RECLAMATION
Managing Water in the West

Quality Assurance Project Plan

Sediment Contaminant Study, Klamath River Sediment Sampling Program

JC Boyle, Copco-1, Copco-2, and Iron Gate Reservoirs; Klamath River Estuary

Draft: August 2009
Revision 1: December 2009
Revision 2: August 2010

U.S. Department of the Interior
Bureau of Reclamation, Mid-Pacific Region
Branch of Environmental Monitoring, MP-157

Abstract

This Quality Assurance Project Plan documents the sampling design and quality assurance guidelines for the Sediment Contaminant Study, Klamath River Sediment Sampling Program. The study is being undertaken to inform the 2012 Secretarial Decision to either remove or retain four Klamath River dams: JC Boyle, Copco 1, Copco 2 and Iron Gate. In conjunction with toxicity studies, chemical, physical and biological analyses will help determine whether constituents may be present at harmful concentrations. This contaminant investigation will help evaluate the potential for exposing or transporting contaminated sediment should the dams be removed.

List of Acronyms

AVS	Acid Volatile Sulfide
BOD	Biological Oxygen Demand
CDH	Contaminant Drill Hole
CHA	Contaminant Hand Auger
COC	Chain of Custody
CN	Cyanide
DDT	Dichlorodiphenyltrichloroethane
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DMMP	Dredge Materials Evaluation and Disposal Procedures User's Manual
DMT	Data Management Team
DI	De-ionized water
DOC	Dissolved Organic Carbon
DQO	Data Quality Objective
EC	Electrical conductivity
EMT	Environmental Monitoring Team
EPA	Environmental Protection Agency
FADC	Flight Auger Dry Core
GEC	Gathard Engineering Consulting
GPS	Global Positioning System
HPAH	High molecular weight polynuclear aromatic hydrocarbon
ID	Identification number
ITM	US Army Corps of Engineers Inland Testing Manual
LPAH	Low molecular weight polynuclear aromatic hydrocarbon
MP157	Mid-Pacific Region Branch of Environmental Monitoring
MPV	Most probable value
MPN	Most probable number
MTBE	Methyl tertiary butyl ether
NOAA	National Oceanic and Atmospheric Administration
OPP	Organophosphorus compounds
PAH	Polycyclic aromatic hydrocarbon
PBDE	Polybrominated diphenyl ethers
PCB	Polychlorinated biphenyls
PCE	Tetrachloroethene
PE	Performance evaluation
POC	Particulate Organic Carbon
PR	Percent Recovery
PSDDA	Puget Sound Dredged Disposal Analysis
PTFE	Polytetrafluoroethylene - Teflon®
QAPP	Quality Assurance Project Plan
QA	Quality assurance
QAT	Quality Assurance Team
QC	Quality control
RL	Reporting limit

RPD	Relative Percent Difference
SEF	Sediment Evaluation Framework
SHPO	State Historic Preservation Office
SL	Screening level
SOW	Scope of Work
SWI	Shannon and Wilson Incorporated
SVOC	Semivolatile organic compounds
TDS	Total Dissolved Solids
TEQ	Toxic equivalent concentration
TCE	Trichloroethene
TOC	Total organic carbon
TVS	Total volatile solids
TMT	Technical Management Team
USACE	United States Army Corp of Engineers
USEPA	United States Environmental Protection Agency
USBR	United States Bureau of Reclamation
VOC	Volatile organic compound
WAD	Weak Acid Dissociable

A. PROJECT MANAGEMENT

A1. Approval Sheet

8-5-2010

Stuart Angerer
US Bureau of Reclamation
Mid Pacific Region
Environmental Monitoring Team Lead

Date

Julie E. Eldridge
signing for Victor Stokmanis

8-5-201

Victor Stokmanis
US Bureau of Reclamation
Mid Pacific Region
Quality Assurance Team Lead

Date

8-5-201

Satpal Kalsi
US Bureau of Reclamation
Mid Pacific Region
Data Management Team Lead

Date

J. Fields

8/5/10

John Fields
US Bureau of Reclamation
Mid Pacific Region
Environmental Monitoring Branch Chief

Date

A2. Table of Contents

List of Tables

List of Figures

A3. Distribution List

Each person listed on the approval sheet and each person listed under Project/Task Organization will receive an electronic copy of this Quality Assurance Project Plan (QAPP). Individuals taking part in the project may request additional copies of the QAPP from personnel listed under Section A4.

This document has been prepared according to the United States Environmental Protection Agency publication *EPA Requirements for QAPPs*, March 2001 (QA/G-5), the American National Standard for quality assurance systems (ANSI/ASQC E4-1994), and the USEPA's *Guidance for Quality Assurance Project Plans* (2002).

A4. Project/Task Organization

4.1 Project personnel and roles

Personnel involved in project implementation are listed in Table 1. Laboratory contacts for analytical testing of sediment (Table 2) and sample elutriate (Table 3) follow.

Table 1: Project Implementation Personnel

Individual	Affiliation	Contact Information	Project Role
Program Management:			
Rhea Graham	Reclamation	rgraham@usbr.gov 916 978-5113	Program Manager
Blair Greimann	Reclamation	bgreimann@usbr.gov 303 445-2563	Technical Management Team Lead
Tom Hepler	Reclamation	thepler@usbr.gov 303 445-3261	Program Director
Project Design:			
Chauncey Anderson	U.S. Geological Survey	chauncey@usgs.gov 503 251-3206	Project design
Laura Benninger	Reclamation	lbenninger@usbr.gov 916 978-5286	Project design; field coordination, supervision, and implementation; QAPP generation; technical report assistance
Mike McCulla	Reclamation	mmcculla@usbr.gov 916 978-5307	Project design; drilling operations coordination, geologist
Greg Mongano	Reclamation	gmongano@usbr.gov 916 978-5331	Project design; coordination with the geotechnical study, geologist

Table 1: Project Implementation Personnel

Individual	Affiliation	Contact Information	Project Role
Brian Ross	Environmental Protection Agency	ross.brian@epa.gov 415 972-3475	Project design
Paul Zedonis	Fish and Wildlife Service	paul_zedonis@fws.gov 707 825-5119	Project design
Quality Assurance:			
Julie Eldredge	Reclamation	jeldredge@usbr.gov 916 978-5240	Quality assurance (QA) validation and review; QA Summary Report generation
Victor Stokmanis	Reclamation	vstokmanis@usbr.gov 916 978-5285	Quality Assurance Team (QAT) Lead; laboratory coordination and budgeting; QAPP generation; QA validation and review
Field Implementation:			
Stuart Angerer	Reclamation	sangerer@usbr.gov 916 978-5046	Environmental Monitoring Team (EMT) Lead; contaminant sample and water column data collection and handling
Rick Carlson	Reclamation	rcarlson@usbr.gov	Contaminant sample collection and handling
Maria Del Hoyo	Reclamation	mdelhoyo@usbr.gov	Contaminant sample and water column data collection and handling
Harry Horner	Reclamation	hhorner@usbr.gov	Alternate field supervisor; contaminant sample and water column data collection and handling
Tim McLaughlin	Reclamation	tmclaughlin@usbr.gov	Contaminant sample collection and handling
James Ross	Reclamation	jross@usbr.gov	Boat operator
April Tower	Reclamation	atower@usbr.gov	Boat operator
Alison Warren	Reclamation	awarren@usbr.gov	Geologist
Data Management:			
Satpal Kalsi	Reclamation	skalsi@usbr.gov 916 978-5278	Data Management Team (DMT) Lead; website coordination
Eva Grey	Reclamation	egrey@usbr.gov	Data entry and

Table 1: Project Implementation Personnel

Individual	Affiliation	Contact Information	Project Role
			validation
Rosa Heredia	Reclamation	rheredia@usbr.gov	Data entry and validation
Drilling Operations:			
See geotechnical Sampling and Analysis Plan for details			
Technical Report:			
Kevin Kelly	Reclamation	kkelly@usbr.gov 866 476-4550	Preliminary data review and assessment; technical report generation

Table 2: Laboratory Contact Information - Sediment Analyses

Individual	Affiliation	Contact	Analyte (Role in Project)
Frank Smith	ALS Laboratory Group	801 266-7700	Volatile Organic Compounds, Polyaromatic Hydrocarbons, Phthalates, Phenols, Chlorinated Pesticides, Polychlorinated Biphenyl (PCB) Aroclors, PCB Congeners, Dioxins, Furans, Carbamates, Polybrominated Diphenyl Ethers (PBDE), Gasoline Range Organics, Residual Range Organics
Theresa Rawthorne	Axys Analytical	888 373-0881	Carbamates
Nathan Hawley	Basic Laboratory	530 243-7234	pH, Specific Conductance, Instantaneous Oxygen Demand, Total Percent Solids, Total Volatile Solids, Total Dissolved Solids, Ammonia, Total Nitrogen, Total Phosphorus, Weak Acid Dissociable Cyanide, Total Sulfide, Acid Volatile Sulfide (AVS), Total Solids
David Block	Block Environmental	925 682-7200	10 day Acute Bioassay (Hyalella azteca, Chironomus dilutus), 28 Day Bioaccumulation (Lumbriculus variegatus, Corbicula fluminea)
Bill Svoboda	Caltest Analytical Laboratory	707 258-4000	Pyrethroids
Linda Laver	Test America	916 374-4362	Organophosphorus Compounds, Total Metals
Stephen Wilson	USGS Denver	303 236-2454	Total Organic Carbon

Table 3: Laboratory Contact Information - Elutriate Analyses

Individual	Affiliation	Contact	Analyte (Role in Project)
Frank Smith	ALS Laboratory Group	801 266-7700	Polyaromatic Hydrocarbons, Phthalates, Phenols, PCB Congeners
Nathan Hawley	Basic Laboratory	530 243-7234	pH, Specific Conductance, Biological Oxygen Demand (5 day), Instantaneous Oxygen Demand, Total Dissolved Solids, Ammonia, Chloride, Total Nitrogen, Total Phosphorus, Weak Acid Dissociable Cyanide, Total Sulfide, Chlorinated Pesticides, Total Organic Carbon, Dissolved Organic Carbon, Particulate Organic Carbon, Total Metals, Polyaromatic Hydrocarbons, Phthalates, Phenols, Organophosphorus Compounds, Chlorinated Pesticides, Polychlorinated Biphenyl Aroclors, Polychlorinated Biphenyl Congeners, Carbamates
David Block	Block Environmental	925 682-7200	96 Hour Acute Bioassay (*Oncorhynchus mykiss*)
Linda Geddes	Montgomery Watson Harza	626 386-1163	Organochlorine Pesticides/PCBs, Semivolatiles, Aldicarbs
Linda Laver	Test America	916 374-4362	Organophosphorus Compounds

* Basic Laboratory will prepare sample elutriate and send the prepared elutriate to other laboratories for further analysis; Block Environmental will prepare their own elutriate.

4.2 Personnel responsibilities

US Bureau of Reclamation (USBR or Reclamation) Program Manager:

- Conduct outreach with regulated industry and internal/external stakeholders
- Oversee progress of the Klamath Sediment Sampling Program

The USBR Technical Management Team (TMT) Lead:

- Conduct outreach with regulated industry and internal/external stakeholders
- Coordinate major program tasks including overseeing progress of the Klamath Sediment Sampling Program
- Oversee maintenance of official, approved QAPP
- Oversee the scheduling of data collection, QA review, tabulation and analysis

The USBR Geology Team:

- Organize drilling operations using the USBR drill team
- Contract an additional drilling team to assist with additional drilling activities

The USBR Environmental Monitoring Team (EMT):

- In collaboration with the USBR Quality Assurance Team (QAT) and members of the Klamath TMT, develop and maintain this QAPP
- Determine required turnaround times for analytical results
- Under the advisement of the TMT, design the environmental monitoring sampling plan. In particular, determine analytes of interest and appropriate collection methods and determine applicable quality standards and associated data quality objectives
- Organize and coordinate sample collection and field logistics
- Collect environmental monitoring data and samples
- Document sampling methods and explain any deviations from the procedures detailed in this QAPP
- Submit environmental and QA samples for analysis by predetermined analytical laboratories. Ensure proper sample collection, preservation, storage and transportation
- Coordinate with the QAT to incorporate QA references, spikes, duplicates and blanks into sample batches prior to submitting samples to the analytical laboratories
- Organize and present QA-validated analytical results
- In collaboration with the QAT, produce and distribute a data report summarizing 1) program objectives, 2) sampling design, 3) sampling methods, 4) quality assurance methods, 5) QA-approved analytical results, and 6) any data qualifications.
- Estimate the labor and equipment costs for completing EMT tasks. Submit this estimate to the Program Manager and inform the Program Manager if budget estimates need adjustment

The USBR Quality Assurance Team (QAT):

- Specify appropriate analytical methods – those which can meet the minimum reporting limits required by the EMT
- Contact QA-approved analytical laboratories and arrange for sample analysis using the predetermined analytical methods. Contract for data turnaround times specified by EMT members

- Obtain sampling requirements from the analytical laboratories and pass this information on to the EMT in an organized and clear manner (specify sample volume, preservation and handling requirements; verify field and laboratory sample hold times)
- Incorporate external QA samples such as references, spikes, duplicates, and blanks
- Supply EMT staff with QA reference and blank materials for inclusion with environmental samples before batches are submitted for analysis
- Within three weeks of receiving an analytical report, validate resulting analytical data following standard USBR QA protocol (QAT, 2009). If QA criteria are not met, ask the laboratories to reanalyze the data
- Determine whether or not samples were analyzed within hold times
- Produce a QA Summary Report for inclusion with the EMT data report described above. Summarize 1) QA results, 2) QA findings, and 3) discussion of QA issues encountered, and how they were resolved
- Estimate the labor and analytical costs of completing QAT tasks. Submit this estimate to the Program Manager and inform the Program Manager if budget estimates need adjustment

The USBR Data Management Team (DMT):

- Within three weeks of receiving QA-validated analytical reports, enter QA-approved analytical results, and any associated data qualifications, into Reclamation's Environmental Monitoring Branch (MP157) Oracle database
- Within two weeks of data entry, verify accuracy of entered data and post verified results to the USBR web
- Maintain binders containing hard copy documentation of sample records and logs
- Estimate the labor and analytical costs of completing DMT tasks. Submit this estimate to the Program Manager and inform the Program Manager if budget estimates need adjustment

Contract laboratories:

- Analyze constituents as indicated on the Chain of Custody documents
- Deliver analytical results within five weeks of sample receipt
- Reanalyze samples if results do not meet USBR QA criteria
- Archive samples until completion of analysis and re-analysis. Upon project completion, return unused sample material to the USBR

A5. Problem Definition/Background

5.1 Problem statement

Based in part upon the data collected in this study, the Secretary of the Department of the Interior will decide whether to approve removal of four dams along the Klamath River**:** JC Boyle, Copco 1, Copco 2 and Iron Gate. Sediment impounded behind these dams may contain chemical or biological contaminants that if exposed or transported, could threaten local, regional, or down-stream environments. A significant volume of sediment is stored behind the dams and previous studies suggest that the sediments may contain potential contaminants. The collection of additional data is critical to making an informed and responsible decision for or against dam removal.

5.2 Decisions or outcomes

Combined, the sediment chemistry, elutriate chemistry, and toxicity studies performed on the Klamath River reservoir and estuary samples will provide a weight-of-evidence to help the Secretary of the Interior determine whether to approve or deny dam removal.

5.3 Sediment and elutriate quality criteria

Sediment quality and toxicity results will be evaluated by comparing analytical results with appropriate bulk sediment screening levels and bioaccumulation triggers. At the least, quality standards will be drawn from the 2009 and 2010 (interim) Sediment Evaluation Framework for the Pacific Northwest (SEF), the United States Army Corps of Engineers (USACE) Inland Testing Manual, the 2008 USACE Dredge Materials Evaluation and Disposal Procedures User's Manual (DMMP), and the 2008 National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (Squirts).

Elutriate data will be evaluated through comparison with regional, state and federal standards for water quality. *A Compilation of Water Quality Goals* (Marshack, 2008) will provide the primary guidance document for elutriate evaluation.

As other applicable sediment and elutriate quality criteria are identified, they will be incorporated into the sediment evaluation.

5.4 Background

Geographic Setting

The Klamath River originates at Upper Klamath Lake, Oregon and flows about 250 miles before emptying into the Pacific Ocean near the town of Klamath, California (Figure 1). The Lower Klamath basin is relatively undeveloped and the lower reaches of the Klamath River remain undammed. In contrast, the Upper Klamath Basin supports mining, agriculture, and other industry and the upper Klamath River is dammed in numerous locations. The most downstream of these dams, JC Boyle, Copco 1, Copco 2, and Iron Gate dams (Figure 2), are privately owned by the PacifiCorp Utility Company, and are the subject of this study.

Copco 1 and Copco 2 dams are located in northern California, about 25 miles northeast of Yreka. Construction of Copco 1 was completed in 1918; Copco 2, which forms a small stilling basin below Copco 1, was finished in 1925. In 1958, JC Boyle was built in southern Oregon, about 15 miles southwest of Klamath Falls and 30 miles upstream from Copco 1. In 1962, Iron Gate dam was built about 20 miles northeast of Yreka, California, approximately six miles downstream from Copco 2.

Sediment Volume Estimates

Altogether, the four PacifiCorp dams contain between 14 and 21 million cubic yards of accumulated sediment (G&G Associates, 2003; GEC, 2006). Estimates agree that Copco 1 and Iron Gate dams retain most of the sediment (Table 4). Note that refined sediment volume estimates will be published in the geotechnical investigation associated with this study.

Table 4: Estimated Volumes of Impounded Sediment

Reservoir Name	Dam Completion	Estimated Volume of Impounded Sediment (10^6 cubic yards)	
		G&G Assoc., 2003	GEC, 2006
JC Boyle	1958	0.03	1
Copco 1	1918	9.3	11
Copco 2	1925	-	<0.2
Iron Gate	1962	4.7	9
Total Volume		14	21

Previous Investigations

In 2006, a reconnaissance-level contaminant study and associated geologic drilling program were carried out by Shannon and Wilson Incorporated (SWI) under subcontract to Gathard Engineering Consulting (GEC). The study included a literature review and field exploration to identify the existence of historic or current contaminant sources that may have affected PacifiCorp reservoir sediments (SWI, 2006a). Potential contaminant sources were verified by the phase-one study. Soon after, GEC and SWI commenced a geotechnical and contaminant investigation of the sediment impounded behind three of the four PacifiCorp reservoirs: JC Boyle, Copco 1 and Iron Gate (SWI, 2006b).

The SWI contaminant study evaluated sediment from 26 total borings: five at JC Boyle, twelve at Copco 1 and nine at Iron Gate. Sediment from each location was homogenized, composited and submitted as a separate sample. Sediment cores were analyzed for a broad range of physical and chemical constituents (Table 5); data quality and results for conventional analytes were not assessed.

Table 5: Summary of Constituents Analyzed

All Samples	One Sample Per Reservoir
▪ Conventional analytes including pH and calcium carbonate ▪ Acid volatile sulfides ▪ Metals ▪ Organochlorine pesticides (including DDT, DDD and DDE) ▪ Chlorinated-acid herbicides ▪ PCB aroclors ▪ Volatile organic compounds (VOC) and semi-volatile organic compounds (SVOC)	▪ Dioxins and furans ▪ Nitrogen and phosphorus ▪ Organophosphorus pesticides ▪ Cyanide

(after SWI, 2006)

In the SWI study, many analytes were not detected (herbicides, PCB aroclors) and detected analytes were most commonly present at concentrations below available Puget Sound Dredge Disposal Analysis (PSDDA) screening levels (DDE, As, Cr, Cu, Ni, Zn, Hg, several SVOCs and VOCs).

In one Copco 1 sample, Ethylbenzene and Total Xylenes were detected above PSDDA screening levels.

Dioxin and furans were detected in each of the three samples analyzed. Individual dioxin/furans vary in toxicity, so individual concentrations are weighted (multiplied by equivalency factors) to determine their toxic equivalents (TEQs). Total TEQs were determined for the JC Boyle, Copco and Iron Gate samples with results of 4.1 pg/g, 4.8 pg/g and 2.5 pg/g, respectively.

Total cyanide (CN) was detected in two of the three samples analyzed (1.41 µg/kg and 2.01 µg/kg). These samples were reanalyzed to determine concentrations of bioavailable (weak-acid dissociable, or WAD) cyanide. WAD cyanide was not detected; however, the samples were analyzed outside of maximum hold times.

A6. Project/Task Description

6.1 Project overview

In support of a Department of the Interior Secretarial Determination, Reclamation will conduct an investigation of the physical and chemical characteristics of sediment impounded behind four dams on the Klamath River (Figure 1). This investigation will be composed of two independent studies: a geotechnical/geologic investigation, and an investigation of sediment contaminant-potential. Data collected in the geotechnical investigation will support future sediment-erodibility and transport studies; contaminant data will be used to help evaluate the potential for exposing and/or transporting contaminated sediment should the Klamath River dams be removed. These studies will help determine the feasibility of dam removal as an alternative to preserving the dams and upgrading them to provide fish-passage.

Contaminant and geotechnical studies are designed in coordination to allow sample collection for both studies to co-occur. Contaminant and geotechnical study designs, methods and results will be reported separately. The geologic and geotechnical studies will be undertaken by Reclamation's Mid-Pacific Region, Division of Design and Construction, Geology Branch (MP-230). Contaminant studies will be conducted by Reclamation's Mid-Pacific Region, Division of Environmental Affairs, Environmental Monitoring Branch (MP-157).

6.2 Primary objectives

The primary goal of this contaminant study is to provide a quantitative estimate of the magnitude and distribution of potential toxicity contained within sediment currently trapped behind the PacifiCorp dams. Data collected should allow insight into whether potential differences in sediment contaminant character may be associated with differences in sediment stratigraphy, depth, or location within (on-thalweg) or outside of (off-thalweg) the active reservoir channel. This main study question will be pursued through the following sub-goals:

- Collect sediment samples from the JC Boyle, Copco 1, Copco 2 and Iron Gate reservoirs from two location types:
    1. Sediment located within the active reservoir channel (along the historic Klamath River thalweg)
    2. Sediment located outside of the active reservoir channel (off the historic Klamath River thalweg)
- Collect samples composited from distinct stratigraphic horizons, or if on-site geologists determine that the sediment is massive (homogenous), composite sediment over five foot depth intervals
- Collect samples that can provide insight into levels of background contamination that may currently reside in the Klamath River Estuary. Collect sediment from depositional areas within two location types:
    1. Sediment located in a marine dominated estuary location
    2. Sediment located in a river dominated estuary location
- Quantify concentrations of chemical, physical and biological "contaminants of concern" through laboratory analysis of target constituents identified in Section A7
- Conduct sediment toxicity testing with target species identified in Section A7
- Use comparable field and analytical techniques to collect, handle, and analyze samples without introducing or eliminating contaminants
- Obtain analytical data that meet quality objectives and quality assurance criteria
- Present analytical results in a format that promotes data usability and analysis

6.3 Schedule of Major Project Tasks

Drilling investigations are planned to begin late September 2009, starting at JC Boyle Reservoir, Oregon and continuing downstream (Copco 1 and then Iron Gate reservoirs, California) until all scheduled borings have been completed, or until weather conditions become unsafe or impractical for drilling. If one to two borings can be completed each day, drilling collections should be complete by December 1, 2009.

Following conclusion of drilling investigations, sediment will be collected by hand-auger or dredge at Copco 2 and the Klamath River Estuary. These sampling events are anticipated to take one to two days and will most likely occur in December 2009 or January 2010.

Laboratory analyses will be initiated as samples are collected, and analytical reports will be reviewed for quality assurance as they are received by the QAT. Following QA review, approved data will be entered into a relational database and accuracy of data entries verified. Once data entry and review is complete, analytical results and quality assurance findings will be summarized and reported. Major project tasks and a tentative schedule for task completion are indicated below (Table 6). This schedule is not constrained by funding or regulatory deadlines.

Table 6: Anticipated Schedule of Major Project Tasks

Task Name	Task Description	Start Date	End Date
Project Development Meeting(s)	Identify program goals and sub-goals based upon input from technical advisors and stakeholders. Develop a sampling plan that will meet program goals. Identify contaminants of concern and data quality objectives (DQOs). Identify responsible parties. Verify budget allocations.	7/1/2009	Sampling Initiation Date
Identify and Retain Contract Analytical Labs	Based on DQOs, identify and retain analytical laboratories that can meet data quality requirements.	7/1/2009	Sampling Initiation Date
Preliminary QAPP Development	Develop QAPP based upon input from internal review, technical advisors, and stakeholders; accept preliminary QAPP prior to initiating field investigations	8/1/2009	10/1/2009
Drilling Investigation	Collect sediment drill core from JC Boyle, Copco 1 and Iron Gate reservoirs. Measure water column physicals. Follow sampling design and methods outlined in Sections B1 and B2.	10/1/2009	11/30/2009
Copco 2 Sample Collection	Dredge or hand auger sediment from Copco 2 reservoir. Follow sampling design and methods outlined in Sections B1 and B2.	12/1/2009	12/1/2009
Estuary Sample Collection	Dredge or hand auger sediment from the Klamath River Estuary. Follow sampling design and methods outlined in Sections B1 and B2.	1/15/2010	1/16/2010
Water Collection for Elutriation	As soon as sediment sampling has been completed on a reservoir, or at the Estuary, collect water for sediment from the appropriate site. Co-submit water and associated sediment for elutriate chemical testing.	see left for timeline	see left for timeline
Laboratory Analyses	Analyze samples for analytes identified in Section A7, Table 14 using approved analytical methods identified in the same section.	12/2/2009	4/1/2010
QA Review	Review data as outlined in Section B5.	1/15/2010	5/15/2010
Data Entry	Following guidelines indicated in Section B10, enter QA-approved data into the USBR database.	1/31/2010	6/1/2010
Data Validation	Following guidelines indicated in Section B10, verify accuracy of data entries.	2/7/2010	6/7/2010
QAPP Finalization	Finalize QAPP based upon input from internal review, technical advisors, and stakeholders	10/1/2009	1/1/2010
Data Summary Report	Compile data into summary tables. Release summary data to interested parties.	6/7/2010	8/1/2010
QA Summary Report	Summarize QA findings and qualifications. Release summary report to interested parties.	5/15/2010	8/1/2010

Table 6: Anticipated Schedule of Major Project Tasks

Task Name	Task Description	Start Date	End Date
Data Assessment	Assess data with respect to applicable sediment and elutriate screening values.	8/1/2010	10/1/2010

6.4 Resource and time constraints

Reservoir investigations need to be completed before winter weather conditions become unsafe or impractical for drilling. During the winter, JC Boyle Reservoir can freeze and roads to all of the reservoirs can become snowy or icy.

Sampling at the Klamath River Estuary should not occur during storm tides or hazardous weather.

The final investigation report should be completed as soon as possible; at latest, it should be ready for inclusion in the Secretarial Decision Overview Report, which is currently scheduled for November 2010.

6.5 Access agreements and historic preservation

Permission to access reservoir sites was obtained through an access agreement with the PacifiCorp utility company under the Geologic Drilling Program Scope of Work (SOW) (Mongano, 2009). Permission to access Klamath River Estuary sites was obtained through an agreement with the Klamath River Yurok Tribes.

Section 106 Cultural Resources compliance documents were submitted to, and approved by, the Office of Historic Preservation (M.W. Donaldson, 2009) and the State Historic Preservation Office (SHPO) of Oregon (M. Diederich, 2009). Cultural resource "exclusion zones" were identified and sampling locations adjusted to remain outside of sensitive areas.

6.6 Field approach - summary

This section summarizes the field approach to addressing the project objectives identified in Section A6.2. Details of the experimental design and sampling methods are described in Sections B1 and B2.

Thirty five reservoir sampling locations were chosen for this study in order to achieve a robust data set (Table 7). Samples collected within the active reservoir channel will be analyzed separately from those collected outside of the active channel. Sediment will be composited according to three strategies as explained in Section B1.2. Each composite type will be submitted or the analyses indicated in Tables 8 and 9. Tables 10 and 11 indicate analyses and sampling requirements for each sediment composite type. Table 12 indicates analyses and sampling requirements for water to be used in sample elutriation. Table 13 specifies sampling equipment to be used at each sample location.

In addition to collecting reservoir sediment, two Klamath River Estuary samples will be analyzed in order to give a coarse estimate of current (background) Klamath Estuary contaminant concentrations. Dam removal will likely release sediment downstream and this material may ultimately discharge to the Pacific through the Klamath River Estuary. Estuary sediment analyses will provide a preliminary indication of background contaminant levels at the mouth of the Klamath River. Note that these estuary grab samples are not meant to provide a complete or representative characterization of contaminant concentrations within Klamath River or Klamath Estuary.

Sediment and elutriate samples will be analyzed for potential chemical and physical contaminants, toxicity studies will also be conducted. Geotechnical sampling and analysis, including physical properties and grain size, are covered by a separate Sampling and Analysis Plan (Mongano, 2009).

Table 7: Numbers and Locations of Sediment Sampling Sites

Site	Total Sampling Locations	On-Thalweg Locations	Off-Thalweg Locations
JC Boyle	8	4	4
Copco 1	12	8	4
Copco 2	3	3	-
Iron Gate	12	8	4
Klamath Estuary	2	2	-
Total reservoir samples	35	23	12
Total estuary samples	2	2	-

Table 8: Sample Collection Overview

Composite Strategy	Analyte Suite[1]	Main Reservoirs[2]	Copco 2	Upper Estuary	Lower Estuary
Interval: Sediment cores composited over stratigraphic horizons, or depth intervals ≤ 5 ft	Comprehensive	All			
Whole Core: Sediment from an individual core composited in its entirety	Special Concern	Two per reservoir: one proximal to the dam, one distal			
On-Thalweg Super Composite: Super-composite of all on-thalweg cores collected from one reservoir	Elutriate Chemistry Toxicity	One per reservoir			
Off-Thalweg Super Composite: Super-composite of all off-thalweg cores collected from one reservoir	Elutriate Chemistry Toxicity	One per reservoir			
Area Composite: Super-composite of all cored or dredged material	Comprehensive Special Concern Elutriate Chemistry Toxicity (upper Estuary only)		One	One	One

[1] Table 9 summarizes groups of constituents to be analyzed for each analyte suite. For a complete analyte list, see Table 14.

[2] JC Boyle Reservoir, Copco 1 Reservoir and Iron Gate Reservoir

Table 9: Constituent Groupings within Analyte Suites shown in Table 8

Comprehensive (Sediment)	Elutriate Chemistry
Ammonia Chlorinated Pesticides Diesel Range Organics Dissolved organic carbon (DOC) Metals Nitrogen Phenols Phosphate Phthalates pH and electrical conductivity (EC) Polyaromatic hydrocarbons (PAHs) Polychlorinated biphenyl (PCB) Aroclors Residual Range Organics Semi-volatile organic compounds Sulfides Total organic carbon (TOC) Total solids Volatile organic compounds (VOCs) Volatile solids Weak-acid dissociable (WAD) cyanide	Comprehensive: Ammonia Biological oxygen demand (BOD) 5-day Chloride Chlorinated Pesticides Dissolved organic carbon (DOC) Dissolved organic carbon (DOC) Metals Nitrogen Particulate organic carbon (POC) Phenols Phosphate Phthalates Physicals (EC, pH) Polyaromatic hydrocarbons (PAHs) Polychlorinated biphenyl (PCB) Aroclors Semi-volatile organic compounds Sulfides Total dissolved solids (TDS) Total organic carbon (TOC) Weak-acid dissociable (WAD) cyanide Special Concerns: Acid Volatile Sulfides Carbamates Organophosphorus Compounds PCB Congeners
Special Concern (sediment)	**Toxicity (sediment and elutriate)**
Acid Volatile Sulfides Carbamates Dioxins/Furans Organophosphorus Compounds PCB Congeners Polybrominated diphenyl ethers Pyrethroids	Elutriate bioassay, 4-day, *Onchorhynchus mykiss* Sediment bioassay, 10-day, *Chironomus dilutus* Sediment bioassay, 10-day, *Hyalella azteca* Sediment bioaccumulation study, 28-day, *Corbicula fluminea* Sediment bioaccumulation study, 28-day, *Lumbriculus variegatus*

Table 10: Sediment Collection Overview - Interval and Whole Core Composite Samples

Composite Type	Grouped Analytes	Lab	Volume (oz)[1]	Volume (ml)	Preservation	Field Hold [2]
Interval	Volatile Organic Compounds	ALS	4	125	no head space	10 days
	PAH, Phthalates, Phenols, Chlorinated Pesticides, PCB Aroclors	ALS	8	250	-	2 wks
	Total % Solids, Total Volatile Solids (TVS)	Basic	8 (4)	250	-	7 days
	EC, pH	Basic	8 (4)	250	-	ASAP
	WAD Cyanide, Ammonia, Total N, Total P	Basic	8 (4)	250	-	ASAP
	Total Sulfide	Basic	4	125	Zn acetate, no headspace	ASAP
	Total Organic Carbon	USGS	4	125	-	indefinite
	Total Metals	Test Am.	4 (1)	125	-	6 months
total sediment needed:		**8 jars**	**20**	**1500**		
Whole Core	Dioxins, Furans	ALS	8	250	-	30 days
	PCB Congeners	ALS	8	250	-	2 wks
	Acid Volatile Sulfides	Basic	4	125	-	14 days
	Organophosphorus Compounds	Test Am.	8 (5)	250	-	14 days
	Carbamates	ALS/Axys	8	250	frozen	7 days
	PBDEs	ALS	8	250	-	1 year
	Pyrethroids	Caltest	8 (4)	250	frozen	7 days
total sediment needed:		**7 jars**	**36**	**1625**		

[1] Parentheses indicate minimum volumes

[2] Field hold indicates the maximum time samples can be held prior to elutriation, extraction or analysis

Table 11: Sediment Collection Overview - Super Composite and Area Composite Samples

Composite Type	Sample ID	Analyte Suite	Lab	Volume (oz)[1]	Volume (ml)	Field Hold [2]
On-Thalweg Super Composite (Boyle, Copco 1, Iron Gate)	CDH-E-JBT/CPT/IGT	Elutriate Chemistry	Basic	4	1 four-liter glass	7 days
	CDH-S-JBT/CPT/IGT	Toxicity	Block	29	8 gallons (plastic buckets are fine)	8 wks
Non-Thalweg Super Composite (Boyle, Copco 1, Iron Gate)	CDH-E-JBN/CPN/IGN	Elutriate Chemistry	Basic	4	1 four-liter glass	2 wks
	CDH-S-JBN/CPN/IGN	Toxicity	Block	29	8 gallons (plastic buckets are fine)	8 wks
Copco 2 Area Composite	CDH-E-CP2	Elutriate Chemistry	Basic	4	1 four-liter glass	2 wks
	CDH-S-CP2	Toxicity	Block	29	8 gallons (plastic buckets are fine)	8 wks
		Interval	As indicated in Table 10			
		Whole Core	As indicated in Table 10			
Upper Estuary Area Composite	CHA-E-002	Elutriate Chemistry	Basic	4	1 four-liter glass	2 wks
	CHA-S-002	Toxicity	Block	29	8 gallons (plastic buckets are fine)	8 wks
		Interval	As indicated in Table 10			
		Whole Core	As indicated in Table 10			
Lower Estuary Area Composite	CHA-S-002	Interval	As indicated in Table 10			
		Whole Core	As indicated in Table 10			

[1] Parentheses indicate minimum volumes

[2] Field hold indicates the maximum time samples can be held prior to elutriation, extraction or analysis

Table 12: Water Collection for Use with Elutriate

Sample ID	Analyses Grouped by Sample Container	Lab	Required Volume (L)	Containers Needed	Extraction Hold	Analysis Hold
JC Boyle	Elutriate Chemistry	Basic	40	10 four-liter glass	3 days	Analyze ASAP
	Elutriate Toxicity	Block	210	12 five-gallon cubitainers	3 days	Analyze ASAP
Copco 1	Elutriate Chemistry	Basic	40	10 four-liter glass	3 days	Analyze ASAP
	Elutriate Toxicity	Block	210	12 five-gallon cubitainers	3 days	Analyze ASAP
Iron Gate	Elutriate Chemistry	Basic	40	10 four-liter glass	3 days	Analyze ASAP
	Elutriate Toxicity	Block	210	12 five-gallon cubitainers	3 days	Analyze ASAP
Upper Estuary	Elutriate Chemistry	Basic	40	10 four-liter glass	3 days	Analyze ASAP
	Elutriate Toxicity	Block	210	12 five-gallon cubitainers	3 days	Analyze ASAP

Water collections: elutriate chemistry collect in glass; for toxicity studies plastic is okay
Short hold - send from field.

Table 13: Sample Collection Equipment

Site	Proposed Collection Method	Collection Method Achieved[1]	Analyte Suite/Composite Strategy
JC Boyle	Barge supported flight auger	Barge supported flight auger	Comprehensive/Interval Special Concern/Whole Core
		Barge supported gravity sampler	Toxicity/Super-composite Elutriate Chemistry/Super-composite
		Manually pushed gravity sampler	Toxicity/Super-composite Elutriate Chemistry/Super-composite
Copco 1	Barge supported flight auger	Barge supported direct push	Comprehensive/Interval Special Concern/Whole Core Toxicity/Super-composite Elutriate Chemistry/Super-composite
		Barge supported vibracore drill	Comprehensive/Interval Special Concern/Whole Core Toxicity/Super-composite Elutriate Chemistry/Super-composite
Iron Gate	Barge supported flight auger	Barge supported gravity sampler	Comprehensive/Interval Special Concern/Whole Core Toxicity/Super-composite Elutriate Chemistry/Super-composite
Copco 2	Clam shell (Ponar) gravity sampler	Clam shell gravity sampler; Manual push gravity sampler	Comprehensive/Area Composite Special Concern/Area Composite Elutriate Chemistry/Area Composite
Klamath Estuary	Clam shell gravity sampler	Manual push gravity sampler	Comprehensive/Area Composite Special Concern/Area Composite
		Manual push gravity sampler; Shovel	Toxicity/Area Composite Elutriate Chemistry/Area Composite

[1] Acheived sampling methods are included in this updated QAPP they varied significantly from the original plan.

A7. Quality Objectives and Criteria for Laboratory Analytical Data

This section summarizes field and analytical approaches to obtaining analytical results that meet data quality objectives and quality assurance criteria. Measurement performance criteria for analytical data are stated in terms of defining and achieving uncertainty levels that will not compromise study objectives. Measurement performance criteria and associated data quality indicators are detailed below.

7.1 Method Sensitivity

In order to ensure accuracy of low level results, for each analyte, analytical methods were selected to achieve a reporting limit 3-5 times lower than the lowest applicable sediment screening level or water quality criteria. Analytes, analytical methods, and their respective reporting limits are shown in Table 14. Note that stated reporting limits may not be achieved due to method limitations, matrix affects, or required sample dilutions.

Table 14: Analytes and Methods	**Sediment (µg/Kg)**			**Elutriate (µg/L)**		
Analyte	**Screening Level**	**RL**	**Analytical Method**	**Criteria**	**RL**	**Analytical Method**
Conventionals						
grain size analysis	--	--	ASTM D 422	--	--	--
pH (units)	--	0.01	EPA 9045	6.5-8.5	0.01	SM4500H+B
Specific Conductance (µS/cm)	--	10	SM2510B	700	10	SM2510B
BOD (5 day)				--	300	SM5210
Ammonia	--	0.25	EPA 350.1	1500	50	EPA 350.1
Chloride				106000	200	EPA 300.0
WAD cyanide	--	500	SM 4500 CN-I	--	5	SM 4500 CN-I
Total Nitrogen	--	25	EPA 351.2	10	200	EPA 351.2
Total Phosphorus	--	50	SM 4500 P Mod	--	50	SM4500P-BE
Total Sulfide	--	0.2	SM 9030B/4500S2D	0.029	20	SM 9030B/4500S2D
AVS	--	500	E821/R-91-100			
TDS				450000	6000	SM2540C
Total Solids	--	0.06	SM 2450 B			
TVS	--	10	SM 2540 G			
TOC	--	0.4	N011, T10, C011, T08	--	300	SM5310C
DOC				--	300	SM5310C
POC				--	--	SM5310C
Total Metals						
Aluminum	--	5	EPA 6020/6010B	87	5	EPA 200.8
Antimony	150	2	EPA 6010B	5.6	0.5	EPA 200.8
Arsenic	57	0.2	EPA 6020	10	0.2	EPA 200.8
Cadmium	5.1	0.1	EPA 6020	varies	0.1	EPA 200.8
Calcium	--	50	EPA 6010B	--	1000	EPA 200.7
Chromium	260	0.2	EPA 6020	50	0.2	EPA 200.8
Copper	390	0.2	EPA 6020	varies	0.2	EPA 200.8
Lead	450	0.1	EPA 6020	varies	0.1	EPA 200.8

Table 14: Analytes and Methods	**Sediment (µg/Kg)**			**Elutriate (µg/L)**		
Analyte	**Screening Level**	**RL**	**Analytical Method**	**Criteria**	**RL**	**Analytical Method**
Magnesium	--	50	EPA 6010B	--	1000	EPA 200.7
Mercury	0.41	0.04	EPA 7471A	0.77	0.04	EPA1631E
Nickel	--	0.2	EPA 6020	varies	0.2	EPA 200.8
Selenium	3000	2000	EPA 6020	--	--	--
Silver	6.1	0.1	EPA 6010B	varies	0.1	EPA 200.8
Zinc	410	1	EPA 6020	varies	1	EPA 200.8
PAH compounds						
Acenaphthylene	560	5.1	EPA 8270D	--	0.1 ug/L	EPA 525.2
Acenaphthene	500	5.1	EPA 8270D	670	0.1	EPA 525.2
Anthracene	960	5.1	EPA 8270D	8300	0.02	EPA 525.2/EPA 8270D
Benzo(a)anthracene	1,300	5.1	EPA 8270D	--	0.05	EPA 525.2
Benzo(a)pyrene	1,600	5.1	EPA 8270D	0.0044	0.02	EPA 525.2
Benzo(b,k)fluoranthene	3,200	5.1	EPA 8270D	--	0.02	EPA 525.2
Benzo(g,h,i)perylene	670	5.1	EPA 8270D	--	0.05	EPA 525.2
Chrysene	1,400	5.1	EPA 8270D	0.0044	0.02	EPA 525.2
Dibenz(a,h)anthracene	230	5.1	EPA 8270D	0.0044	0.05	EPA 525.2
Fluoranthene	1,700	5.1	EPA 8270D	130	0.1	EPA 525.2
Fluorene	540	5.1	EPA 8270D	1100	0.05	EPA 525.2
Indeno(1,2,3-cd)pyrene	600	20	EPA 8270D	0.0044	0.05	EPA 525.2
Naphthalene	2,100	20	EPA 8270D/8260C	17	0.1	EPA 525.2
Phenanthrene	1,500	5.1	EPA 8270D	--	0.04	EPA 525.2
Pyrene	2,600	5.1	EPA 8270D	830	0.04	EPA 525.2
Total LPAH	5,200	170	EPA 8270D	960	0.05	EPA 525.2
Total HPAH	12,000	170	EPA 8270D	960	0.05	EPA 525.2
Pthalates						
Dimethyl phthalate	71	167	EPA 8270D	27000	5000	EPA 525.2
Diethyl phthalate	200	167	EPA 8270D	17000	5000	EPA 525.2

Table 14: Analytes and Methods	**Sediment (µg/Kg)**			**Elutriate (µg/L)**		
Analyte	**Screening Level**	**RL**	**Analytical Method**	**Criteria**	**RL**	**Analytical Method**
Di-n-butyl phthalate	1,400	167	EPA 8270D	2000	5000	EPA 525.2
Butyl benzyl phthalate	63	167	EPA 8270D	--	5000	EPA 525.2
Bis(2-ethylhexyl)phthalate	1,300	167	EPA 8270D	--	5000	EPA 525.2
D-n-octyl phthalate	6,200	167	EPA 8270D	--	5000	EPA 525.2
Phenols						
Phenol	420	167	EPA 8270D	4200	5000	EPA 8270D
2 Methylphenol	63	167	EPA 8270D	--	5000	EPA 8270D
4 Methylphenol	670	167	EPA 8270D	--	5000	EPA 8270D
2,4-Dimethylphenol	29	167	EPA 8270D	100	5000	EPA 8270D
Pentachlorophenol	400	3.33	EPA 8151A	0.1	20000	EPA 8151A
Chlorinated Pesticides						
2,4'-DDD	--	0.667	ENV by GC-MS Specialty	--	0.02	EPA 8081
4,4'-DDD	9	0.667	EPA 8081A	0.00083	0.02	EPA 8081/EPA 525.2
2,4'-DDE	--	0.667	ENV by GC-MS Specialty	--	0.01	EPA 8081
4,4'-DDE	16	0.667	EPA 8081A	0.00059	0.01	EPA 8081/EPA 525.2
2,4'-DDT	--	0.667	ENV by GC-MS Specialty	--	0.01	EPA 8081
4,4'-DDT	34	0.667	EPA 8081A	0.00059	0.01	EPA 8081/EPA 525.2
Aldrin	--	0.667	EPA 8081A	0.00013	0.02	EPA 505
alpha Chlordane	--	0.667	EPA 8081A	--	0.02	EPA 525.2
technical Chlordane	--	3.33	EPA 8081A	--	0.1	EPA 8081
alpha-BHC	--	0.667	EPA 8081A	0.0039	0.02	EPA 8081/EPA 525.2
beta-BHC	--	0.667	EPA 8081A	0.025	0.02	EPA 8081
delta-BHC	--	0.667	EPA 8081A	--	0.02	EPA 8081
Dieldrin	--	0.667	EPA 8081A	0.002	0.02	EPA 505

Table 14: Analytes and Methods

Analyte	Sediment (µg/Kg) Screening Level	Sediment (µg/Kg) RL	Sediment (µg/Kg) Analytical Method	Elutriate (µg/L) Criteria	Elutriate (µg/L) RL	Elutriate (µg/L) Analytical Method
Endosulfan I	--	0.667	EPA 8081A	0.056	0.02	EPA 8081/EPA 525.2
Endosulfan II	--	0.667	EPA 8081A	0.056	0.02	EPA 8081/EPA 525.2
Endosulfan Sulfate	--	0.667	EPA 8081A	0.056	0.02	EPA EPA 525.2
Endrin	--	0.667	EPA 8081A	0.036	0.02	EPA 505
Endrin Aldehyde	--	0.667	EPA 8081A	0.29	0.02	EPA 8081/EPA 525.2
Endrin Ketone	--	0.667	EPA 8081A	--	0.02	EPA 8081
gamma-BHC (lindane)	--	0.667	EPA 8081A	0.2	0.02	EPA 8081/EPA 505
gamma chlordane	--	0.667	EPA 8081A	--	0.02	EPA 8081/EPA 525.2
Heptachlor	--	0.667	EPA 8081A	0.0038	0.02	EPA 505
Heptachlor epoxide	--	0.667	EPA 8081A	0.0038	0.02	EPA 505/EPA525.2
Methoxychlor	--	0.667	EPA 8081A	30	0.02	EPA 505
Toxaphene	--	33.3	EPA 8081A	0.0002	1.0	EPA 505
Organophosphorus Compounds						
Azinphosmethyl	--	33	EPA 8141A	0.01	0.95	EPA 8141A
Bolstar	--	33	EPA 8141A	--	0.95	EPA 8141A
Chlorpyrifos	--	33	EPA 8141A	0.014	0.95	EPA 525.2
Coumaphos	--	33	EPA 8141A	--	0.95	EPA 8141A
Demeton: o,s, total	--	39	EPA 8141A	0.1	0.95	EPA 8141A
Diazinon	--	33	EPA 8141A	0.05	0.95	EPA 525.2
Dichlorvos	--	33	EPA 8141A	--	0.95	EPA 525.2
Dimethoate	--	--	EPA 8141A	--	0.95	EPA 525.2
Disulfoton	--	48	EPA 8141A	0.05	0.95	EPA 8141A
EPN	--	--	EPA 8141A	--	0.95	EPA 8141A
Ethoprop	--	33	EPA 8141A	--	0.95	EPA 8141A
Famphur	--	--	EPA 8141A	--	0.95	EPA 8141A

Table 14: Analytes and Methods

	Sediment (µg/Kg)			Elutriate (µg/L)		
Analyte	**Screening Level**	**RL**	**Analytical Method**	**Criteria**	**RL**	**Analytical Method**
Fensulfothion	--	33	EPA 8141A	--	0.95	EPA 8141A
Fenthion	--	33	EPA 8141A	--	0.95	EPA 8141A
Malathion	--	13	EPA 8141A	0.1	0.95	EPA 525.2
Methyl Parathion	--	--	EPA 8141A	--	0.95	EPA 8141A
Mevinphos	--	33	EPA 8141A	--	0.95	EPA 8141A
Parathion	--	33	EPA 8141A	--	0.95	EPA 525.2
Phorate	--	33	EPA 8141A	--	0.95	EPA 8141A
Ronnel	--	16	EPA 8141A	--	0.95	EPA 8141A
Stirophos	--	13	EPA 8141A	--	0.95	EPA 8141A
Sulfotepp	--	--	EPA 8141A	--	0.95	EPA 8141A
Thionazin	--	--	EPA 8141A	--	0.95	EPA 8141A
Tokuthion	--	13	EPA 8141A	--	0.95	EPA 8141A
Trichloronate	--	13	EPA 8141A	--	0.95	EPA 8141A
0,0,0-Triethylephosphorothioate	--	--	EPA 8141A	--	0.95	EPA 8141A
PCBs						
Aroclor PCB-1016	--	33.5	EPA 8082	--	0.08	EPA 505
Aroclor PCB-1221	--	67.1	EPA 8082	--	0.1	EPA 505
Aroclor PCB-1232	--	33.5	EPA 8082	--	0.1	EPA 505
Aroclor PCB-1242	--	33.5	EPA 8082	--	0.1	EPA 505
Aroclor PCB-1248	--	33.5	EPA 8082	--	0.1	EPA 505
Aroclor PCB-1254	--	33.5	EPA 8082	--	0.1	EPA 505
Aroclor PCB-1260	--	33.5	EPA 8082	--	0.1	EPA 505
Total PCBs	--	33.5	EPA 8082	--	0.08	EPA 505
PCB congeners (209 compounds)	--	--	EPA 1668A/1668B	--	--	EPA 1668A
VOCs						
Trichloroethylene (TCE)	--	5	EPA 8260C			
Tetrachloroethene (PCE)	--	5	EPA 8260C			
Ethylbenzene	--	5	EPA 8260C			

Table 14: Analytes and Methods	**Sediment (µg/Kg)**			**Elutriate (µg/L)**		
Analyte	**Screening Level**	**RL**	**Analytical Method**	**Criteria**	**RL**	**Analytical Method**
m,p-xylene	--	10	EPA 8260C			
o-xylene	--	5	EPA 8260C			
Benzene	--	5	EPA 8260C			
MTBE	--	5	EPA 8260C			
1,1-Dichloroethene	--	5	EPA 8260C			
Vinyl chloride	--	5	EPA 8260C			
Toluene	--	5	EPA 8260C			
Trans-1,2-dichlorethylene	--	5	EPA 8260C			
1,1,1-Trichloroethane (1,1,1-TCA)	--	5	EPA 8260C			
Chloroform	--	5	EPA 8260C			
Diesel Range Organics	--	5	EPA 8015B DRO			
Residual Range Organics	--	5	EPA 8015B RRO			
Dioxins and Furans						
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD)	--	0.001	EPA 8290A			
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin (PeCDD)	--	0.001	EPA 8290A			
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin (HxCDD)	--	0.001	EPA 8290A			
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin (HxCDD)	--	0.001	EPA 8290A			
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin (HxCDD)	--	0.001	EPA 8290A			
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin (HpCDD)	--	0.001	EPA 8290A			
1,2,3,4,5,6,7,8-Octachlorodibenzo-*p*-dioxin (OCDD)	--	0.001	EPA 8290A			
2,3,7,8-Tetrachlorodibenzofuran (TCDF)	--	0.001	EPA 8290A			
1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	--	0.001	EPA 8290A			

Table 14: Analytes and Methods	**Sediment (µg/Kg)**			**Elutriate (µg/L)**		
Analyte	**Screening Level**	**RL**	**Analytical Method**	**Criteria**	**RL**	**Analytical Method**
2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	--	0.001	EPA 8290A			
1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	--	0.001	EPA 8290A			
1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	--	0.001	EPA 8290A			
1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	--	0.001	EPA 8290A			
2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	--	0.001	EPA 8290A			
1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	--	0.001	EPA 8290A			
1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	--	0.001	EPA 8290A			
1,2,3,4,5,6,7,8-Octachlorodibenzofuran (OCDF)	--	0.001	EPA 8290A			
Total Tetrachlorodibenzo-*p*-dioxin (TCDD)	--	0.001	EPA 8290A			
Total Pentachlorodibenzo-*p*-dioxin (PeCDD)	--	0.001	EPA 8290A			
Total Hexachlorodibenzo-*p*-dioxin (HxCDD)	--	0.001	EPA 8290A			
Total Heptachlorodibenzo-*p*-dioxin (HpCDD)	--	0.001	EPA 8290A			
Total Tetrachlorodibenzofuran (TCDF)	--	0.001	EPA 8290A			
Total Pentachlorodibenzofuran (PeCDF)	--	0.001	EPA 8290A			
Total Hexachlorodibenzofuran (HxCDF)	--	0.001	EPA 8290A			
Total Heptachlorodibenzofuran (HpCDF)	--	0.001	EPA 8290A			
Carbamates						
3-Hydroxycarbofuran	--	0.1	EPA 8318/ EPA8321/ MLA-047	--	0.5	EPA 531.2
Aldicarb	--	0.1	EPA 8318/ EPA8321/ MLA-047	3	0.5	EPA 531.2

Table 14: Analytes and Methods

Analyte	Sediment (µg/Kg) Screening Level	Sediment (µg/Kg) RL	Sediment (µg/Kg) Analytical Method	Elutriate (µg/L) Criteria	Elutriate (µg/L) RL	Elutriate (µg/L) Analytical Method
Aldicarb sulfone	--	0.2	EPA 8318/ EPA8321/ MLA-047	--	0.5	EPA 531.2
Aldicarb sulfoxide	--	0.2	EPA 8318/ EPA8321/ MLA-047	--	0.5	EPA 531.2
Baygon	--	0.1	MLA-047	30	0.5	EPA 531.2
Carbaryl	--	0.1	EPA 8318/ EPA8321/ MLA-047	700	0.5	EPA 531.2
Carbofuran	--	0.1	EPA 8318/ EPA8321/ MLA-047	18	0.5	EPA 531.2
Methiocarb	--	0.2	EPA 8318/ EPA8321/ MLA-047	--	0.5	EPA 531.2
Methomyl	--	0.2	EPA 8318/ EPA8321/ MLA-047	--	0.5	EPA 531.2
Oxamyl	--	0.1	EPA 8318/ EPA8321/ MLA-047	50	0.5	EPA 531.2
Pyrethroids						
Allethrin	--	0.33	GCMS-NCI-SIM			
Bifenthrin	--	0.33	GCMS-NCI-SIM			
Cyfluthrin	--	0.33	GCMS-NCI-SIM			
Lamda-Cyhalothrin	--	0.33	GCMS-NCI-SIM			
Cypermethrin	--	0.33	GCMS-NCI-SIM			
Deltamethrin:Tralomethrin	--	0.33	GCMS-NCI-SIM			
Esfenvalerate:Fenvalerate	--	0.33	GCMS-NCI-SIM			
Fenpropathrin	--	0.33	GCMS-NCI-SIM			
Tau-Fluvalinate	--	0.33	GCMS-NCI-SIM			
Permethrin	--	0.33	GCMS-NCI-SIM			
Phenothrin	--	0.33	GCMS-NCI-SIM			
Resmethrin	--	0.33	GCMS-NCI-SIM			

Table 14: Analytes and Methods	**Sediment (µg/Kg)**			**Elutriate (µg/L)**		
Analyte	**Screening Level**	**RL**	**Analytical Method**	**Criteria**	**RL**	**Analytical Method**
Tetramethrin	--	0.33	GCMS-NCI-SIM			
PBDEs						
49 PBDE Compounds	--	--	EPA 1614			

		Bulk Sediment			**Elutriate**		
Test Organism	**Units**	**Screening Level**	**RL**	**Analytical Method**	**Screening Level**	**RL**	**Analytical Method**
Toxicity - Bioassays (4 day, acute)							
Oncorhynchus mykiss (Rainbow Trout)	% survival				> 90%	N/A	600/R-99/064
Toxicity - Bioassays (10 day, acute)							
Hyalella azteca (amphipod)	% survival	> 90%	N/A	600/R-99/064			
Chironomus dilutus (midge)	% survival	> 90%	N/A	600/R-99/064			
Bioaccumulation (28 day, acute)							
Corbicula fluminea (fresh water clam)	% survival	> 90%	N/A	600/R-99/064			
Lumbriculus variegatus (oligochaete worm)	% survival	> 90%	N/A	600/R-99/065			

7.2 Analytical Bias

Analytical bias will be assessed by reviewing the results of the external QA samples as well as the laboratory quality control (QC) samples. Acceptance criteria for external QA samples are below in section 7.4; acceptance criteria for laboratory QC samples can be found in the analytical methods or the laboratory SOP documents. If a QA/QC result does not meet the relevant acceptance criteria, bias to the environmental samples will be assessed based on USBR MP-157 standard operating protocols (QAT, 2009) and samples will be qualified as possibly biased high or possibly biased low as appropriate. Any result that is determined to have a bias will be flagged with a data qualifier.

Analytical bias will also be assessed by comparing analytical results for individual constituents that are analyzed by more than one method. For example, sediment will be analyzed using both standard methods 8260 and 8270. Both of these methods can detect Naphthalene; Naphthalene results obtained through alternate methods can be used to help determine the accuracy of the analytical results.

7.3 Quality Control Protocols

Chemical testing protocols are determined by United States Environmental Protection Agency (USEPA) methods or other approved standard methods. Reporting limits and Quality Control (QC) protocols are specified by e analytical method.

7.4 External Quality Assurance Sample Acceptance Criteria

The QA acceptance criteria for external QA checks are based on control limits reported in the MP-157 SOP manual for quality assurance (QAT, 2009). Criteria used to assess data validity are listed below (Table 15).

Table 15: Quality Assurance Acceptance Criteria for Soil and Elutriate

Result Concentration/Reference Certified Value	Precision	Accuracy	Contamination
Soil Matrix			≤ 2 x RL, ≤ 10% of the lowest production sample result or within Vendor's Acceptance Range
≥ 5 x RL	≤ 35% Relative Percent Difference (RPD)	65% - 135% Recovery or within Vendor's Acceptance Range	
< 5 x RL	± 2 x RL	± 2 x RL or within Vendor's Acceptance Range	
Elutriate Matrix			
≥ 5 x RL	≤ 20% RPD	80% - 120% Recovery or within Vendor's Acceptance Range	
< 5 x RL	± 1 x RL	± 1 x RL or within Vendor's Acceptance Range	

7.5 Completeness

To meet data completeness objectives for this project, all attempts will be made to collect greater than 95% of planned samples.

7.6 Comparability

Comparability is achieved by collecting and analyzing samples in the same manner at the same sites over the life of the project. In this study, all samples were collected in accordance with MP-157 sampling protocols. Field personnel received training prior to sample collection in order to ensure use of comparable collection procedures. If field conditions require any deviations from anticipated methods, all deviations will be thoroughly documented in field record books.

Throughout this program, individual constituents will be analyzed by the same laboratories and analytical methods. Consistent use of laboratories (Tables 2 and 3) and analytical methods (Table 14) will help to ensure data comparability.

In future, data collected in this study will be compared with, and evaluated in combination with, contaminant data from the SWI 2006 study. No direct effort was made to match the sampling or analytical methods in this study with the prior study. When the combined data is evaluated, the new dataset will be evaluated for data comparability.

A8. Special Training/Certification

The Environment Monitoring, Quality Assurance and Data Management team leads are responsible for ensuring that all personnel involved with their respective sections have the training and skills needed for successful completion of their assigned tasks. Team leads will verify that tasks are completed in accordance with applicable MP-157 SOP guidelines. No specialized certifications are required for this project.

A9. Documents and Records

9.1 Document and record control

The written, illustrated and photographic recording media for the project will be both paper and electronic. The project will implement proper document and record control procedures for both paper and electronic media, consistent with USBR quality management procedures. For instance, hand-recorded data records will be taken with indelible ink, and changes to such data records will be made by drawing a single line through the error with an initial by the responsible person. The Project Manager will have ultimate responsibility for all changes to records and documents.

The QAT and EMT team leaders will be responsible for approval of the final QAPP and approval of any updates. The EMT lead will be responsible for distribution of the current or updated QAPP. The USBR Branch of Environmental Monitoring shall retain copies of all sample collection documentation, laboratory reports and correspondence, and any emails associated with project activities.

9.2 Other documents/records

Other records and documents will produced in conjunction with this project:

- Sample Identification (ID)Labels
- Field Record Books
- Field Log Sheets
- Chain of Custody Records
- Core Log
- Spike Book
- Laboratory Analytical Reports
- Project Data and QA Summary Reports

Sample Identification Labels

Sediment samples will be labeled with at least the following information:

- Unique identification number (described below)
- Sample collection date
- Analyses required
- Chemical preservative where applicable (see Table 10)

Water samples (collected for elutriate and biological tests) will be labeled with at least the following information:

- Lake name or estuary location
- Sample collection date and time
- Required analyses

Reservoir samples will be assigned unique IDs in coordination with the contaminant drill hole (CDH) and contaminant hand auger (CHA) identifiers shown in Table 16. These IDs were assigned through the geologic/geotechnical investigation.

Table 16: Proposed Contaminant Sample Locations

	Coordinates		
Drill Hole ID	Northing	Easting	Topographic Elevation (feet)
JC Boyle Reservoir			
CDH-09-001	2666449.1	6554048.5	3793
CDH-09-002	2666153.2	6552000.8	3793
CDH-09-003	2663970.2	6551811.5	3793
CDH-09-004	2663960.5	6552286.4	3793
CDH-09-005	2662282.1	6552787.2	3793
CDH-09-006	2660797.7	6553238.7	3793
CDH-09-007	2656810.2	6549292.2	3793
CDH-09-008	2656730.3	6549814.2	3793

Table 16: Proposed Contaminant Sample Locations

	Coordinates		
Drill Hole ID	**Northing**	**Easting**	**Topographic Elevation (feet)**
Copco 1 Reservoir			
CDH-09-009	2599640.0	6488234.5	2605
CDH-09-010	2601331.0	6484823.0	2605
CDH-09-011	2603678.4	6483434.6	2605
CDH-09-012	2603567.5	6482366.7	2605
CDH-09-013	2605231.2	6479555.7	2605
CDH-09-014	2606869.5	6478576.7	2605
CDH-09-015	2606622.1	6476962.9	2605
CDH-09-016	2605531.2	6475079.8	2605
CDH-09-017	2607114.9	6474673.9	2605
CDH-09-018	2606785.8	6474070.0	2605
CDH-09-019	2606357.1	6472106.2	2605
CDH-09-020	2604978.7	6472087.6	2605
Copco 2 Reservoir			
CHA-09-003	to be arranged	to be arranged	2472
CHA-09-004	to be arranged	to be arranged	2472
CHA-09-005	to be arranged	to be arranged	2472
Iron Gate Reservoir			
CDH-09-021	2601162.0	6459883.1	2325
CDH-09-022	2600274.0	6455224.6	2325
CDH-09-023	2602352.3	6452436.0	2325
CDH-09-024	2601888.6	6451804.8	2325
CDH-09-025	2598982.1	6446338.0	2325
CDH-09-026	2597723.5	6446269.1	2325
CDH-09-027	2599708.7	6443348.8	2325
CDH-09-028	2598746.1	6442283.5	2325
CDH-09-029	2595752.7	6443483.5	2325
CDH-09-030	2592846.3	6444075.9	2325
CDH-09-031	2591964.4	6442822.1	2325
CDH-09-032	2589051.7	6443887.4	2325
Upper Estuary			
CHA-09-002	to be arranged	to be arranged	~5
Lower Estuary			
CHA-09-001	to be arranged	to be arranged	~5

Coordinates and elevations are approximate (CCS83, Zone 1, US Survey Feet), exact locations will be determined at site based on field conditions and water level.

Contaminant sample IDs will be based on sample location, composite strategy (Interval, Whole-core, Super-composite, Area-composite) and sample matrix to be analyzed (sediment or elutriate). Distinction between sediment and elutriate analyses is required for data entry purposes.

There are two basic sample ID formats, one for Interval and Whole-core composite samples and one for Super-composite and Area-composite samples.

For Interval and Whole Core composite samples, use the format indicated in Table 17; for multiple core Super Composite samples, use the format shown in Table 18.

Table 17: Sample Identifiers for Interval and Whole Core samples

	Sample ID	
Sample Location	**Sediment (S)**	**Elutriate Chemistry (E)**
Reservoirs	CDH-S-### (depth interval)	CDH-E-### (depth interval)
Estuary	CHA-S-###	CHA-E-###

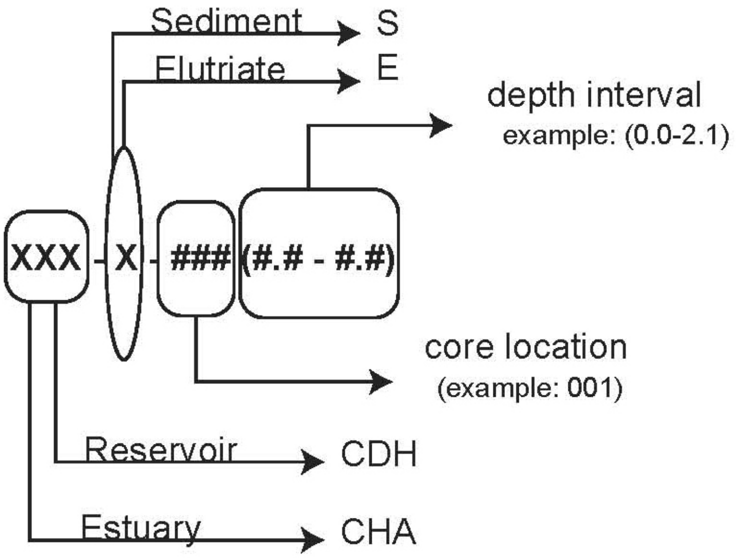


Table 18: Sample Identifiers for Super Composite (Multiple Core) Samples

		Desired Analyses	
Reservoir Name	**Super Composite Location**	**Toxicity**	**Elutriate Chemistry**
JC BOYLE	Thalweg	CDH-S-JBT	CDH-E-JBT
	Non-thalweg	CDH-S-JBN	CDH-E-JBN

Table 18: Sample Identifiers for Super Composite (Multiple Core) Samples

		Desired	Analyses
Reservoir Name	**Super Composite Location**	**Toxicity**	**Elutriate Chemistry**
COPCO 1	Thalweg	CDH-S-CPT	CDH-E-CPT
	Non-thalweg	CDH-S-CPN	CDH-E-CPN
COPCO 2	Thalweg	CDH-S-CP2	CDH-E-CP2
IRON GATE	Thalweg	CDH-S-IGT	CDH-E-IGT
	Non-thalweg	CDH-S-IGN	CDH-E-IGN

Field Record Book

A bound field notebook will be used to record at least the following information:

- Project name
- Site location/Global Positioning System (GPS) coordinates
- Date
- On site start time
- Off site end time
- Names of sampling personnel and record keeper
- Sample identification number (including depth interval)
- Conditions that may affect sample
- Significant observations
- Sample recovery
- Name of visitors and other persons on site

Field personnel will maintain the field record. Corrections will be made by crossing a line through faulty entries and entering the correct information. Corrections will be initialed and dated by the person making the correction. Logbook entries will be dated, legible, in ink, and contain accurate information. Language used will be objective, factual, and free of personal opinion.

Field Log Sheets and Chain of Custody Records

The following information will be recorded on field log sheets and the chain of custody (COC):

- Project name
- Site location
- Sample identification number (including depth interval)
- Sample matrix
- Sample collection date

- Required laboratory analyses
- Name of field personnel

Instrument Calibration Verification Sheet

The instrument calibration/verification sheet serves as a record showing that either 1) the Sonde multi-probe instrument was properly calibrated prior to collecting water measurements or 2) if proper calibration could not be verified, the instrument was recalibrated.

The following information will be documented on the instrument calibration sheet:

- Project name
- Date and time
- Name of person conducting the calibration/verification
- Instrument brand and model
- Instrument number
- Calibration standard used (value)
- Pre-calibration instrument measurement (value)
- If needed, post-calibration instrument measurement (value)

Core Log

USBR geologists will log a detailed description of each contaminant before core is sampled for contaminant analyses. The following attributes of the core will be recorded:

- Core location
- Sampling method
- Core length
- Date
- Detailed physical description of the core including color, ductility, plasticity, grain size, mineralogy, scent
- Name of geologist

Spike Record Book

The QA specialist is responsible for documenting the necessary information pertaining to the QA samples in the spike book. A spike book is a bound notebook that contains spike worksheets. Documentation on the spike worksheet includes the following information:

- Project name
- Number of samples
- Collection date
- Batch identification number
- Range of sample ID numbers assigned to the batch of samples
- Range of laboratory ID numbers assigned to the batch of samples
- Site name for the selected QA site

- Types of QA samples incorporated
- Field IDs that correspond to the QA samples
- Source ID for reference material used
- Parameters to be spiked
- Measured volumes of spike samples
- Volume and concentration of spike aliquots delivered
- Final concentration of particular parameters in the spike sample
- Reporting limits for parameters
- Dated initials of QA personnel incorporating the external QA samples

Analytical Report

The laboratory produces the analytical report, which contains laboratory data results. The analytical report documents the analytical results for each parameter analyzed on each sample submitted. The analytical report generally includes the following information:

- Case narrative
- Analytical results
- Reporting limits (RL) for parameters
- Methods used to analyze the sample(s)
- Date sample(s) was/were collected, prepared, and analyzed
- Laboratory's quality control results

9.3 Storage of project information

Paper copies of project information will be stored as outlined in the MP-157 *Standard Operating Procedures for Data Management* guidance documents (DMT, 2009). Electronic copies of project information will be stored as outlined in the USBR Information Technology guidance documents.

B DATA GENERATION AND ACQUISITION

B1. Sampling Process Design

B1.1 Site distribution

Reservoirs

Sampling locations on JC Boyle, Copco 1 and Iron Gate Reservoirs were chosen following a targeted sample design. For each reservoir, sample locations were divided between those located along the estimated location of the historic Klamath River thalweg (20 total sites) and sites located off of estimated historic thalweg location (16 total sites). The path of the historic Klamath River thalweg was estimated from pre-dam topography indicated on USGS topographic maps. Sites were spaced to have an approximately even distribution along the thalweg of each reservoir, then off thalweg locations were filled in with an approximately even distribution. Site locations were adjusted to avoid archeologically sensitive areas and to avoid replicating sites sampled in the screening level study. Site locations are indicated in Table 16 and in Figures 3 through 6.

Copco 2

Copco 2 is very narrow and essentially covers the thalweg of the historic Klamath River. Due to the small size of the reservoir, locations were chosen to have an even areal distribution. On and off thalweg locations were not distinguished as the entire reservoirs is most likely "on thalweg". Three to six sampling locations are to be determined in the field. The sediment cover thickness will determine the number of sites needed. If sediment cover is thin, more sites will be needed in order to fill volume requirements for sample analyses.

Estuary

Two Klamath River Estuary sites are to be sampled, one representing an upper estuary, river-dominated environment and one a lower estuary marine-dominated environment (Figure 6). Exact locations and density of sample sites will be determined on-site. Each sample will be composited from 3 to 6 locations distributed within a half mile radius; if sediment is difficult to capture, numerous very closely spaced sample replicates will be collected to fill volume requirements at each sub-location.

Estuary samples will be analyzed in order to give a coarse estimate of current (background) Klamath Estuary contaminant concentrations. Dam removal will likely release sediment downstream and this material may ultimately discharge to the Pacific through the Klamath River Estuary. Estuary sediment analyses will provide a preliminary indication of background contaminant levels at the mouth of the Klamath River. Note that these estuary grab samples are not meant to provide a complete or representative characterization of contaminant concentrations within Klamath River or Klamath Estuary.

B1.1 Site density

In order to achieve a data set representative of the entire reservoirs, sample locations were distributed throughout each reservoir and coring locations were situated within 4000 ft of each other.

B1.2 Sediment Collection Strategies

Interval Composite

As indicated in Table 8, "Interval composite" samples will be collected at all reservoir bore-hole locations. This type of sample will be composited by stratigraphic horizon, or if sediment is massive, by five foot depth intervals. For example, imagine recovering a three-foot core composed of one foot of clay underlain by two feet of silty-sand. This core would yield two Interval composite samples: one collected from sediment/water interface to one foot below (0.0 - 1.0), the second composited from sediment collected between one and three feet deep (1.0 – 3.0). Alternately, if the sediment were not stratified, only one Interval composite would be collected (from the zero to three foot depth horizon). A 12 foot long homogeneous core would yield three samples, each composited from sediment collected between the zero to five (0.0-5.0); five to ten (5.0-10.0), and ten to twelve (10.0-12.0) depth intervals.

Compositing stratigraphic or depth horizons at all drill hole locations will help to resolve spatial variations in reservoir sediment chemical composition. This strategy was chosen for the analysis of common sediment characteristics (e.g. EC, pH), contaminants that are widespread in the environment (e.g. heavy metals, polyaromatic hydrocarbons), and certain persistent contaminants with potential local inputs (e.g. chlorinated pesticides, WAD cyanide). Interval composite samples will be collected at each boring location in order to maximize spatial distribution of data points.

Whole Core Composite

“Whole Core" composite samples will be composited over the entire length of a complete core: from the water/sediment interface to the contact between reservoir-sediment and pre-reservoir basement. Contact with basement, as with all cores collected, will be confirmed by on-site geologists.

Whole Core composite samples will not expose chemical heterogeneity, but do provide a reasonable approach for estimating average sediment composition. Whole Core composite samples will be collected at two locations per reservoir. This composite strategy was chosen for the analysis of constituents of emerging concern (e.g. polybrominated diphenyl ethers) and for constituents meriting confirmation or clarification of prior results (e.g. dioxins/furans, PCB congeners). If constituents in the Whole-core analyte suite are found in significant concentrations, then future studies can be conducted to determine the extent and spatial distribution of their occurrence.

Super Composite

Multiple-core “Super Composite” samples will be composed from whole-core composite samples that were collected from every on-thalweg and every off-thalweg (non-thalweg) borehole location within a reservoir. This is the best approach for determining average sediment composition in all on-thalweg, and all non-thalweg locations lake-wide. Super Composite samples were chosen for analysis of sediment elutriate and for toxicity studies for two main reasons:

1. Sediment with a reservoir-wide average composition was desired for toxicity testing. Toxicity tests are meant to expose concerns that may not be revealed through targeted chemical testing. Analysis of targeted (potentially non-representative) samples would not meet toxicity-testing goals.
2. Toxicity and elutriate testing requires large sediment volumes and multiple-core composites are needed to fill volume requirements. Core samples yield approximately three liters of uncontaminated sediment for every five feet of

recovery. To complete all of the desired toxicity and elutriate testing, approximately 6 gallons of sediment are needed per reservoir.

Area Composite

Copco 2 and Klamath Estuary multiple-core "Area Composite" samples will be composed from Whole Core samples collected at every sampling location within Copco 2 and the Estuary respectively. This is the best approach for determining average sediment composition area-wide. These samples will not be segregated according to thalweg/non-thalweg location since the entire Copco 2 stilling basin is an active channel, and since fine-grained estuary sediment will be collected wherever it is found.

B1.3 Water Column Profile Collection

At each sampling site, or once each day that sediment is collected, the overlying water column will be profiled for the following characteristics: turbidity, pH, temperature, dissolved oxygen, and specific conductance. Water column profiles will be collected using a Yellow Springs Instrument (YSI) multi-probe Sonde. The instrument will be deployed from the back of the drilling barge using a reel and 200 ft data cable with a YSI data logger. In water less than fifty feet deep, data will be logged in one foot increments; in deeper water, data will be logged every five feet until the instrument is within ten feet of the bottom, then data will be collected every foot. Calibration of each probe will be verified or re-calibrated prior to each deployment of the instrument.

B2. Sampling Methods

B2.1 Sediment collection equipment

Reservoir

Coring is the preferred sampling method for this project. Coring devices facilitate sampling of thick sediment packages. Coring also allows collection of relatively undisturbed samples and retrieval of samples over discreet intervals.

Two types of coring equipment will be tried while in the field: a barge-supported steel auger (Flight Auger Dry Core or FADC); and a gravity corer with a Lexan (plastic) tube. Collection equipment is described in detail in the QAPP for the companion geotechnical report. The FADC method will be used to sample near-dam regions where thick sediments are anticipated. This method may be slow, requires meticulous decontamination, and can have low sample yield (see Section B2.2). Logistical issues can also preclude sampling in water depths greater than about 80 feet.

In shallow sediment, the gravity sampler may be the preferred sampling device. This sampler may allow for more rapid sample retrieval and may yield a greater volume of uncontaminated sediment due to the greater diameter core-tube used by this device.

Estuary

Estuary sampling will be attempted with the gravity sampler deployed from a small boat. However, gravity core sampling may not be practical - estuary sediment is anticipated to be coarse-grained, sandy or gravelly in many areas. The Lexan gravity core tube has an 2-5/8 inch inside diameter and may become blocked by gravel or cobbles; sandy sediment with low cohesion may not be contained within the sampler, even if a sediment retaining basket (sand fingers) is attached.

While gravity core sampling is good for collecting sub-surface material, it will not be an efficient method for collecting large sample volumes. If attempts with the gravity corer fail, samples will be collected either with a small stainless-steel clam-shell dredge devise, and/or with a stainless steel shovel.

B2.2 Methods for removing sediment from the sampling device and collecting sub-samples

Sediment collected using the FADC method will be extracted and sub-sampled using the following method: Lay the closed auger casing on a wooden surface covered in plastic. Open the split sides to reveal the sediment core. Sample will be described and photographed by on site geologists. When the geologist gives the go-ahead, use a stainless steel or Teflon-coated palette knife to cut the sample in half lengthwise and lay it open. Reserve one of the halves for use with geotechnical studies. Sample the remaining half for contaminant studies by removing material from the center of the core with a stainless steel spoon. Leave a margin at least 0.5 inch thick on all sides in order to avoid contamination. Place material into a stainless steel bowl and homogenize as described in Section B2.3.

Sediment collected with the gravity devise will be “plunged” from the tube using a flat Teflon disk ("Core Extruding Plug") that sits on top of the sediment and is pushed with a long dowel. Place the Lexan-tube on a wooden bench covered with clean plastic, on a length of aluminum foil, or on an aluminum baking-sheet, and then extrude. Sample description, photographing, and sub sampling will occur as described above.

B2.3 Compositing Procedures

Sample material will be composited before homogenization and distribution into sample jars. Interval samples will be composited over the entire interval designated. Whole Core samples will be composited over the entire length of each individual core. On-Thalweg and Non-thalweg Super Composites will be composited by combining pre-homogenized Whole Core samples. Care will be taken to combine only complete Whole Core samples. For estuary samples, where basement was not reached and "whole cores" cannot be collected, equal volumes of sample will be combined (composited) from each sub-sample location.

B2.4 Homogenization Procedures

Samples will be homogenized by mixing thoroughly and vigorously with a stainless steel spoon, or by mixing with a stainless steel paint mixer head attached to an electric drill. Homogenization procedures are described in the MP-157 *Standard Operating Procedures for Environmental Monitoring* manual (EMT, 2009).

Samples collected for VOC analyses will not be homogenized – instead, small spoonfuls of sediment will be collected along the entire core length and placed in the appropriate sample container until it is full. Care will be taken to make sure that equal volumes of sediment are collected along the entire length of the core and that the container is not filled before the entire core length has been sampled.

B3. Sample Handling and Custody

B3.1 Maximum sample hold times

Maximum holding times allowed from sample collection to extraction and/or analysis for sediment and elutriate analyses are shown in Tables 19 and 20 respectively.

Table 19: Extraction and Analysis Holding Times – Sediment

Method	Hold Time - Sediment	
	Extract	Analysis
ENV by GC-MS Specialty	14 days	40 days
EPA 8015B	14 days	40 days
EPA 7471A	-	28 days
EPA 6010B	-	6 months
EPA 6020	-	6 months
USGS:N011,T10 USGS:C011,T08	-	indefinite
EPA 1614	1 year	45 days
EPA 8082	14 days	40 days
EPA 8260C	-	14 days
EPA 8290A	30 days	45 days
EPA 8318 and EPA 8321	14 days	40 days
MLA-047 Rev 03	7 days	40 days
GCMS-NCI-SIM	7 days	40 days
SM 9045	-	asap
EPA 8015B	14 days	40 days
E821/R-91-100	-	14 days
SM 2540B	-	7 days
SM 2540G	-	none
EPA 350.1	-	none
SM 4500CN I	-	none
SM 2510B	-	none
EPA 351.2	-	none
EPA 1668A	14 days	40 days
EPA 8081	14 days	40 days
EPA 8141A	14 days	40 days
EPA 8270D	14 days	40 days
EPA 8151A	14 days	40 days
SM 4500P Mod	-	none
SM 9030B/4500S2D	-	asap

Table 20: Extraction and Analysis Holding Times - Elutriate

Method	Hold Time - Elutriate	
	Extract	Analysis
SM 5210	-	48 hours
EPA 300	-	28 days
SM 5310C	-	28 days
EPA 1631E	-	90 days
EPA 200.7	-	6 months
EPA 200.8	-	6 months
EPA 505	14 days for all except heptachlor; heptachlor is 7 days	24 hours
EPA 525.2	14 days for all except the following which must be extracted immediately: carboxin, diazinon, disulfoton, disulfoton sulfoxide, fenamiphos, and terbufos	30 days
EPA 531.2	-	28 days
SM 4500H+B	-	asap
SM 2540C	-	7 days
EPA 350.1	-	28 days
SM 4500CN I	-	14 days
SM 2510B	-	28 days
EPA 351.2	-	28 days
EPA 1668A	7 days	40 days
EPA 8081	7 days	40 days
EPA 8141A	7 days	40 days
EPA 8270D	7 days	40 days
EPA 8151A	7 days	40 days
SM 4500P Mod	-	28 days
SM 9030B/4500S2D	-	7 days

B3.2 Sample handling and decontamination

All sampling equipment and containers will be made of non-contaminating materials (Teflon, stainless steel, or glass for chemical testing; plastic for toxicity studies) and will be thoroughly clean prior to every use. For chemical testing, pre-cleaned sample containers will be provided by analytical laboratories. If plastic bags are used to contain sediment bound for toxicity testing, bags will be taken from newly opened boxes. Before drilling and between borings, any part of the drill string that will contact sediment will be cleaned.

The cleaning method for equipment and containers is described as follows. Hold equipment to be cleaned over a catchment bucket and pre-rinse with environmental water to remove visible sediment. Using a large plastic squirt bottle filled with de-ionized water and a small amount of Alconox™ detergent, thoroughly cover equipment surfaces with water/Alconox™ solution and scrub vigorously with a plastic scrub brush. Rinse equipment three times with de-ionized water using a second DI-filled squirt bottle. Collect all waste-water in cubitianers or other covered containers and dispose of on-shore in an appropriate sewer system. Cover all cleaned equipment with aluminum foil or plastic (as appropriate) until use.

Field personnel will wear Nitrile gloves when handling sample material and insure that samples touch only clean or decontaminated sampling equipment before they are placed in appropriate sample containers. Airborne contamination will be minimized by keeping sample containers and sampling equipment covered when not in use (aluminum foil or plastic, as appropriate).

Diesel engines (boat motors) will be turned-off during sampling and cigarette smoking will be discouraged.

The spill hazard analysis for barge drilling operations is outlined in the SOW for the geotechnical study (Mongano, 2009).

Samples will be mailed to contract laboratories if the field hold time is less than one week. For samples with a longer field hold, samples will be mailed to the USBR QA Officer for incorporation of QA samples; the QA officer will then send samples on to the contract laboratories, within the field hold time (Table 10). For the purposes of this project, the "field hold" is determined by the shortest applicable hold time when hold times for elutriation, extraction and analysis are considered.

B3.3 Sample Containers, preservation, and labeling

USBR personnel will contain samples collected for chemical analysis in laboratory-supplied pre-cleaned EPA-approved glass jars with Teflon-lined plastic lids. Container sizes and special requirements are indicated in Section A6, Table 10. Sediment to be analyzed for VOC and sulfide analyses will be collected as soon as possible after each sample has been recovered. Sediment for VOC analyses will be packed into containers, leaving no headspace. Samples collected for sulfide analysis will be preserved with 5 mL of 2-normal zinc acetate, and then capped. All caps and lids will be checked for tightness immediately after capping.

Sediment collected for toxicity testing will be contained in heavy-duty plastic bags and five gallon plastic tubs with lids.

Each container will be given a permanent, waterproof sample label written in waterproof ink. At a minimum, each sample label will include sample ID, sample date, and a summary list of analysis required. A container list (Table 10) and secondary review by a second field sampler will be used to verify that all samples are properly collected and labeled.

B3.4 Sample transport

As soon as possible after collection, all samples will be placed in insulated coolers with blue ice. At the end of each sampling day, samples will be transferred from ice chests to refrigerators and chilled to 4°C. Caps and lids will be checked for tightness. Samples submitted for Carbamate and Pyrethroid analyses will be frozen as soon as possible after collection and kept frozen during transport. Before freezing, bottles should be checked to make sure that there is room for expansion.

Samples will be shipped in insulated coolers directly to the contract laboratories or if hold times permit, to the QA Officer at Reclamation’s MP157’s facility. All samples will be handled, prepared, transported and stored in a manner so as to minimize bulk loss, analyte loss, contamination, or biological degradation. Prior to transport, samplers will complete and sign COC documents and include them with sample shipments. Sample transport containers will be packed carefully and contents will be secondarily reviewed to insure that all samples correlate with COC records. Ice chests will be checked to make sure lids are secure, then sealed with tape.

Sample transfer will be documented using COC forms filled out in ink; COCs will contain the following information: sample IDs, collection date, sample matrix, number of sample containers, analyses requested, and any additional remarks. When the samples are transferred from one party to another, the individuals will sign, date, and note the time on the form.

Upon sample receipt, samples will be stored in laboratory refrigerators or freezers as appropriate.

To ensure that holding times are not exceeded, samples will be collected, processed, and shipped in a timely manner. The holding times, bottle, and preservation requirements, are listed in Tables 10, 11 and 12, Section A6.

B4. Quality Control

Quality Control requirements are fully documented in the Environmental Monitoring Branch SOP manual for QA (QAT, 2009).

B4.1 External Quality Assurance Samples

Quality assurance samples were incorporated into sample batches before submission to the analytical laboratories as shown in Tables 21 and 22. The QA samples assess the laboratory’s ability to process samples with an acceptable level of precision and accuracy without introducing contamination to the sample. If any of the external QA samples do not meet the criteria stated in section 7.4, Table 15, the samples will be reanalyzed. If the laboratory is unable to confirm the original result upon reanalysis, a bracket of samples or the entire batch of samples will be submitted for reanalysis.

Table 21: Constituents with Externally Added QA - Sediment

Inorganic (n=26)				
ALUMINUM	B	D	F	RB
AMMONIA AS N	B	D	F	
ANTIMONY	B	D	F	RB
ARSENIC	B	D	F	RB
CADMIUM	B	D	F	RB
CALCIUM	B	D	F	RB
CHROMIUM	B	D	F	RB
COPPER	B	D	F	RB
CYANIDE, WAD	B			
EC	B	D	F	
IRON	B	D	F	
LEAD	B	D	F	RB
MAGNESIUM	B	D	F	RB
MERCURY	B	D	F	RB
NICKEL	B	D	F	RB
NITROGEN, TOTAL	B	D		
pH		D	F	
PHOSPHORUS, TOTAL AS P	B	D	F	
SELENIUM	B	D	F	
SILVER	B	D	F	RB
SULFIDE	B	D	F	
SULFIDE, ACID VOLATILE	B			
TOC		D	F	
TOTAL SOLIDS	B	D	F	
TOTAL VOLATILE SOLIDS	B			
ZINC	B	D	F	RB

Organic (n=119)				
1,2,3,4,6,7,8-HPCDD				RB
1,2,3,4,6,7,8-HPCDF				RB
1,2,3,4,7,8,9-HPCDF				RB
1,2,3,4,7,8-HXCDD				RB
1,2,3,4,7,8-HXCDF				RB
1,2,3,6,7,8-HXCDD				RB
1,2,3,6,7,8-HXCDF				RB
1,2,3,7,8,9-HXCDD				RB
1,2,3,7,8,9-HXCDF				RB
1,2,3,7,8-PECDD				RB
1,2,3,7,8-PECDF				RB
2,3,4,6,7,8-HXCDF				RB
2,3,4,7,8-PECDF				RB
2,3,7,8-TCDD				RB
2,3,7,8-TCDF				RB
2,4,5-TRICHLOROPHENOL	B	D	F	RB
2,4,6-TRICHLOROPHENOL	B	D	F	RB
2,4-DICHLOROPHENOL	B	D	F	RB
2,4-DIMETHYLPHENOL	B	D	F	RB
2,4-DINITROPHENOL	B	D	F	RB
2,4-DINITROTOLUENE	B	D	F	RB
2,6-DINITROTOLUENE	B	D	F	RB
2-CHLORONAPHTHALENE	B	D	F	RB
2-CHLOROPHENOL	B	D	F	RB
2-METHYLNAPHTHALENE	B	D	F	RB
2-METHYLPHENOL	B	D	F	RB
2-NITROANILINE	B	D	F	RB
2-NITROPHENOL	B	D	F	RB
3,3'-DICHLOROBENZIDINE	B	D	F	RB
3-NITROANILINE	B	D	F	RB
4,4'-DDD	B	D	F	
4,4'-DDE	B	D	F	
4,4'-DDT	B	D	F	
4,6-DINITRO-2-METHYLPHENOL	B	D	F	RB
4-BROMOPHENYL PHENYL ETHER	B	D	F	RB
4-CHLORO-3-METHYLPHENOL	B	D	F	RB
4-CHLOROANILINE	B	D	F	RB
4-CHLOROPHENYL PHENYL ETHER	B	D	F	RB
4-METHYLPHENOL	B	D	F	RB
4-NITROANILINE	B	D	F	RB
4-NITROPHENOL	B	D	F	RB
ACENAPHTHENE	B	D	F	RB
ACENAPHTHYLENE	B	D	F	RB
ALDRIN	B	D	F	
ANTHRACENE	B	D	F	RB
AROCLOR 1016	B	D	F	
AROCLOR 1221	B	D	F	

Table 21 – Constituents with Externally Added QA - Sediment

Organic (n=119)				
AROCLOR 1232	B	D	F	
AROCLOR 1242	B	D	F	
AROCLOR 1248	B	D	F	
AROCLOR 1254	B	D	F	
AROCLOR 1260	B	D	F	
AROCLOR 1268	B	D		
BENZ(A)ANTHRACENE	B	D	F	RB
BENZO(A)PYRENE	B	D	F	RB
BENZO(B)FLUORANTHENE	B	D	F	RB
BENZO(G,H,I)PERYLENE	B	D	F	RB
BENZO(K)FLUORANTHENE	B	D	F	RB
BENZOIC ACID	B	D	F	RB
BENZYL ALCOHOL	B	D	F	RB
BIS(2-CHLOROETHOXY) METHANE	B	D	F	RB
BIS(2-CHLOROETHYL) ETHER	B	D	F	RB
BIS(2-CHLOROISOPROPYL) ETHER	B	D	F	RB
BIS(2-ETHYLHEXYL) PHTHALATE	B	D	F	RB
BUTYL BENZYL PHTHALATE	B	D	F	RB
CARBAZOLE	B	D	F	RB
CHLORDANE (TECHNICAL)	B	D		
CHLORDANE-ALPHA	B	D	F	
CHLORDANE-GAMMA	B	D	F	
CHRYSENE	B	D	F	RB
DIBENZ(A,H)ANTHRACENE	B	D	F	RB
DIBENZOFURAN	B	D	F	RB
DIELDRIN	B	D	F	
DIESEL RANGE ORGANICS	B	D	F	
DIETHYL PHTHALATE	B	D	F	RB
DIMETHYL PHTHALATE	B	D	F	RB
DI-N-BUTYL PHTHALATE	B	D	F	RB
DI-N-OCTYL PHTHALATE	B	D	F	RB
ENDOSULFAN I	B	D	F	
ENDOSULFAN II	B	D	F	
ENDOSULFAN SULFATE	B	D	F	
ENDRIN	B	D	F	
ENDRIN ALDEHYDE	B	D	F	
ENDRIN KETONE	B	D	F	
FLUORANTHENE	B	D	F	RB
FLUORENE	B	D	F	RB
GAMMA-BHC	B	D	F	
HCH-ALPHA	B	D	F	
HCH-BETA	B	D	F	
HCH-DELTA	B	D	F	
HEPTACHLOR	B	D	F	
HEPTACHLOR EPOXIDE	B	D	F	
HEXACHLOROBENZENE	B	D	F	RB
HEXACHLOROCYCLOPENTADIENE	B	D	F	RB
HEXACHLOROETHANE	B	D	F	RB
INDENO(1,2,3-CD)PYRENE	B	D	F	RB
ISOPHORONE	B	D	F	RB
METHOXYCHLOR	B	D	F	
NITROBENZENE	B	D	F	RB
N-NITROSODI-N-PROPYLAMINE	B	D	F	RB
N-NITROSODIPHENYLAMINE	B	D	F	RB
OCDD				RB
OCDF				RB
PENTACHLOROPHENOL	B	D	F	RB
PHENANTHRENE	B	D	F	RB
PHENOL	B	D	F	RB
PYRENE	B	D	F	RB
PYRIDINE	B	D	F	RB
TOTAL HPCDD				RB
TOTAL HPCDF				RB
TOTAL HXCDD				RB
TOTAL HXCDF				RB
TOTAL PECDD				RB
TOTAL PECDF				RB
TOTAL TCDD				RB
TOTAL TCDF				RB
TOXAPHENE	B	D		

B = Blank D = Duplicate F = Reference or Blank Spike RB = Rinse Blank

Table 22: Constituents with Externally Added QA - Elutriate

Inorganic (n=38)			
ALUMINUM	B	D	F
ALUMINUM (DISSOLVED)	B	D	F
AMMONIA AS N	B	D	F
ANTIMONY	B	D	F
ANTIMONY (DISSOLVED)	B	D	F
ARSENIC	B	D	F
ARSENIC (DISSOLVED)	B	D	F
BOD (5 DAY)	B	D	F
CADMIUM	B	D	F
CADMIUM (DISSOLVED)	B	D	F
CALCIUM	B	D	F
CALCIUM (DISSOLVED)	B	D	F
CHLORIDE	B	D	F
CHROMIUM	B	D	F
CHROMIUM (DISSOLVED)	B	D	F
COPPER	B	D	F
COPPER (DISSOLVED)	B	D	F
CYANIDE, WAD	B		
DOC	B	D	F

Inorganic (n=38)			
EC	B	D	F
LEAD	B	D	F
LEAD (DISSOLVED)	B	D	F
MAGNESIUM	B	D	F
MAGNESIUM (DISSOLVED)	B	D	F
MERCURY	B	D	F
NICKEL	B	D	F
NICKEL (DISSOLVED)	B	D	F
NITROGEN, TOTAL	B	D	F
pH		D	F
PHOSPHORUS, TOTAL AS P	B	D	F
POC	B		
SILVER	B	D	F
SILVER (DISSOLVED)	B	D	F
SULFIDE	B	D	F
TDS	B	D	F
TOC	B	D	F
ZINC	B	D	F
ZINC (DISSOLVED)	B	D	F

Organic (n=0)

B = Blank D = Duplicate F = Reference or Blank Spike RB = Rinse Blank

Accuracy

Certified reference samples or blank spikes are incorporated to assess accuracy. They are incorporated at a rate of 10% of the production samples. If less than 10 production samples are collected, at least one reference sample is incorporated. Accuracy is assessed using percent recovery:

The PR for a reference sample is calculated as follows:

$$PR = \left(\frac{F}{MPVorMPN}\right)(100)$$

PR = Percent Recovery
F = Reference Sample Result
MPV = Most Probable Value
MPN = Most Probable Number

$$PR = \frac{(S - R)}{A}(100)$$

PR = Percent Recovery
S = Spiked Sample Result
R = Regular Sample Result
A = Amount of Spike Added

Precision

Duplicate samples are incorporated to assess precision. They are incorporated at a rate of 10% of the production samples. If less than 10 production samples are collected, at least one duplicate sample is incorporated. Precision is assessed using relative percent difference:

$$RPD = \frac{|R - D|}{\left({(R + D)} / {2} \right)}(100)$$

RPD = Relative Percent Difference
R = Regular Sample Result
D = Duplicate Sample Result

Contamination

Blank water samples (DI water) and blank soil references are incorporated to assess laboratory contamination. They are incorporated at a rate of 5% of the production samples. If less than 20 production samples are collected, at least one blank sample is incorporated.

B4.2 Laboratory Quality Control Samples

The laboratory will incorporate QC samples at the frequency specified in the analytical method and the laboratory SOP. The results for the QC samples will be assessed based on the acceptance criteria in the analytical method and the laboratory SOP. If any laboratory QC samples do not meet the established acceptance criteria, the laboratory will follow the corrective action protocol detailed in the analytical methods or the laboratory SOP.

B4.3 Holding Times

The date of the sample extraction/preparation and analysis will be compared to the date the sample was collected to ensure the sample was analyzed for the parameter within its holding time. If the holding times are exceeded, the program manager will determine if re-sampling is required. If re-sampling is not required, the QA Officer will qualify the data as necessary.

B4.4 Missing Data

Procedures for handling data anomalies such as missing data will be handled by QA personnel who will contact the analytical laboratories and secure an explanation of, and remedy for, missing data.

B4.5 Data Outliers

Outlier analysis is a tool that the QAT uses to determine if a result needs to be reanalyzed due to possible laboratory error. The QAT assesses outliers for long-term, routine monitoring programs where the site locations remain constant and the water quality and/or other environmental conditions are expected to remain in stasis over an extended period of time. Since this program is a one-time monitoring event, an outlier assessment was not done.

B5. Instrument/Equipment Testing, Inspection and Maintenance

Maintenance and testing of sample drilling equipment is described in the geotechnical companion report. There is no specific inspection or maintenance requirements for other sediment sampling equipment, field equipment will be inspected and maintained for safety and to prevent sample contamination.

B6. Instrument/Equipment Calibration and Frequency

Instruments used to profile water column profiles will be calibrated according to the methods stated in the Environmental Monitoring SOP documents (EMT, 2009).

Accuracy of calibration will be verified at the beginning of each day that water column data will be collected.

The laboratory performs instrument calibrations following the procedures and protocols stated in the analytical methods for each parameter.

B7. Inspection/Acceptance for Supplies and Consumables

Level 1 certified bottles that have been pre-preserved (when necessary) are used for sample collection. Calibration standards for calibrating field instruments are inspected prior to using to insure that standards are not out-of-date and that packages have not been tampered with or contaminated. References used for external QA incorporation have certified values from the vendor. Spike solutions used for external QA incorporation will be certified to be within 90%-110% of the expected value prior to use.

B8. Non-Direct Measurements

Secondary data will not be incorporated into this study.

B9. Data Management

9.1 Recordkeeping and tracking

Record keeping and tracking of field sheets, COC, laboratory data reports, field log books and project binders will follow standard MP-157 procedures and document control systems.

Field sheets and COC's will be generated, inspected and signed by the field sampler, and then relinquished to the QA officer. The QA officer will contact any field sampler whose paper work contains significant errors or omissions. The QA officer turns these documents over to the DMT to be entered into the MP-157 Environmental Monitoring Database and filed in the project binder.

Laboratory data reports received by the QA officer will be reviewed to document QA metadata. After the laboratory data reports are reviewed by the QA officer, the data reports will be signed and sent to the DMT for review. The DMT will enter the analytical results and the QA metadata into the Environmental Monitoring Database.

All data will be entered into the database following MP-157 SOP protocol (DMT, 2009). As a QC check, all data entered will be secondarily reviewed by an additional DMT member and initialed. After all data has been entered into the database, the data is signed and filed in project binders.

Field logbooks and project binders are to be locked in a file cabinet and must be signed-out for use.

9.2 Data handling

USBR computers will be used to process, compile, analyze, and transmit electronic data. Paper data records and documents will be filed. Individuals responsible for elements of the data management scheme are listed in Section 4.1

9.2 Data-quality control

Procedures for entering electronic and hand-written data into the database will follow standard USBR MP-157 standard operating procedures (DMT, 2009).

9.3 Archival and retrieval

Data is archived on secure USBR computers. Following QA approval and formal data release, data will be available for public review on the USBR website:

http://www.usbr.gov/mp/mp150/mp157/DM/index.html

C ASSESSMENT AND OVERSIGHT

C1. Assessment and Response Actions

1.1 Audits

Laboratory

The QAT audits laboratories analyzing samples. The three-tier audit consists of reviewing the laboratory’s QA Manual, reviewing the laboratory’s performance evaluation (PE) sample results, and conducting an intensive, on-site, system audit of the laboratory. The laboratory’s expertise in conducting analyses, their capability for generating valid data, their ability to effectively support the data, and the integrity of the QA/QC practices are assessed during the on-site audit. Laboratory audits are conducted every three years. The audit reports are issued to the laboratory. The laboratory then generates a response with corrective actions to MP157. At that time, the QAT determines whether or not to approve the laboratory for use and contacts the laboratory with their decision.

Field

The QAT audits field samplers collecting samples. The field audit consists of reviewing the relevant SOPs, submitting PE samples and reviewing the results, and accompanying the field sampler while they demonstrate the sample collection process. The QAT assesses the field sampler’s expertise in collecting representative samples. Field audits are conducted every two years. The field audit reports are sent to the field sampler and the EMT Leader. The EMT Leader is responsible for issuing corrective actions.

Documentation

Yearly, field logbooks, instrument calibration sheets, and field sheets are audited by the QAT to ensure that all the necessary information is correctly documented. The documentation audit reports are sent to the field sampler and the EMT Leader. The EMT Leader is responsible for issuing corrective actions.

1.2 Pre-sampling review

The Quality Assurance Officer will conduct an informal review immediately prior to beginning field investigations to insure that lab contracts are in place, that the analytical methods chosen meet data quality objectives, and that applicable MP-157 SOPs are current and accurate. The QA Officer will report findings to the Project Manager, who will take corrective action (if any is necessary) before the data collection task begins.

C2. Reports to Management

Three kinds of reports will be prepared: a QAPP, a QA summary report, and a Data Assessment. Informal progress reports will note the status of project activities and identify whether any QA problems were encountered (and, if so, how they will be handled). A preliminary data report will be released as soon as all acceptable results have been compiled. This report will primarily consist of data tables. The QA summary report will discuss the results of the external QA samples, the results of the laboratory's QC samples, holding times, and any other data quality issues. The final data report will analyze and interpret data, present observations, and draw conclusions.

Laboratory reports documenting activities and results associated with sample analyses are to be provided within 6 weeks of sample receipt. Timely results from the laboratories will allow decisions to be made regarding continued biological testing. Laboratories will provide at a minimum:

- Results of the laboratory analysis and QA/QC
- Methods used for analysis
- Date and time each sample was analyzed
- Laboratory reporting limits for all parameters analyzed
- Chain of custody procedures

Table 23: Project Status Reports

Type of Report	Frequency	Preparer	Recipients
Preliminary QAPP	Once, before primary data collection begins	Laura Benninger, USBR	All recipients of original QAPP
Amended QAPP	As needed	Laura Benninger, USBR	Involved agencies, stakeholders
QA Summary Report	Once	Julie Eldredge, USBR	Involved agencies, stakeholders
Data Assessment	Once	Kevin Kelly, USBR	Involved agencies, stakeholders

D DATA VALIDATION AND USABILITY

D1. Data Review, Verification and Validation Outcomes

Data will be accepted as valid if all external QA samples and laboratory QC samples meet their acceptance criteria and all samples are analyzed within their holding times.

If data do not meet external QA criteria for precision, accuracy or contamination, samples will be reanalyzed. If a result is confirmed after reanalysis, the result will be accepted as valid. A result is considered confirmed if it meets the precision acceptance criteria when the reanalyzed result is compared to the original analysis result.

Data will be qualified if results demonstrate unacceptable QA after being analyzed an additional time, if the laboratory QC sample results are unacceptable, or if the holding times were exceeded.

Data that does not meet QA/QC criteria will be released with qualification. Data usability will be determined by the user.

D2. Verification and Validation Methods

The QA Officer will validate the data by following the guidelines in the Environmental Monitoring Branch's *Standard Operating Procedures for Quality Assurance* (2009-05). Validation consists of reviewing the results of external quality assurance samples, laboratory quality control results, and whether the holding times for the parameters were met.

If any of the external QA sample results do not meet the acceptance criteria stated in section 7.4, Table 15, the samples are submitted for reanalysis. If the laboratory confirms the original result, the original value is accepted based on the laboratory demonstrating that sample preparation and instrumentation was performed properly during initial analysis. A result is considered confirmed if it meets the precision acceptance criteria when the reanalyzed result is compared to the original analysis result. If the original result cannot be confirmed, the laboratory must then analyze a bracket of samples or the entire batch of samples an additional time for the parameter. The bracket of samples or the entire batch of samples that has been analyzed an additional time is then evaluated for the parameter to see if the results meet the acceptance criteria in section 7.4, Table 15. Professional judgment is used to decide which set of data to accept and whether or not the data should be qualified if both sets of data demonstrate unacceptable external QA sample results.

D3. Reconciliation with User Requirements

Qualified results will be identified to the data entry staff (DMT) by completing the "Qualified Results" form per MP157 protocol. The data qualifier flag will be entered next to the result in MP-157's Environmental Monitoring database. Additionally, if results are qualified, the result will be marked with a footnote on the data table submitted to the data assessor with the footnote detailing the qualification.

3.1 Meeting user needs

Results of the study will be QA reviewed and evaluated to determine whether the needs of the project were met.

3.2 Managing unusable data

Unusable data will not be included in data tables or analysis.

E CITATIONS

Diederich, M., 2009. Memorandum to Michael Chotkowski in reply to: SHPO Case No. 09-1913 "J.C. Boyle Dam Costs/Benefits Study on Removal Project 39S 7E 29, 30, 31, 32 and 40S 7E 6, Klamath County", State Historic Preservation Office, Salem Oregon, September 29, 2009.

Donaldson, M.W., 2009. Memorandum to Michael Chotkowski in reply to: BUR090825B "Re: Geologic Investigation is Support of a Costs and Benefits Study on the Removal of Three Dams on the Klamath River, Siskiyou County, California (Tracking # 09-KBAO-253.1)", Office of Historic Preservation, California Department of Parks and Recreation, September 2, 2009.

DMT, 2009. *Standard Operating Procedures for Data Management*, Satpal Kalsi ed., United States Bureau of Reclamation, Mid Pacific Region, Environmental Monitoring Branch, July.

EMT, 2009. *Standard Operating Procedures for Environmental Monitoring*, Stuart Angerer ed., United States Bureau of Reclamation, Mid Pacific Region, Environmental Monitoring Branch, August.

EPA/USACE, 1998. Evaluation of Dredged Material Proposed For Discharge in Water of the U.S. – Testing Manual EPA-823-B-98-004. United States Environmental Protection Agency – Office of Water (4305) and Department of the Army US Army Corps of Engineers

EPA/USACE, 2001. The San Francisco Regional Water Quality Control Board, the San Francisco Bay Conservation and Development Commission.. Guidelines for Implementing the Inland Testing Manual in the San Francisco Bay Region

EPA/USACE, 1999. Proposed Guidance for Sampling and Analysis Plans (Quality Assurance Project Plans) for Dredging Projects within the USACE San Francisco District. San Francisco District Public Notice number 99-4

EPA/USACE, 2009. Washington Department of Ecology, Washington Department of Natural Resources, Oregon Department of Environmental Quality, Idaho Department of Environmental Quality, National Marine Fisheries Service, U.S.

Fish and Wildlife Service. Sediment Evaluation Framework for the Pacific Northwest, May.

EPA/USACE, 2008. Washington State Department of Natural Resources, Washington State Department of Ecology. Dredged Material Evaluation and Disposal Procedures (Users' Manual). Prepared by the Dredged Material Management Office

Shannon & Wilson, Inc. 2006a. Upland Contaminant Source Study, Segment of Klamath River, Oregon and California: report prepared by Shannon and Wilson, Inc., Richland, Washington for Gathard Engineering Consulting, Seattle Washington, Project no. 21-1-11192-001, August.

Shannon & Wilson, Inc., 2006b. Sediment Sampling, Geotechnical Testing, and Data Review Report, Segment of Klamath River, Oregon and California: report prepared by Shannon and Wilson, Inc., Richland, Washington for Gathard Engineering Consulting, Seattle Washington, Project no. 21-1-12195-001, September.

G&G Associates, 2003. Klamath River Dam Removal Investigations, J.C.Boyle Dam, Copco 1 Dam, Copco 2 Dam, and Iron Gate Dam, July.

Gathard Engineering Consulting, 2006. Klamath Sediment Study, Sediment Sampling Plan: Plan prepared by Gathard Engineering Consulting, Seattle, Wash., June.

Marshack, J.B. et. al., 2008. A Compilation of Water Quality Goals August 2003 with tables updated August 2007: California Regional Water Quality Control Board Central Valley Region.

Mongano, G. 2009, Scope of Work – Description of Geologic Drilling Program, Exhibits A and B. United States Bureau of Reclamation, Mid Pacific Region, Geology Branch.

QAT, 2009, *Standard Operating Procedures for Quality Assurance 2009-05*, Victor Stokmanis ed., United States Bureau of Reclamation, Mid Pacific Region, Environmental Monitoring Branch, May.

F FIGURES

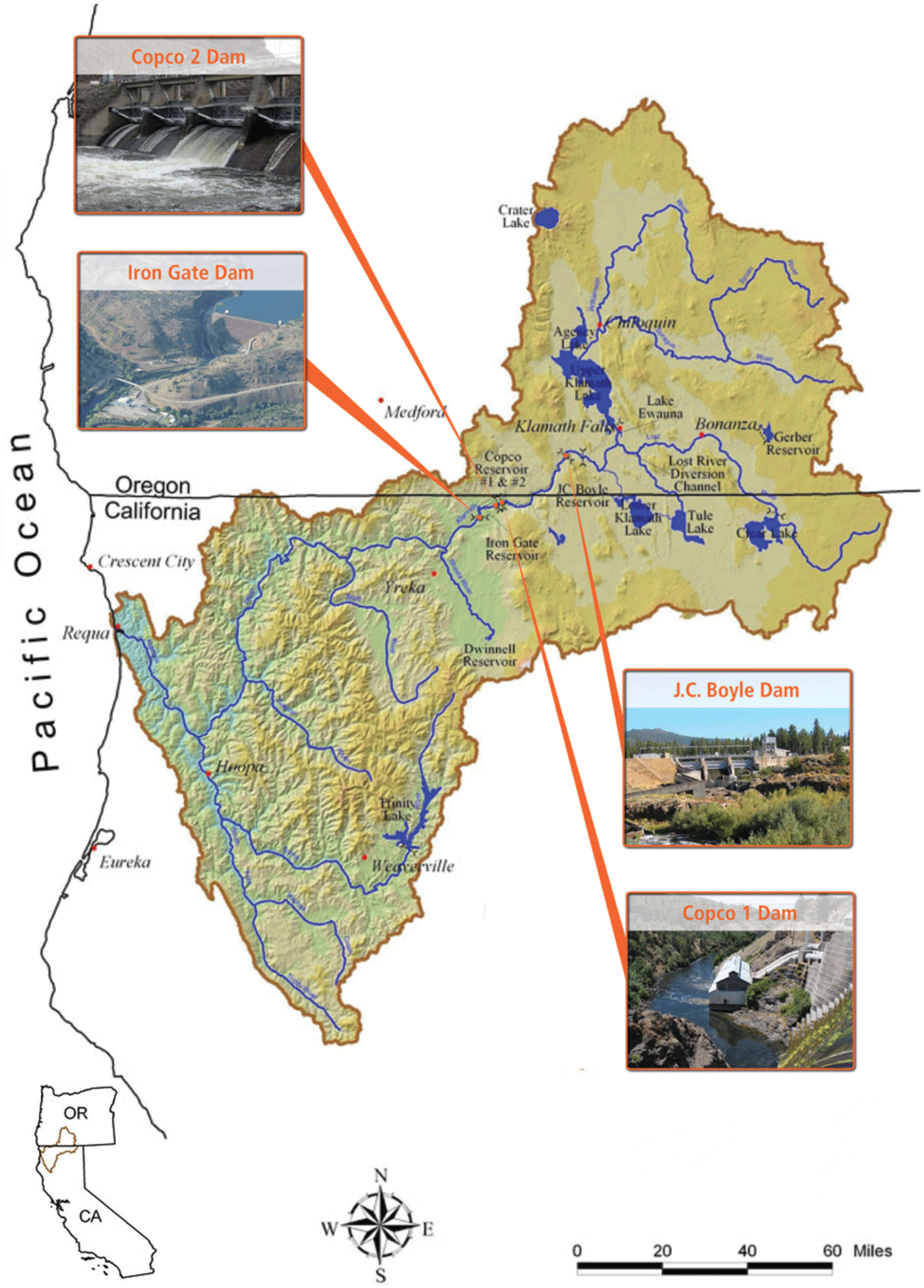


Figure 1: Regional overview of the Klamath River Basin, Oregon and California.

Locations of reservoir study sites JC Boyle, Copco 1 and 2, and Iron Gate.
The Klamath Estuary study site is located near the town of Requa, CA.

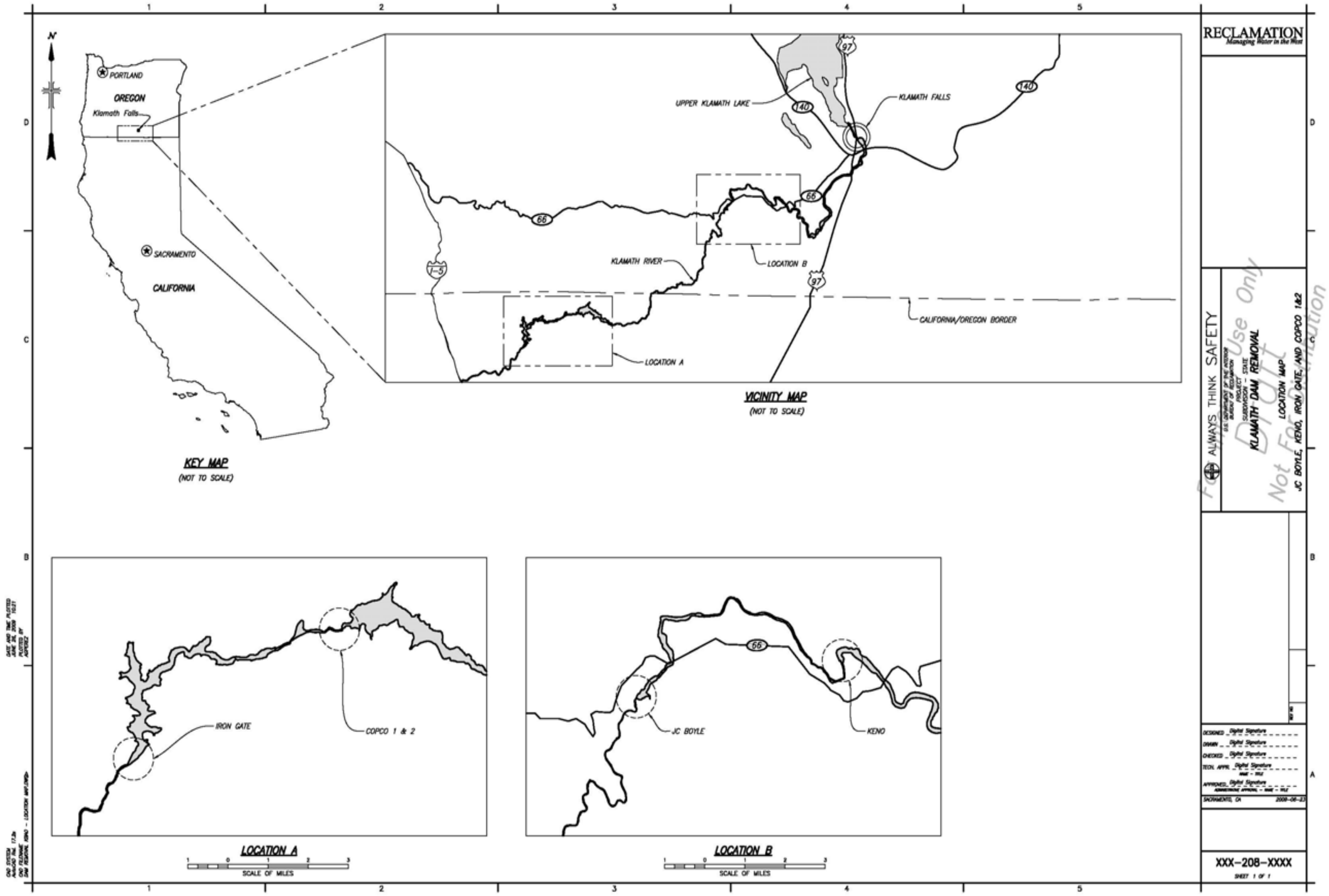
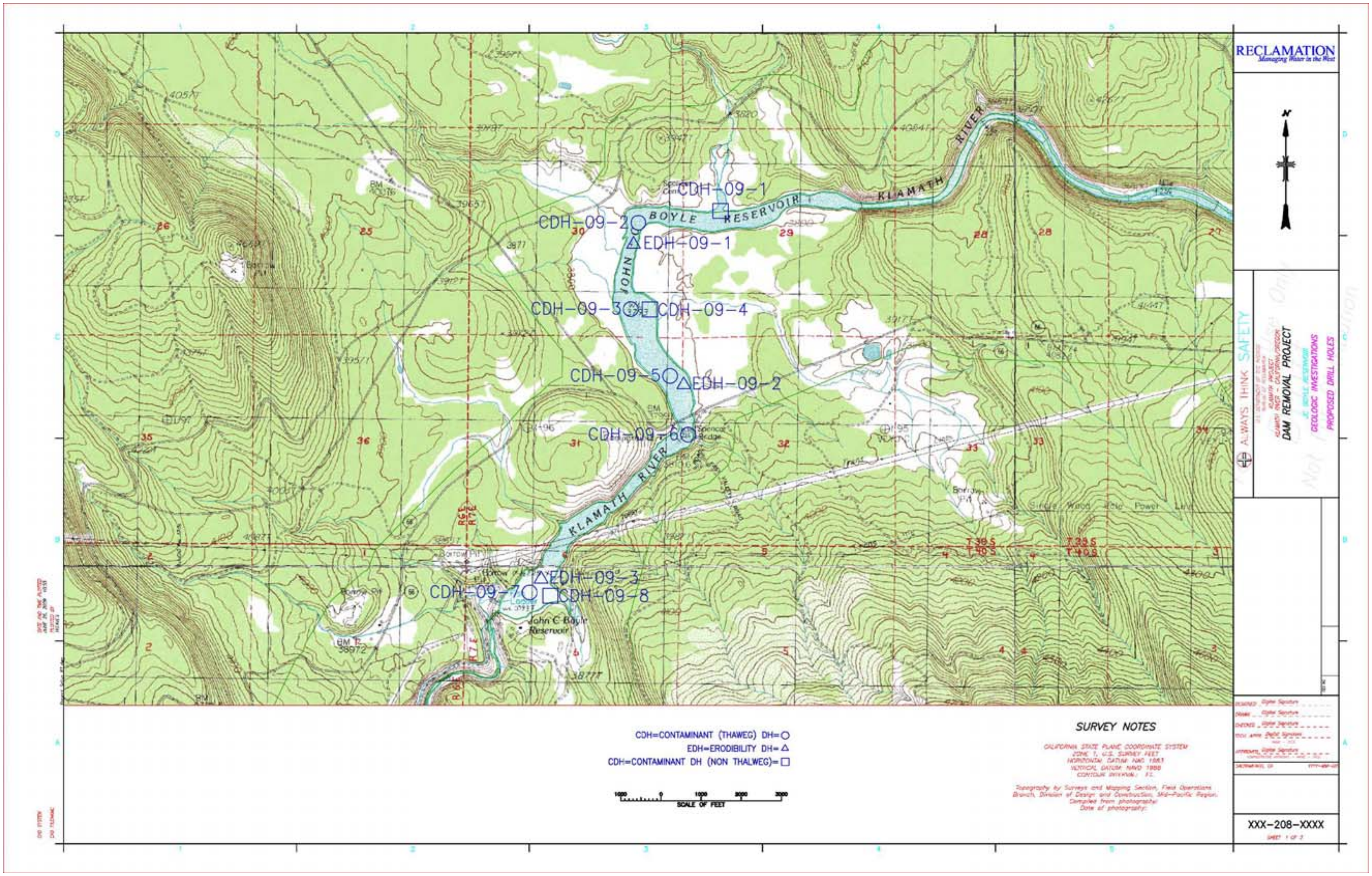
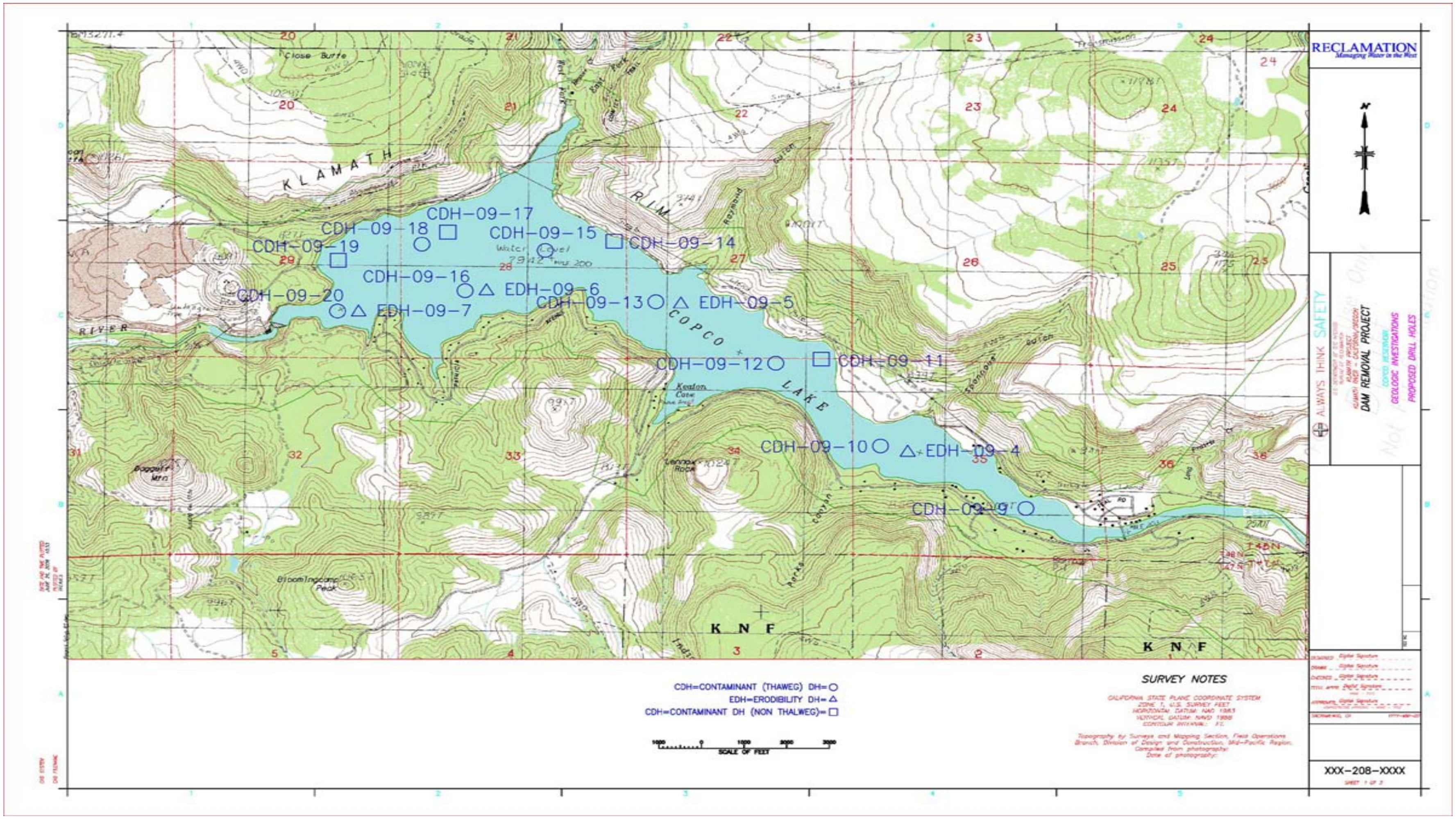


Figure 2: Location Overview - JC Boyle, Copco 1 & 2, and Iron Gate Reservoirs



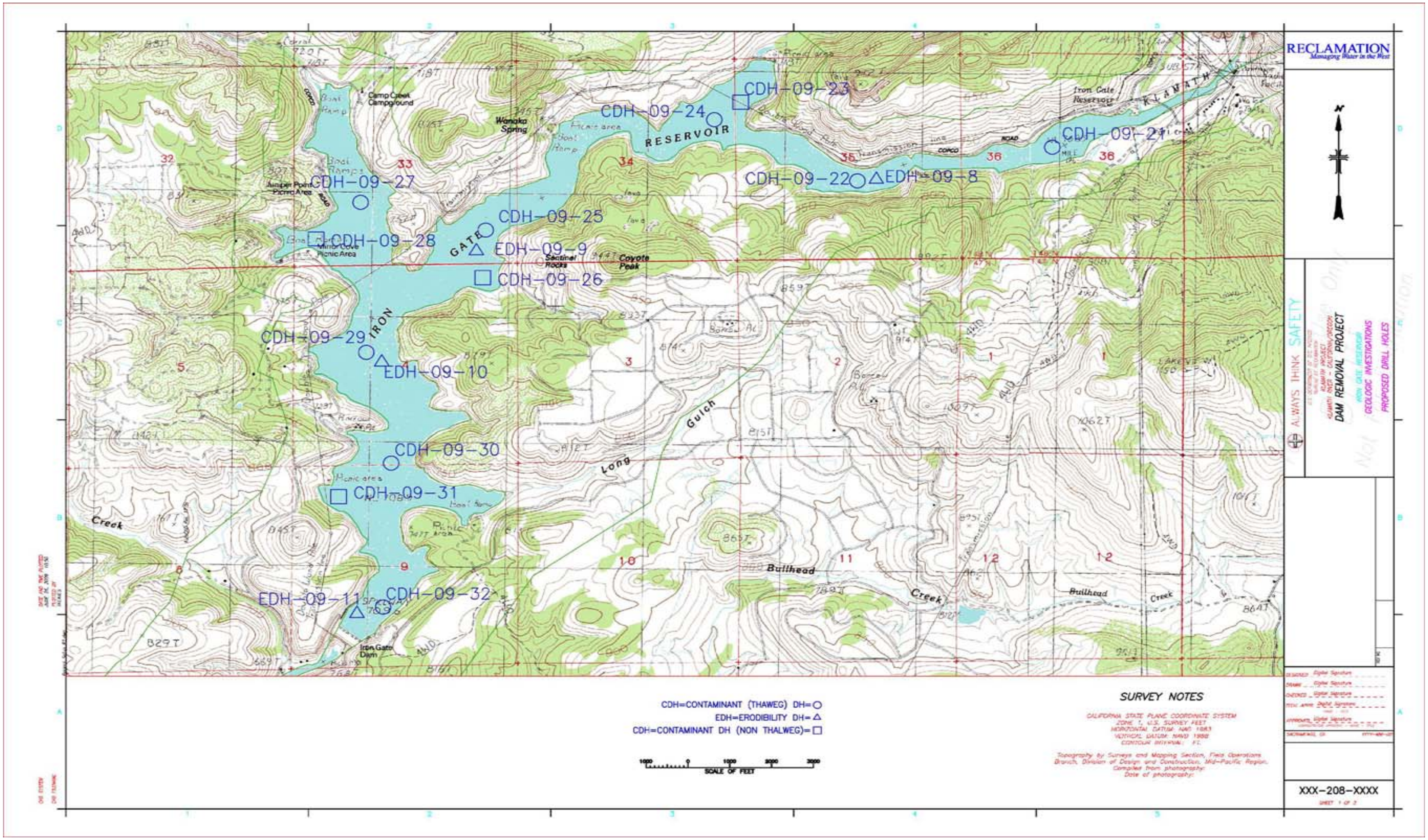
Open circles and open triangles indicate proposed locations for contaminant drill holes

Figure 3: Proposed Drill Hole Locations - JC Boyle Reservoir, CA



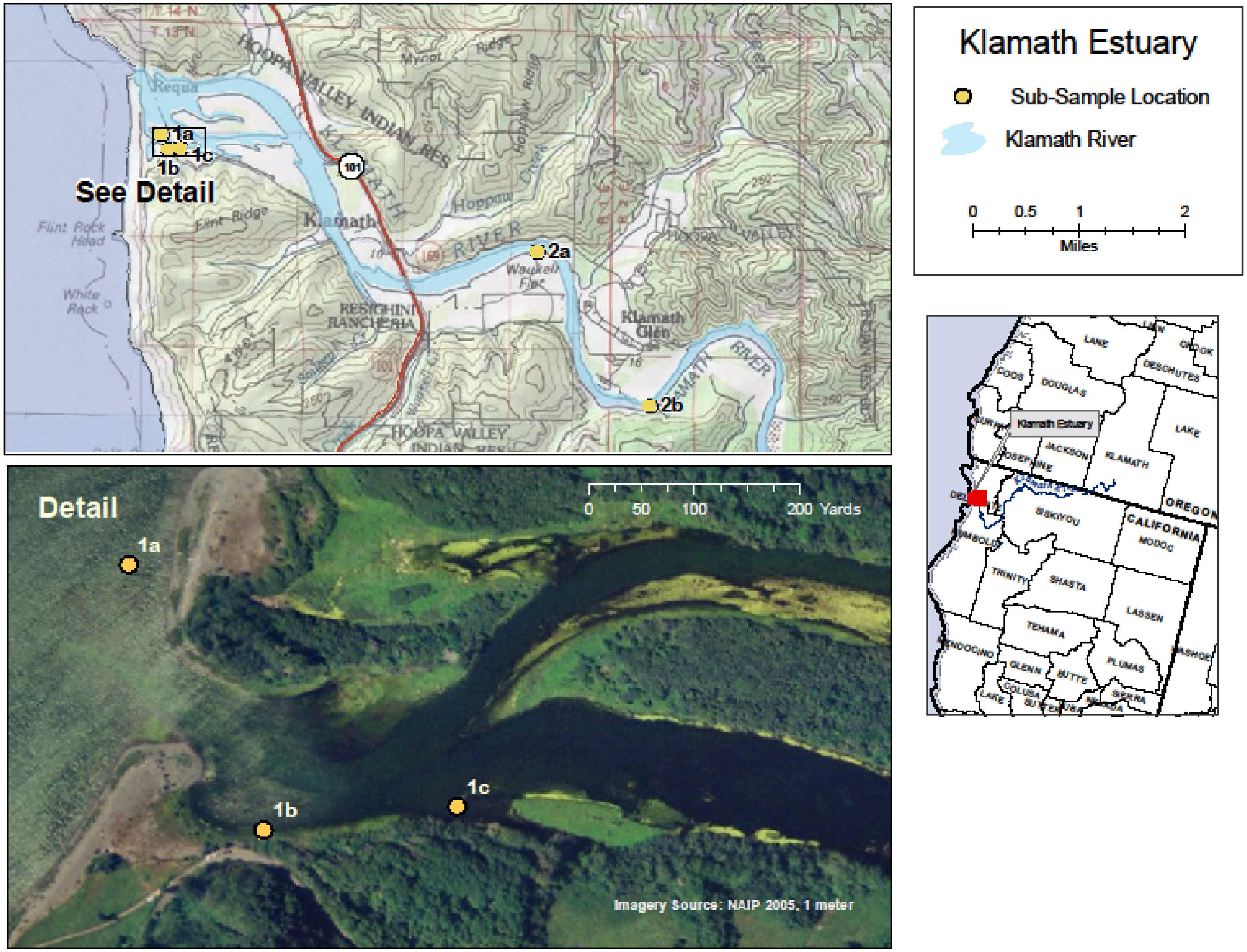
Open circles and open triangles indicate proposed locations for contaminant drill holes

Figure 4: Proposed Drill Hole Locations - Copco Reservoir, CA



Open circles and open triangles indicate proposed locations for contaminant drill holes

Figure 5: Proposed Drill Hole Locations - Iron Gate Reservoir, CA



04/27/2010

Figure 6: Proposed Sample Locations - Klamath River Estuary, CA

On maps, locations for sample CHA-S-001 are shown as 1a, 1b and 1c; locations for CHA-S-002 are shown as 2a and 2b.