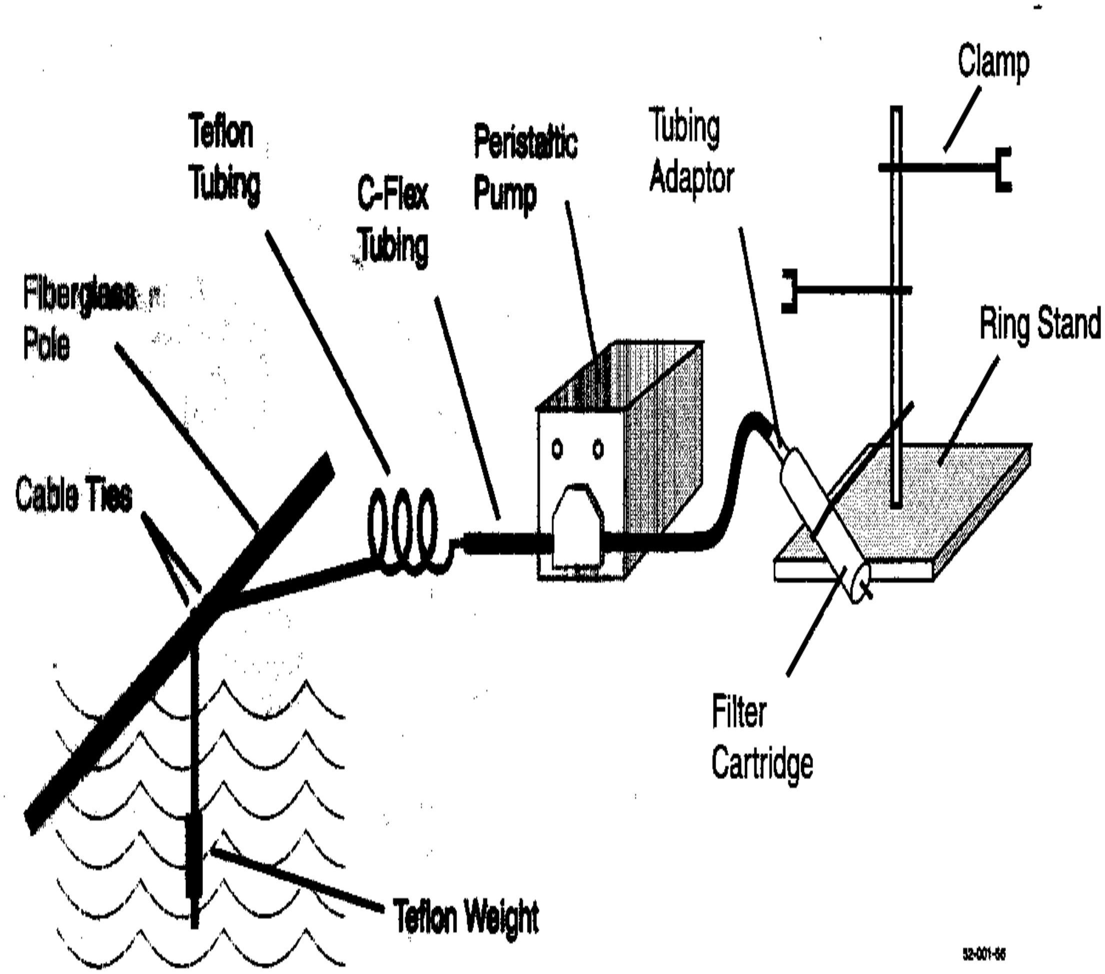


Figure 4 - Sample Pumping System



QUALITY ASSURANCE PROJECT PLAN

APPENDIX B
EXAMPLE DATA REVIEW AND VERIFICATION CHECKLIST

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APPENDIX B.

DATA REVIEW AND VERIFICATION CHECKLIST

This checklist should be used to document data review verification of data generated through implementation of the FERC-approved study plan.

GENERAL

☐ For each sampling event, samples have been collected and analyzed at all locations and for all analyses specified in the study plan.
☐ For each sample and analyses, the project file contains records field notes, chain-of-custody, and analytical results, including quality assurance documentation (hardcopy and electronic)

FIELD DATA

☐ Field notes and/or data sheets include date, time of sample collection, field sampling staff, time arrived at site, time left site, site identification, description of site conditions (weather), field parameters, reservoir level or flow information (measured or estimated), sample collection procedures, and call-out quality assurance samples collected. If mistakes are found on the field data sheet, changes can be made by crossing out the mistake and marking the change with a date of change, initials, and reason for change.
☐ Documentation of field equipment calibration is in the fieldnotes and/or project records.
☐ Field data entered into Excel have been checked by a second-party.

LABORATORY REPORT

☐ Field duplicates, blanks, and rinsates were submitted to the laboratory at the frequency specified in the study plan.
☐ Any constituents found in blanks or rinsates are discussed in the final report.
☐ Any duplicate concentrations that differ by more than 10% are discussed in the final report.
☐ Samples were received by the laboratory intact and analyzed within method and/or study specified holding times.
☐ Laboratory reports are accurate with respect to sample IDs, analyses, reporting/detection limits, units, column labels, footnotes, and titles. Have lab re-issue report with corrections if there are inconsistencies.
☐ Check that non-detects are always reported in the same manner using consistent notation. For example, either “ND” or “<.” Have lab re-issue report with corrections if there are inconsistencies.
☐ If observed, “J” qualified data and/or elevated detection limits are discussed in the final report.

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Technical Memorandum 2-3

Water Quality

Attachment 2-3B
Part 2

Hydrolab Quanta and MS5 Calibration Forms

Yuba River Development Project
FERC Project No. 2246

February 2013

DATE: 10-23-08	**DOCUMENT#:** 19002-00-QUANTA
Page 3 of 4	**REVISION:** 2

3.0

Quanta and Quanta G Functional Test Sheet

Section A:

Service Request # 312090083	Customer Rental	Serial # QT0142
Technician HL	Model Type [✓ Quanta] Quanta G	Date Started 05-18-12

Performance, Test and Evaluation

Current MPL Rev. 3.1 Upgrade to MPL Rev N/A	DO membrane installed [✓ Yes] No NA	PH Electrolyte and Teflon Junction installed - [✓ Yes] No NA
Lenses cleaned [✓ Yes] No NA	Desiccant installed [✓ Yes] No NA	Turbidity Firmware Rev.

Section B:

	Submission___ Day_____	Submission __ Day_____	Submission __ Day_____
Verified customer's observations	Y / N PT&E / Upgrade	Y / N PT&E / Upgrade	Y / N PT&E / Upgrade
Verified proper operation of circulator	Y / N / NA	Y / N / NA	Y / N / NA
Temp probe test at room temperature 22.5 °C	22.4		
pH 7 Buffer calibration verified (+/- .2 pH)	7		
pH slope calibration verified at 10 units.	10.02		
Conductivity calibration verified (+/-.2mS/cm) 12.856 mS/cm / 47.6 mS/cm	12.86		
ORP calibration verified at ______degrees C (+/-20 mV)	N/A		
Conductivity .100 mS linearity verified– (+/- .005 mS)	.102		
Conductivity 1.412 mS linearity verified – (+/- .15 mS)	1.42		
DO 100% sat integrity window verified at +50 mmHg above current bp.	[✓ P] /F / NA	P /F / NA	P /F / NA
DO 100% saturation calibration verified – local (+/- .5%)	634		
Turbidity calibration verified in DI water 0.0-(+/-.5NTU)	0.0		
4 Beam Turbidity calibrated at _____ NTU (+/- 1 NTU) Dilute Formazin verified against "in-house" 2100P	100		
4 Beam Turbidity linearity verified at ____ NTU with Dilute Formazin verified against "in-house" 2100P (+/- 10% of reading.)	40.2		
Depth calibration verified – (+/- .02 meters)	0.0		
Depth check – (+/- .1 meters)	pass		
Logging/Sensor Stability Test	[✓ P] /F / NA	P /F / NA	P /F / NA
pH linearity verified at ________ units. (+/- 0.20 units)	✓		

Calibrated Test Equipment Used –

Description	**X-number**
DVM Multimeter	X- N/A

Section C. Final Check-off Prior to Submitting for Estimate -

Exterior is clean ✓ Storage cup filled with pH 4 buffer ✓	Hach Business System updated ✓ **Date Completed** 05-21-12

3.0 Series 5, and 5X Sonde Functional Test Data Sheet

Section A:

Service Request # 312090083	Customer Rental	Date Started 05-08-12
Housing Serial # R49191	Embedded Serial# R49191	Additional Driver Firmware:
Technician HL	Model: Datasonde [✓ Minisonde] Pipesonde [✓ 5] 5X	

Customer Display Information

I/D	DOM	Baud Rate	Security	SDI	TTY
Parameter	Time	Temp	pH	Spcond	Sal
Units		°C	units	mS/cm	ppt
Parameter	Depth 200	TurbiSC	LDO%	LDO	IBatt
Units	meters	NTU		mg	Volts

For Sonde with Depth – Coefficients

A:	B:	C:	D:
E:	F:	G:	H:
I:	J:	SER:	

FLUOROMETER OFFSETS

1ST	X10:	X1:
2ND	X10:	X1:

For Sonde with TDG or PAR – Coefficients

A:	B:	C:	D:
Local:	Ref:		

Performance, Test and Evaluation

Current MPL Rev-- 5.43 Upgrade to MPL Rev-- N/A	pH Electrolyte & Teflon Junction Replaced- [✓ Yes] No NA	DO membrane Replaced Yes No NA
Lenses cleaned [✓ Yes] No NA	RTC Battery Replaced [✓ Yes] No	Desiccant Replaced [✓ Yes] No

Section B:

	Submission Day ✓	Submission Day	Submission Day
Customer Observations Verified	/ Y / N / PT&E / Upgrade	/ Y / N / PT&E / Upgrade	/ Y / N / PT&E / Upgrade
Set Time and Date	✓		
Verified all hardware updates as current	✓		
Total current draw. (Circle all that apply) MPL PCB 40mA SC Turbidity 20mA LDO 70mA 4Beam Turbidity 10mA Flourometers: 1st 30mA 2nd 30mA 3rd 30mA PAR 10mA (Optimal Values not to exceed +20mA overall.)	120 mA		
Current draw of circulator. (20 mA max. beyond previous values.)	NA		
Operation of self cleaning motor verified—	[✓ P] F NA	P F NA	P F NA
Audio functions correctly	[✓ P] F	P F	P F
RTC sleep/wake-up test.	[✓ P] F	P F	P F
Temp probe test at room temperature. 21.89 °C			
DO 100% sat integrity window verified at +50 mmHg over current bp. (Clark Cell only)	P F NA	P F NA	P F NA

3.0 Series 5, and 5X Sonde Functional Test Data Sheet

Section A:

Service Request # 312090083	Customer Rental	Date Started 05-08-12
Housing Serial # R49191	Embedded Serial# R49191	Additional Driver Firmware:
Technician HL	Model: Datasonde [✓ 5] [✓ Minisonde] Pipesonde 5X	

Customer Display Information

I/D	DOM	Baud Rate	Security	SDI	TTY
Parameter	Time	Temp	pH	spcond	Sal
Units		°C	units	mS/cm	ppt
Parameter	Depth 200	TurbiSC	100%	LDO	IBatt
Units	meters	NTU		mg	Volts

For Sonde with Depth – Coefficients

A:	B:	C:	D:
E:	F:	G:	H:
I:	J:	SER:	

FLUOROMETER OFFSETS

1ST	X10:	X1:
2ND	X10:	X1:

For Sonde with TDG or PAR – Coefficients

A:	B:	C:	D:
Local:	Ref:		

Performance, Test and Evaluation

Current MPL Rev-- 5.43 Upgrade to MPL Rev-- N/A	pH Electrolyte & Teflon Junction Replaced- [✓ Yes] No NA	DO membrane Replaced Yes No NA
Lenses cleaned -[✓ Yes] No NA	RTC Battery Replaced [✓ Yes] No	Desiccant Replaced -[✓ Yes] No

Section B:

	Submission Day ✓	Submission Day	Submission Day
Customer Observations Verified	/ Y / N / PT&E / Upgrade	/ Y / N / PT&E / Upgrade	/ Y / N / PT&E / Upgrade
Set Time and Date	✓		
Verified all hardware updates as current	✓		
Total current draw. (Circle all that apply) MPL PCB 40mA SC Turbidity 20mA LDO 70mA 4Beam Turbidity 10mA Flourometers: 1st 30mA 2nd 30mA 3rd 30mA PAR 10mA (Optimal Values not to exceed +20mA overall.)	120 mA		
Current draw of circulator. (20 mA max. beyond previous values.)	NA		
Operation of self cleaning motor verified—	[✓ P] F NA	P F NA	P F NA
Audio functions correctly	[✓ P] F	P F	P F
RTC sleep/wake-up test.	[✓ P] F	P F	P F
Temp probe test at room temperature. 21.89 °C			
DO 100% sat integrity window verified at +50 mmHg over current bp. (Clark Cell only)	P F NA	P F NA	P F NA

DATE 10-24-08	**DOCUMENT#: 19002-00-Series5Sonde**
PAGE	**REVISION 3**

DO 100% saturation calibration verified- local – (+/- 0.2 mg/l Clark Cell) (+/- 0.1 mg/l LDO)	630.7		
Scale Factor. (1.5 to 0.5) (LDO only)	0.933297		
Conductivity zero (air) calibration verified - (+/- .005mS)	0.0		
Conductivity calibration verified – (+/-.2 mS) 12.856 mS/cm / 47.6 mS/cm	12.86		
Conductivity 1.412mS linearity verified –(+/-.15 mS)	1.43		
Conductivity .100mS verified – (+/-.005 mS)	.102		
pH 7 buffer calibration verified– (+/- .2 pH)	7.0		
pH slope calibration verified at ______ units.	10.02		
ORP calibration verified at ________ ° C (+/- 20 mV)			
Turbidity - Calibration accepted & verified with DI Water (0.0 +/-0.7 NTU)	0.0		
Turbidity - Calibration accepted & verified at (100.0 +/- 1 NTU) with Hach StablCal	99.8		
Turbidity - Linearity verified with 40 NTU Hach StablCal – (+/- 4 NTU)	40.2		
Depth zero calibration verified – (.02 meters)	0.0		
Depth Check verified – (+/- 0.03 meters)- Tank depth	passed		
Specific Ion Low C mV High C mV	Specific Ion Low C mV High C mV		Specific Ion Low C mV High C mV
N03- calibration verified	P F [✓ NA]	P F NA	P F NA
NH4+ calibration verified	P F [✓ NA]	P F NA	P F NA
Cl- calibration verified	P F [✓ NA]	P F NA	P F NA
Chlorophyll 'a' calibration verified	P F [✓ NA]	P F NA	P F NA
Rhodamine 'wt' calibration verified	P F [✓ NA]	P F NA	P F NA
Blue-green Algae calibration verified	P F [✓ NA]	P F NA	P F NA
PAR calibration verified	P F [✓ NA]	P F NA	P F NA
TDG calibration verified (+/- 2 mmHg)	P F [✓ NA]	P F NA	P F NA
Logging/Sensor Stability Test	[✓ P] F	P F	P F
pH linearity verified at ____ units. (+/- 0.20 units)	✓		
Battery pack setup and checked	[✓ P] F NA	P F NA	P F NA
Hydras3 LT Communications verified, unused slots deactivated.	✓		
Display, Baud Rate, Communications mode settings returned as received.	[✓ Yes] No	Yes No	Yes No

Calibrated Test Equipment Used –

Description	**X-number**
Power Supply	X- 7208
DVM Digital Multimeter	X-XXX 7240

Section C. Final Check-off Prior to Submitting for Estimate --

Exterior is clean ✓ Storage cup filled with pH 4, buffer ✓	Hach Business System updated ✓ Date Completed 05-21-12

3.0

Quanta and Quanta G Functional Test Sheet

Section A:

Service Request # 312090083	Customer Rental	Serial # QT0142
Technician HL	Model Type [✓ **Quanta**] **Quanta G**	Date Started 05-18-12

Performance, Test and Evaluation

Current MPL Rev. 3.1 Upgrade to MPL Rev NA	DO membrane installed [✓ Yes] No NA	PH Electrolyte and Teflon Junction installed - [✓ Yes] No NA
Lenses cleaned [✓ Yes] No NA	Desiccant installed [✓ Yes] No NA	Turbidity Firmware Rev.

Section B:

	Submission___ Day_____	Submission __ Day _____	Submission __ Day _____
Verified customer's observations	Y / N PT&E / Upgrade	Y / N PT&E / Upgrade	Y / N PT&E / Upgrade
Verified proper operation of circulator	Y / N / NA	Y / N / NA	Y / N / NA
Temp probe test at room temperature 22.5 °C	22.4		
pH 7 Buffer calibration verified (+/- .2 pH)	7		
pH slope calibration verified at 10 units.	10.02		
Conductivity calibration verified (+/-.2mS/cm) 12.856 mS/cm / 47.6 mS/cm	12.86		
ORP calibration verified at ______degrees C (+/-20 mV)	NA		
Conductivity .100 mS linearity verified– (+/- .005 mS)	.102		
Conductivity 1.412 mS linearity verified – (+/- .15 mS)	1.42		
DO 100% sat integrity window verified at +50 mmHg above current bp.	[✓ P] /F / NA	P /F / NA	P /F / NA
DO 100% saturation calibration verified – local (+/- .5%)	634		
Turbidity calibration verified in DI water 0.0-(+/-.5NTU)	0.0		
4 Beam Turbidity calibrated at _____ NTU (+/- 1 NTU) Dilute Formazin verified against "in-house" 2100P	100		
4 Beam Turbidity linearity verified at ____ NTU with Dilute Formazin verified against "in-house" 2100P (+/- 10% of reading.)	40.2		
Depth calibration verified – (+/- .02 meters)	0.0		
Depth check – (+/- .1 meters)	pass		
Logging/Sensor Stability Test	[✓ P] /F / NA	P /F / NA	P /F / NA
pH linearity verified at ________ units. (+/- 0.20 units)	✓		

Calibrated Test Equipment Used –

Description	**X-number**
DVM Multimeter	X- NA

Section C. Final Check-off Prior to Submitting for Estimate -

Exterior is clean ✓ Storage cup filled with pH 4 buffer ✓	Hach Business System updated ✓ **Date Completed** 05-21-12

Technical Memorandum 2-3

Water Quality

Attachment 2-3B
Part 3

Data Reviewed and Verification Cheklist (Completed)

Yuba River Development Project
FERC Project No. 2246

February 2013

DATA REVIEW AND VERIFICATION CHECKLIST

This checklist should be used to document data review verification of data generated through implementation of the FERC-approved study plan.

GENERAL

☑ For each sampling event, samples have been collected and analyzed at all locations and for all analyses specified in the study plan.
☑ For each sample and analyses, the project file contains records field notes, chain-of-custody, and analytical results, including quality assurance documentation (hardcopy and electronic)

FIELD DATA

☑ Field notes and/or data sheets include date, time of sample collection, field sampling staff, time arrived at site, time left site, site identification, description of site conditions (weather), field parameters, reservoir level or flow information (measured or estimated), sample collection procedures, and call-out quality assurance samples collected. If mistakes are found on the field data sheet, changes can be made by crossing out the mistake and marking the change with a date of change, initials, and reason for change.
☑ Documentation of field equipment calibration is in the fieldnotes and/or project records.
☑ Field data entered into Excel have been checked by a second-party.

LABORATORY REPORT

☑ Field duplicates, blanks, and rinsates were submitted to the laboratory at the frequency specified in the study plan.
☑ Any constituents found in blanks or rinsates are discussed in the final report.
☑ Any duplicate concentrations that differ by more than 10% are discussed in the final report.
☑ Samples were received by the laboratory intact and analyzed within method and/or study specified holding times.
☑ Laboratory reports are accurate with respect to sample IDs, analyses, reporting/detection limits, units, column labels, footnotes, and titles. Have lab re-issue report with corrections if there are inconsistencies.
☑ Check that non-detects are always reported in the same manner using consistent notation. For example, either "ND" or "<." Have lab re-issue report with corrections if there are inconsistencies.
☑ If observed, "J" qualified data and/or elevated detection limits are discussed in the final report.

12/23/12
1/30/13