Susitna-Watana Hydroelectric Project Document
ARLIS Uniform Cover Page

Title: Baseline water quality study, Study plan Section 5.5 : Initial study report -- Part B: Supplemental information (and errata) to Part A (February 3, 2014 Draft Initial Study Report)	**SuWa 223**
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Author(s) – Corporate: URS/Tetra Tech, Inc. [as stated on Attachment 1]	
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Notes: Most of Part B consists of: Attachment 1. Quality assurance project plan (QAPP) for water quality (WQ) and mercury assessment.	

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SUSITNA-WATANA HYDRO

Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Baseline Water Quality Study
Study Plan Section 5.5

Initial Study Report
Part B: Supplemental Information (and Errata) to Part A (February 3, 2014 Draft Initial Study Report)

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

June 2014

PART B: SUPPLEMENTAL INFORMATION (AND ERRATA) TO PART A (FEBRUARY 3, 2014 DRAFT INITIAL STUDY REPORT)

Part A Reference	Description
Section 5	Data for this study has been uploaded to GINA as part of the 5.5 Water Quality Study. The database 'Baseline water quality field data' has been updated on GINA since the February 2014 draft ISR. It can now be found at the following location: http://gis.suhydro.org/reports/isr
Section 4	An updated Quality Assurance Project Plan (QAPP) has been included as Attachment 1 to this document.
Page 13, Section 4.3.4, Paragraph 2	Delete entire paragraph, replace with: Point samples were also collected at PRM 174.0 to characterize water quality conditions below the dam site.
Page 16, Paragraph 7, Sentences 2 & 3	Ten sediment sampling sites were proposed in RSP section 5.5.4.6., not eight. Six sites were not visited in 2013 (Susitna Above Watana Dam, Susitna Below Watana Dam, Fog, Deadman, Watana, and Tsusena), not four. Visits to ten sites for collection of sediment samples were proposed in the RSP Section 5.5.4.6. Six sites were not visited in 2013 (Fog, Deadman, Watana, and Tsusena Creeks).
Page 21, Section 5.2, Paragraph 3	The referenced database 'Thermistor Data' [and summarized in Appendix B] has been updated on GINA since the February 2014 draft ISR. It can now be found at the following location: http://gis.suhydro.org/reports/isr
Page 22, Section 5.3, Paragraph 3	The referenced database 'Station MET data' [and summarized in Appendix C] has been updated on GINA since the February 2014 draft ISR. It can now be found at the following location: http://gis.suhydro.org/reports/isr
Page 22, Section 5.4.1., Paragraph 2	The referenced database 'Baseline water quality field data' [and summarized in Appendix D] has been updated on GINA since the February 2014 draft ISR. It can now be found at the following location: http://gis.suhydro.org/reports/isr
Page 27, Section 5.4.1.5., Paragraph 2	The referenced database 'Baseline water quality chlorophyll *a* data set' [and summarized in Appendix E] has been updated on GINA since the February 2014 draft ISR. It can now be found at the following location: http://gis.suhydro.org/reports/isr

Page 25, Section 5.4.2., Paragraph 3	The referenced database 'Focus Area field data spreadsheet' [and summarized in Appendix G] has been updated on GINA since the February 2014 draft ISR. It can now be found at the following location: http://gis.suhydro.org/reports/isr
Page 25, Section 5.4.2.5., Paragraph 2	The referenced database 'Focus Area chlorophyll *a* data set' [and summarized in Appendix G] has been updated on GINA since the February 2014 draft ISR. It can now be found at the following location: http://gis.suhydro.org/reports/isr
Page 21, Section 5.1. Data Validation/Verification, Paragraph 1	Add following sentence to the end of paragraph 1 in Section 5.1. "Data validation/verification reports (DVRs) provide a detailed analysis of the laboratory quality control process. Laboratory data that has undergone this portion of the quality assurance review can be found on the GINA website."
Page 31, Section 5.8. Groundwater Quality Selected Habitats, Paragraph 2, Sentence 2	Section 5.5 should be referenced as the section detailing why provisional lab data is not included in the ISR.
Page 39, Table 5.8-2	Table is incorrectly numbered Section 9, Tables. It should be numbered as Table 4.3-2 and is correctly referenced in the Section 4 text.
Page 40, of Table 5.8-2 (now updated to Table 4.3-2)	In corrected numbered table 4.3-2 (see above, was incorrectly numbered as Table 5.8-2), PRM: 174, Description: Susitna Below Watana Dam Site
Page 41, Table 5.8-1	Table is incorrectly numbered in Section 9, Tables. Should be numbered as Table 4.4-1 and is correctly referenced in the Section 4 text.

PART B – ATTACHMENT 1: QUALITY ASSURANCE PROJECT PLAN FOR WATER QUALITY AND MERCURY ASSESSMENT

Susitna-Watana Hydroelectric Project
(FERC No. 14241)

Baseline Water Quality Study
Study Plan Section 5.5

Initial Study Report
Part B – Attachment 1
Quality Assurance Project Plan (QAPP) for Water Quality (WQ) and Mercury Assessment

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

URS/Tetra Tech, Inc.

June 2014

A PROJECT MANAGEMENT ELEMENTS

A.1 Title and Approvals:

Title: Quality Assurance Project Plan for Water Quality and Mercury Assessment for the Susitna-Watana Hydroelectric Project, Susitna River, Southcentral Alaska

Date: May 2014

Project Implementation by: Alaska Energy Authority (AEA), URS Corporation (URS), and Tetra Tech, Inc. (Tt)

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Tetra Tech
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Name: Robert Plotnikoff WQ Technical Lead Phone: 206-728-9655
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Signature: _____ Date: _____

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A.2 TABLE OF CONTENTS

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LIST OF ABBREVIATIONS

AAC	Alaska Administrative Code
ADEC	Alaska Department of Environmental Conservation
AEA	Alaska Energy Authority
APDES	Alaska Pollutant Discharge Elimination System
AWQS	Alaska Water Quality Standards
BETX	benzene, ethylbenzene, toluene, xylenes
°C	degrees Celsius
cfu	colony forming unit
cm	centimeters
COC	chain of custody
DO	dissolved oxygen
DQI	data quality indicators
DQO	data quality objectives
DMRQA	Discharge Monitoring Report Quality Assurance
EPA	U. S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
GINA	Geographic Information Network of Alaska
g	grams
IDL	instrument detection limit
m	meter(s)
MDL	method detection limit
MSDS	material safety data sheet
µS/cm	microSiemens per centimeter
µg/L	micrograms per liter
mg/L	milligrams per liter
MQO	measurement quality objectives
NELAC	National Environmental Laboratories Accreditation Conference
NEPA	National Environmental Policy Act
ND	non-detect
NPS	nonpoint source
PAHs	polynuclear aromatic hydrocarbons
PDF	portable document format
PM	project manager
PQL	practical quantitation limit
PRM	Project river mile

PT	performance test
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	quality control
QCO	Quality Control Officer
RL	reporting limit
RM	river mile
RPD	relative percent difference
RSD	relative standard deviation
SNTEMP	Stream Network Temperature
SOP	Standard Operating Procedure
TAH	total aromatic hydrocarbons
TAqH	total aqueous hydrocarbons
TMDL	Total Maximum Daily Load
TL	Technical Lead
Tt	Tetra Tech, Inc.
URS	URS Corporation
USGS	United States Geological Survey

A.3 DISTRIBUTION LIST

This document will be distributed to Alaska Energy Authority (AEA), URS Corporation (URS), Tetra Tech, Inc. (Tt), and Alaska Department of Environmental Conservation (ADEC) staff members who are involved in this project, as well as to all other participants directly involved in supporting data collection, analysis, and data management for this project. Table 1 presents the distribution list for this Quality Assurance Project Plan (QAPP).

Table 1: QAPP Distribution List

Name	Position	Agency/ Company	Division/Branch/ Section	Contact Information
Betsy McGregor	Project Manager/ Environmental	AEA	Environmental Branch	Phone: 907-771-3957 Email: bmcgregor@aidea.org
Paul Dworian	URS Principal Manager	URS	GSR	Phone: 907-261-6735 Email: paul.dworian@urs.com
William Loskutoff	Project Quality Assurance Officer	URS	GSR	Phone: 907-261-6736 Email: william.loskutoff@urs.com
Harry Gibbons	Tetra Tech Project Manager	Tt	SWG	Phone: 206-728-9655 Email: harry.gibbons@tetratech.com
Robert Plotnikoff	Water Quality Technical Lead	Tt	SWG	Phone: 206-728-9655 Email: robert.plotnikoff@tetratech.com
Gene Welch	Quality Control Lead	Tt	SWG	Phone: 206-728-9655 Email: gene.welch@tetratech.com
Mark Vania	URS Field Operations	URS	GSR	Phone: 907-261-9755 Email: mark.vania@urs.com
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Nicole Noel	Project Analyst	Northern Lake Service, Inc.	Analytical Laboratory and Environmental Services	Phone: 716-478-2777
Dana Stewart	Data Manager	DES.IT, LLC	Data Resources Management	Phone: (907) 345-6398 Email:datadana3@yahoo.com
William Ashton	Project Manager	ADEC	DOW	Phone: (907) 269-6283 Email: William.Ashton@alaska.gov
TBD	Quality Assurance Officer	ADEC	DOW	907-465-5305 xxx.xxx@alaska.gov

AEA = Alaska Energy Authority
ADEC = Alaska Department of Environmental Conservation
DOW = Division of Water
GRS = Geosciences & Remediation Services
URS = URS Corporation
Tt =Tetra Tech
SWG = Surface Water Group

A.4 PROJECT TASK/ORGANIZATION

Table 2 lists the duties and responsibilities of key individuals and organizations participating in the Project. Figures 1a and 1b describe how each entity contributes to the project. The lines of reporting and communication between project staff are identified.

Additional technical staff will be responsible for conducting specific tasks during the project (e.g., performing field sampling and collecting surface water quality data) under the direction of the URS Field Operations Project Manager and the Tt Sampling Manager. The URS Field Operations Project Manager will have primary responsibility of all field staff and the Tt Sampling Manager. The URS Field Operations Manager and Tt Sampling Manager will supervise the technical staff participating in the project, including implementing the quality control (QC) program, completing assigned work in compliance with the approved QAPP and within schedule, and completing required documentation. They will direct the work of the field sampling team including collection, preparation, and shipment of samples and completion of field-sampling records. The field-sampling team will include scientific staff technically competent in the required field-sampling activities with experience qualifications set forth by ADEC, as necessary, to ensure the highest quality data are collected without incident, Technical staff involved with the program will be responsible for reading and understanding this QAPP and complying with and adhering to its requirements in executing their assigned tasks relative to this project.

Table 2: Project Organizational Responsibilities

Position Title	Company/ Agency	Division/ Branch/ Section	Responsibilities
Environmental Manager: **Betsy McGregor**	AEA	Environmental Branch	Responsible for project coordination with local, borough, state, and federal government officials; and for reviewing drafts of the study plan, QAPP and summary data reports. Directs URS activities.
Project Manager **William Ashton**	ADEC	DOW	Responsible for review of the QAPP and for ensuring permittee complies with permit required water quality monitoring as specified in the approved QAPP.
Water Quality Assurance Officer: **TBD**	ADEC	DOW	Responsible for review of the QAPP and quality assurance documentation for each of the water quality studies and overseeing data collection activities that are conducted to meet project data quality objectives.
Principal Manager: **Paul Dworian**	URS	GRS	Responsible for directing daily project activities and tracking product delivery. Communicates with AEA Environmental Manager on project schedule and timing for product delivery. Primary responsibility of URS staff and URS subcontractors.
Field Operations Project Manager: **Mark Vania**	URS	GRS	Responsible for project management of field logistics, sampling strategies, and field protocols. Ensures that all samples are collected from scheduled collection sites on a daily basis. Ensures that sample sets are transported each day to the laboratory. Also responsible for direction of URS and subcontractor field staff conducting water quality monitoring and sampling.
Project Quality Assurance Officer: **William Loskutoff**	URS	GRS	Reviews and approves the QAPP and independently evaluates progress in implementing the QAPP elements. Has stop work authority if necessary to correct QA/QC issues and directly apprises URS Principal Manager of any QA issues that may impact data quality and usability.
Water Quality Technical Lead: **Robert Plotnikoff**	Tt	SWG	Responsible for preparing the QAPP, coordinating Tt staff involved with sampling activities, analyzing project data, and preparing the draft and final data reports. Serves as the principal project team contact for Tt field staff for the duration of the study
Project Manager: **Harry Gibbons**	Tt	SWG	Responsible for managing the project for Tt, reports to URS Principal Manager, reviews analysis of project data, and review of the draft and final data reports. Serves as the Tt principal project team contact for the technical aspects of the study.
Sampling Manager: **Shannon Brattebo**	Tt	SWG	Responsible for Tt staff conducting water quality and field sampling. Ensure that field forms have data entries and are completed in accordance from direction of Field Operations Project Manager. Assists with sample packaging and shipment to analytical laboratory.
Quality Control Lead: **Gene Welch**	Tt	SWG	Reviews QAPP. Provides technical assistance on QA/QC issues during the implementation and assessment of the project.
Laboratory Manager: **Charles Homestead**	SGS	Alaska Division	Alaska Division Manager for SGS Laboratory Analytical Services. Manages laboratory staff that provide sample collection materials, sample handling and chain-of-custody documentation, and return of sample results to URS, including those from sub-contracted laboratories like Brooks and Rand and Northern Lake Service, Inc. Reports any laboratory errors and sample condition issues.
Data Manager: **Dana Stewart**	DES.IT, LLC	Data Resources Management	Responsible for organization, development, and management of AEA project database.

AEA = Alaska Energy Authority ADEC = Alaska Department of Environmental Conservation DOW – Division of Water GRS = Geosciences and Remediation Services
SWG = Surface Water Group URS = URS Corporation Tt =Tetra Tech

Figure 1a: Line of Authority

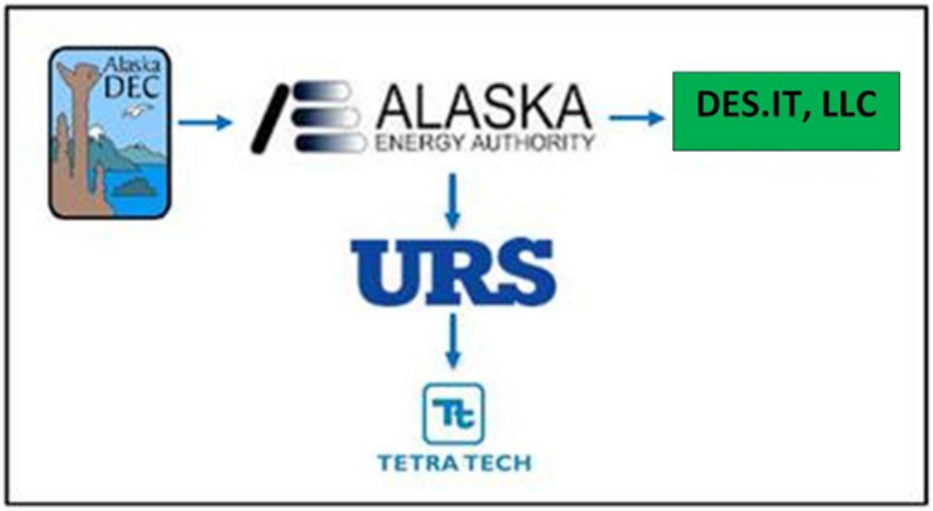
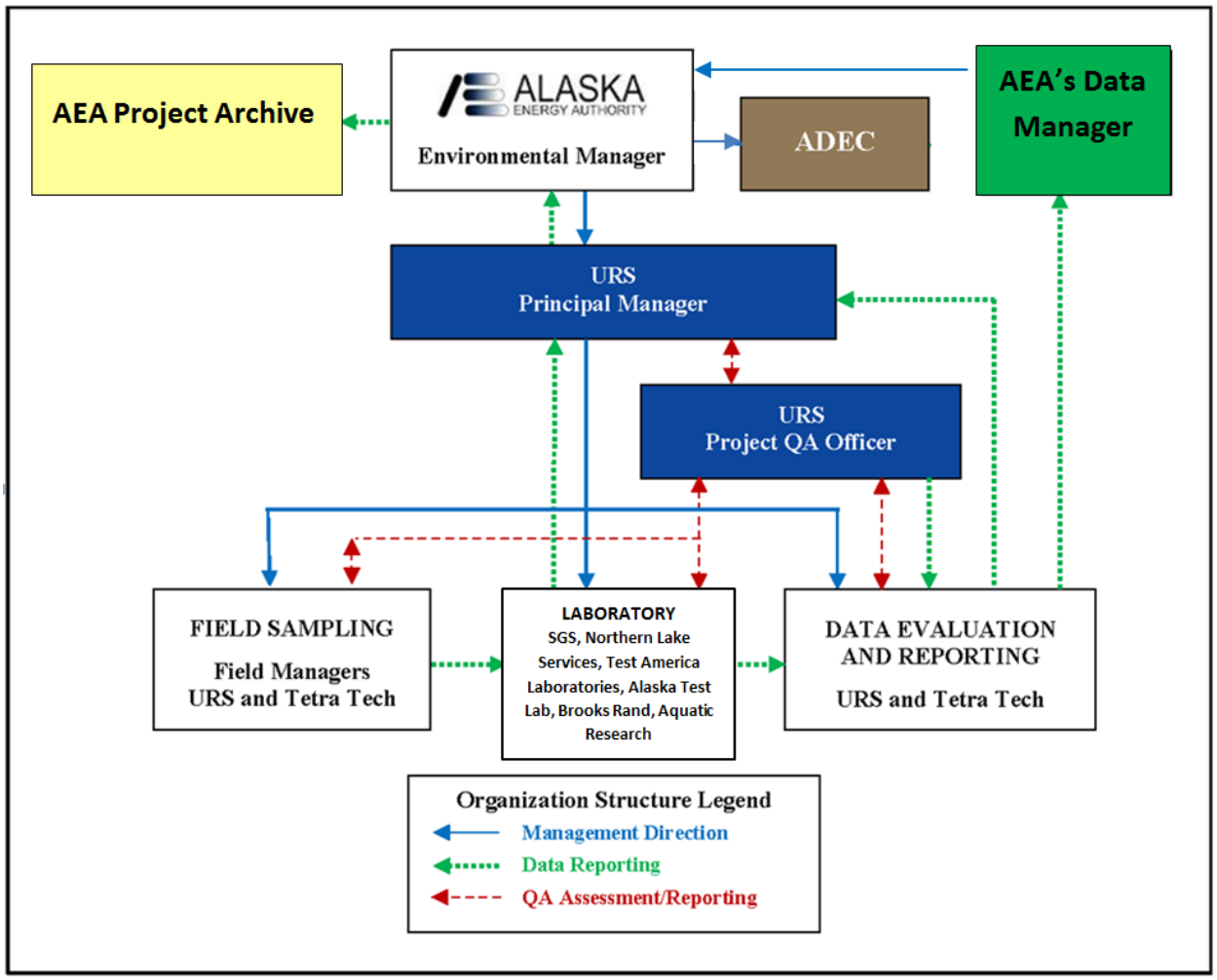


Figure 1b: Management and Reporting Scheme



A.5 PROBLEM DEFINITION/BACKGROUND AND PROJECT OBJECTIVES

A.5.1 Problem Definition

The AEA is preparing a License Application that will be submitted to the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project (Project). Construction and operation of the Project as described in the Pre-Application Document (PAD) (AEA 2011) is expected to change some of the water quality characteristics of the resulting riverine portion of the drainage downstream of the dam site as well as the inundated area that will become the reservoir. A large-scale assessment of water quality conditions throughout the Susitna drainage has not been completed. Monitoring information in the immediate vicinity of the reservoir and riverine habitat will be important for developing two models (reservoir and riverine) which will be coupled for predicting expected water quality conditions following construction. Additionally, establishment of new hydroelectric reservoirs has reported concerns with bioaccumulation and biomagnification of mercury in aquatic life and terrestrial wildlife following the flooding of terrestrial areas to create reservoirs. Potential receptors for mercury bioaccumulation are and will be present in the inundation area (macroinvertebrates, fish, birds, etc.).

On December 14, 2012, AEA filed its Revised Study Plan (RSP) with FERC for the Susitna-Watana Hydroelectric Project, FERC Project No. 14241, which included 58 individual study plans (AEA 2012). Included within the RSP was the Baseline Water Quality Study (Section 5.5.) and the Mercury Assessment and Potential for Bioaccumulation Study (Section 5.7). These sections, along with the Water Quality Modeling Study (Section 5.6), focus on the methods for assessing the effects of the proposed Project and its operations on water quality in the Susitna River basin. On April 1, 2013 FERC issued its study determination (April 1 SPD) for the RSP Section 5.5 and Section 5.7 approving the study with modifications. The FERC approved RSP as modified by FERC's April 1 SPD is referred to herein as the "Study Plan".

The Study Plan outlines the objectives and methods for developing a water quality monitoring program that will adequately characterize environmental conditions in the Susitna River watershed, within and downstream of the proposed Project area. This QAPP addresses the steps that AEA will undertake and protocols that AEA will follow when implementing the Baseline Water Quality Study (Study5.5) and the Mercury Assessment and Potential for Bioaccumulation Study (Study 5.7), collectively referred to as the Water Quality and Mercury Assessment. This comprehensive QAPP consolidates 1) the Baseline Water Quality Monitoring Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP) (December 2012) and 2) the Mercury Assessment and Potential for Bioaccumulation Study Sampling and Analysis Plan (SAP)/Quality Assurance Project Plan (QAPP) (December 2012) into one stand-alone QAPP. In so doing, this QAPP supersedes those previous QAPPs. This QAPP also incorporates FERC recommended changes to the previous QAPPs stated in the April 1, 2013 FERC Study Plan Determination (FERC SPD). See FERC SPD at B-8.

A.5.2 Project Background

Historical water quality information available for the study area includes water temperature data, some general water quality data, and limited metals data primarily collected during the 1980s.

Additional data have recently been collected at limited mainstem Susitna sites describing flow, in-situ, general, and metals parameters by the United States Geological Survey (USGS).

The purpose of the Water Quality and Mercury Assessment is to implement an expanded network for continuous temperature monitoring and for water quality and mercury data collection (including sediment, surface water, porewater, and groundwater, fish, soils, and vegetation). This additional information will be collected for the following reasons:

- More information is needed to define existing thermal refugia throughout the Susitna drainage.
- Limited information is available on natural, background conditions for water quality.
- It is unknown if seasonal patterns exist for select water quality parameters.
- Additional information is required for calibrating the water quality models (reservoir and riverine) to be used in the water quality modeling study. More recent water quality data will be used for predicting reservoir conditions and predicting riverine conditions downstream of the proposed dam.
- To determine whether conditions within the reservoir will cause mercury methylation following inundation.
- To determine the concentrations of methylmercury that might occur.
- Identify whether a mechanism exists (via fish and small invertebrates living in the methylation zone) to transfer that methylmercury to wildlife, resulting in detrimental impacts.

Table 3a summarizes selected historical information predominantly collected by USGS at five established monitoring sites that were used to help determine where and what to sample for model development as part of this Project. Table 3b summarizes mercury and methylmercury concentrations in sediment and fish at select locations within the Susitna River basin -reported by in Frenzel (2000). Historic data presented in these tables were generated using approved methods for analysis at that time. The peer review-process for USGS data reports ensures that all scientific and technical information observed current, accepted methods for generation of results.

Table 3a: Summary of Historic Monitoring Data

		Susitna River Monitoring Site Locations					Most Stringent Water Quality Standard & Designated Uses
Location Name		**Susitna**	**Sunshine**	**Talkeetna**	**Susitna at Gold Creek**	**Susitna near Cantwell**	
Project River Mile		**29.9**	**88.0**	**102.8**	**140.0**	**225.5**	
Date Collected		**October 2003 (USGS 15294350)**	**June 1986 (USGS 15292780)**	**May 2011 (USGS 15292700)**	**September 1986 (USGS 15292000)**	**July 1986 (USGS 15291500)**	
Analyte	**Units**						
Water Temperature	ºC	0-5	5-14	3.5-13.5	0-6.5	4.0-13	13-20 ºC [growth and propagation of fish and shellfish, other aquatic life and wildlife; aquaculture] 15 ºC [migration routes, rearing areas; drinking water supply] 13 ºC [spawning areas and egg & fry incubation]
Dissolved Oxygen	mg/L	10.5-13	9-13.4	9.9-12.5	11.1-13.3	11.5-12.0	≥7.0 and ≤17.0 mg/L [growth and propagation of fish and shellfish, other aquatic life and wildlife; aquaculture]
pH	Standard Units	7.6-8.0	7.1-8.3	7.3-8.6	7.2-8.3	7.5-8.1	6.5-8.5 pH units (and ≤0.5 from natural) [growth and propagation of fish and shellfish other aquatic life and wildlife; aquaculture]
Turbidity	NTUs	1.2-75	43-500	2-340	5.3-10	N/A	Natural + 5-15 NTUs [contact and secondary recreation]
Conductivity	µmhos/cm	108-230	80-170	62-157	107-300	125-187	N/A
Ortho-phosphate	mg/L	<0.1	0.031-0.061	<0.031	0-0.061	<0.1	N/A
Nitrate –Nitrogen, Total	mg/L	0.16-0.28	N/A	0.1-0.21	NA	0-0.25	10,000 µg/L [contact recreation; drinking water supply]

Location Name		Susitna River Monitoring Site Locations					Most Stringent Water Quality Standard & Designated Uses
		Susitna	Sunshine	Talkeetna	Susitna at Gold Creek	Susitna near Cantwell	
Project River Mile		29.9	88.0	102.8	140.0	225.5	
Date Collected		October 2003 (USGS 15294350)	June 1986 (USGS 15292780)	May 2011 (USGS 15292700)	September 1986 (USGS 15292000)	July 1986 (USGS 15291500)	
Analyte	Units						
Bicarbonate	mg/L	55-92	52	25-50	45-107	59-72	RSC <1.25 m_{eq}/L [agricultural stockwater; agricultural irrigation]
Chloride	mg/L	3.1-18	2.2-5.8	1.4-9.5	5-20	2.1-9.2	230,000 µg/L [chronic aquatic life criteria]
Sulfate	mg/L	13-20	3-16	1-18	12-38	10-18	250,000 µg/L [drinking water supply]
Calcium (dissolved)	mg/L	16-31	14-23	6.8-17	16-37	18-25	SAR <2.5, Na% <60, RSC <1.25 m_{eq}/L [agricultural stockwater; agricultural irrigation]
Magnesium (dissolved)	mg/L	2.6-4.6	2-3.5	0.4-3.9	2.2-8.3	2.2-4.4	SAR <2.5, Na% <60, RSC <1.25 m_{eq}/L [agricultural stockwater; agricultural irrigation]
Sodium (dissolved)	mg/L	2.8-8.6	2.3-4.4	2.7-9.7	4-13	2.1-6.3	SAR <2.5, Na% <60, RSC <1.25 m_{eq}/L [agricultural stockwater; agricultural irrigation]
Potassium (dissolved)	mg/L	1.1-2.0	1.1-2.8	0.5-2.9	1.1-5	1.4-5.2	Na% <60, 110,000 µg/L [growth and propagation of fish and shellfish; agricultural stockwater; agricultural irrigation water]
Total Hardness	mg/L	51.6-96	43.6-72	22-50.8	49-120	58-76	N/A
Aluminum (total)	µg/L	NA	22,000	4,600	14,000	NA	87 µg/L (or 750 if pH is ≥7.0 and hardness is ≥50) [chronic aquatic life criteria]
Barium (total)	µg/L	<100	20-0	0-200	NA	NA	2000 µg/L [drinking water supply]
Cadmium (dissolved)	µg/L	≤1	≤1-24	≤1-5	≤1-20	NA	0.09-0.64 µg/L [chronic aquatic life criteria; hardness dependent]

		Susitna River Monitoring Site Locations					Most Stringent Water Quality Standard & Designated Uses
Location Name		**Susitna**	**Sunshine**	**Talkeetna**	**Susitna at Gold Creek**	**Susitna near Cantwell**	
Project River Mile		**29.9**	**88.0**	**102.8**	**140.0**	**225.5**	
Date Collected		**October 2003 (USGS 15294350)**	**June 1986 (USGS 15292780)**	**May 2011 (USGS 15292700)**	**September 1986 (USGS 15292000)**	**July 1986 (USGS 15291500)**	
Analyte	**Units**						
Selenium (total)	µg/L	<1	<1	<1	<1	NA	5 µg/L [chronic aquatic life criteria]
Copper (dissolved)	µg/L	2-20	1-10	10-30	2-5	NA	2.7-29 µg/L [chronic aquatic life criteria; Hardness dependent in the range 25-400]
Iron (total)	µg/L	260-5,400	7,600-32,000	70-17,000	800	12,000	1000 µg/L [chronic aquatic life criteria]
Lead (dissolved)	µg/L	<2-11	<1-3	<10-<30	<1-5	NA	0.54-11 µg/L [chronic aquatic life criteria; Hardness dependent in the range 25-400]
Manganese (total)	µg/L	20-130	170-670	10-520	20	230	50 µg/L [consumption of water + aquatic organisms]
Mercury (dissolved)	µg/L	0-3	<0.1	NA	≤0.2	NA	0.012 µg/L as total [chronic aquatic life (from 1999 AWQS)]
Arsenic (dissolved)	µg/L	0-4	1-3	0-8	1-2	NA	10 µg/L as total [drinking water supply]
Nickel (dissolved)	µg/L	0-5	0-2	0-5	0-3	NA	16-170 µg/L [chronic aquatic life criteria; Hardness dependent in the range 25-400]
Zinc (dissolved)	µg/L	6-160	10-65	3-90	6-20	NA	36-380 µg/L [acute and chronic aquatic life criteria; Hardness dependent in the range 25-400]

Note: Shaded cells indicate values that are greater than the most stringent water quality standard

Table 3b: Summary of Mercury and Methylmercury in Sediment and Fish

Location	Media	Total Mercury (µg/g dry weight)	NOAA Sediment Screening Level for Total Mercury (µg/g dry weight)	Methylmercury
Talkeetna River	Sediment	0.04	0.174	N/A
	Fish	0.08		N/A
Deshka River	Sediment	0.021-0.46	0.174	0.00510
	Fish	0.11-0.246		N/A
Costello Creek	Sediment	0.169-0.23	0.174	0.00004
	Fish	0.08-0.101		N/A
Colorado Creek	Sediment	0.18	0.174	N/A

Notes:
All data from Frenzel, 2000. *Selected Organic Compounds and Trace Elements in Streambed Sediments and Fish Tissues, Cook Inlet Basin, Alaska*. USGS Water Resources Investigation Report 00-4004.
N/A – not available
µg/g – micrograms per gram
NOAA-SQuiRTs Tables (Buchman, 2008). Threshold Effects Level (TEL) value for sediment shown.

In 2012, The Alaska Department of Environmental Conservation (ADEC) analyzed total mercury in salmon and other freshwater species for the Susitna River drainages, which included six of the eight species targeted in the Study Plan (ADEC, 2012a). Total mercury concentrations in those six species ranged from 0.0735 to 0.38 milligrams per kilogram (wet weight). The ADEC limit for mercury in fish tissue that protects human health consumption is 0.3 mg/kg. Those concentrations in this data set that exceed the human health criterion were measured from older age class pike and burbot.

In 2011, a data gap analysis was conducted for water quality and sediment transport summarizing mainstem and tributary data available (URS 2011). Additionally, in 2012, water temperature data loggers and meteorological stations were installed throughout the Project area and maintained for continuous data collection as part of ongoing studies. Some general observations based on existing data are as follows:

- Large amounts of data were collected during the 1980s. However, a comprehensive data set for the Susitna River and tributaries is not available.
- The influence of major tributaries (Chulitna and Talkeetna rivers) on Susitna River water quality conditions is unknown. There are no monitoring stations in receiving water at these mainstem locations.
- Continuous temperature data and seasonal water quality data are not available for the Susitna River mainstem and sloughs potentially used for spawning and rearing habitat.
- Establishment of new hydroelectric reservoirs had reported concerns with bioaccumulation and biomagnification of mercury in aquatic life and terrestrial wildlife. Studies conducted by others at developed projects document increased mercury concentrations in wildlife following the flooding of terrestrial areas to create reservoirs.

Selection of parameters for the proposed monitoring plan was based on three elements:

- Identification of data gaps based on analysis of historic data collection effort;
- A need for current water quality information and parameters for developing a riverine and reservoir model; and
- Additional parameters based on consultation with license participants.

A.5.3 Project Objective(s)

This QAPP presents the project organization, project data quality objectives, sampling and analytical protocols, and data management procedures to be implemented to help ensure that the data collected for the Water Quality and Mercury Assessment are scientifically valid and defensible and that uncertainty has been reduced to a known and practical minimum. This QAPP documents the quality assurance (QA) and quality control (QC) measures that will be employed to confirm sample collection and field measurements are compliant with the approved procedures in this QAPP; that laboratory analyses are performed per the methods and criteria presented in this QAPP; and that data are accurately reported, meet specified measurement quality objectives, are validated and qualified if necessary, and are usable to address stated project data quality objectives. Data collection methods will follow established state and federal (e.g., ADEC, U.S. Environmental Protection Agency [EPA]) guidelines.

The goal of the Water Quality and Mercury Assessment is to assess the impacts of the proposed Project construction and operations on water quality in the Susitna River basin with particular reference to state water quality standards set forth in ADEC regulations Title 18-Health, Safety, and Housing; Chapters: 70-Water Quality Standards; and 80-Drinking Water Standards of the Alaska Administrative Code (AAC); 18 AAC 70, and 18 AAC 80, respectively (ADEC 2012b and ADEC 2012c). Predicting the potential impacts of the dam and its proposed construction and operations on water quality will require the development of water quality models. In addition, requirements of the 401 Water Quality Certification Process will be addressed by products generated in Study 5.6 (Water Quality Modeling).

The Water Quality and Mercury Assessment will generate data from multiple media and estimate the potential changes to water quality and mercury concentrations post-impoundment, and the impacts these changes will have on the ecosystem. Data will be collected from surface water, groundwater, porewater, sediment, fish tissue, feathers or fur from piscivorous birds and mammals, vegetation, and soils. Additionally, continuous temperature monitoring will be conducted across the Project to inform the predictive model on how the mainstem river and tributaries will respond to alternative Project operational scenarios and if changes in water quality conditions could affect aquatic life use and survival in the Project area. Specific studies found in this QAPP include: the Baseline Water Quality Study (Study5.5), and the Mercury Assessment and Potential for Bioaccumulation Study (Study5.7).

The objectives of the Baseline Water Quality Study are to:

• Measure baseline metals concentrations in sediment and fish tissue for comparison to state criteria.

- • Document historical water quality data and combine with data generated from this study. The combined data set will be used in the water quality modeling study to predict Project impacts under various operations.

- Add three years of current stream temperature and meteorological data to the existing historical data. Stream temperatures and meteorological data were collected in 2012 (Tetra Tech 2012) and will continue to be collected in 2013 and 2014.
- Develop a monitoring program to adequately characterize surface water physical, chemical, and bacterial conditions in the Susitna River within and downstream of the proposed Project area.
- Measure baseline inorganic metals concentrations in sediment and fish tissue for comparison to applicable federal and state criteria.
- Perform Thermal Infrared Remote (TIR) sensing of the Susitna River from Susitna

Station (Project River Mile [PRM] 29.9) to Deadman Creek (PRM 235.6), and use this

data to map groundwater discharge and possible extent of thermal refugia.

The objectives of the Mercury Assessment and Potential for Bioaccumulation Study are to:

- Summarize available and historic water quality data and combine with data generated from this study. The combined data set will be used in the water quality modeling study to predict Project impacts under various operations.
- Characterize the baseline mercury concentrations of various media within the Susitna River and tributaries based on collection and analysis of samples from vegetation, soil, water, sediment, porewater, fish tissue, and feathers or fur from piscivorous birds and mammals.
- Utilize available geologic information to determine if a mineralogical source of mercury exists within the inundation area.
- Map mercury concentrations of soils and vegetation within the proposed inundation area. This information will be used to determine where mercury methylation may occur.
- Use the water quality model to predict where in the reservoir conditions (pH, dissolved oxygen, turnover) are likely to be conducive to methylmercury formation and when fish are exposed to potential for bioaccumulation of methylmercury.
- Use modeling to estimate methylmercury concentrations in fish.
- Assess potential pathways for methylmercury to migrate to the surrounding environment.
- Coordinate study results with other study areas, including fish, instream flow, and other piscivorous bird and mammal studies.

A.6 PROJECT/TASK DESCRIPTION AND SCHEDULE

A.6.1 Project Description

The Project is located on the Susitna River, an approximately 300 mile long river in the south-central region of Alaska. The study area includes the Susitna River within the proposed Watana Reservoir and downstream of the proposed Watana Dam. Water quality studies will be conducted from project river mile (PRM) 19.9 (Susitna River above Alexander Creek) to PRM 235.2 (at Oshetna River, just above the upper extent of the proposed reservoir area) and within select tributaries. The proposed dam would be located at PRM 187.2. The dam would create a reservoir 42.5 miles long and 1 to 2 miles wide, with a normal reservoir surface area of approximately 23,546 acres and a normal maximum pool elevation of 2,050 feet. The lowermost

boundary of the monitoring activity is above the area protected for Beluga whale activity. The results of this study and others will provide information needed to support the FERC's National Environmental Policy Act (NEPA) analysis for the Project license.

The sampling components associated with the Water Quality and Mercury Assessment are largely based on sampling frequency, parameters measured, and geography. Baseline water quality monitoring sites will be located at (or nearby) the same sites characterized during the 1980s studies, as well as additional locations along the mainstem river (Figure 2a). Additional details on the continuous temperature and baseline water quality monitoring sites may be found in the Study Plan and Section B.1.2.

Seven focus areas, located in or near major tributaries, are intended to serve as specific geographic areas of the river that will be the subject of intensive investigation by multiple resource disciplines including water quality (Figure 2b). Focus areas represent important spawning and rearing habitat for anadromous and resident fisheries and are sampled at a higher frequency compared to baseline monitoring. Groundwater will be collected from four of the seven focus areas. Additional information on the location of monitoring sites is in Section B.1.2.

To determine the potential for mercury bioaccumulation following inundation, samples of soil, vegetation, surface water, sediment porewater, sediment, feathers from piscivorous birds, fur from mammals, and fish tissue will be collected and analyzed. Sample locations for soil, vegetation, fur, and feather will be based on areas where the reservoir is expected to inundate existing vegetation and soils above the current waterline. The sample location of aqueous media (surface water, groundwater, sediment, porewater, and fish tissue) will correspond to the previously described sampling activities along the mainstem, tributaries, and the focus areas.

Parameters to be measured as part of the Water Quality Monitoring and Mercury Assessment Program are listed in Table 4. The parameters selected for analyses as part of the Baseline Water Quality Monitoring correspond to the Alaska Water Quality Standards water quality criteria (18 ACC 70.020(b)) for protecting designated uses in fresh water, when available. Similar to Baseline Water Quality Monitoring, Focus Area samples were analyzed for organics, metals, nutrients, and conventional/ other analyses; however, only surface water and ground water samples were collected in these reaches. Sub-sets of the full set of conventional parameters and metals were considered for other media like: sediment, soils, vegetation, fur, feathers, and fish tissue and determined based on concerns that some constituents in these media are known to be released when new reservoirs are flooded. In addition, the parameters listed in Table 4 that will be analyzed in each of the media are known to transfer between trophic levels once sequestered in sediment or absorbed by vegetation.

Figure 2a. Overview of Baseline Water Quality and Temperature Data Collection Sites

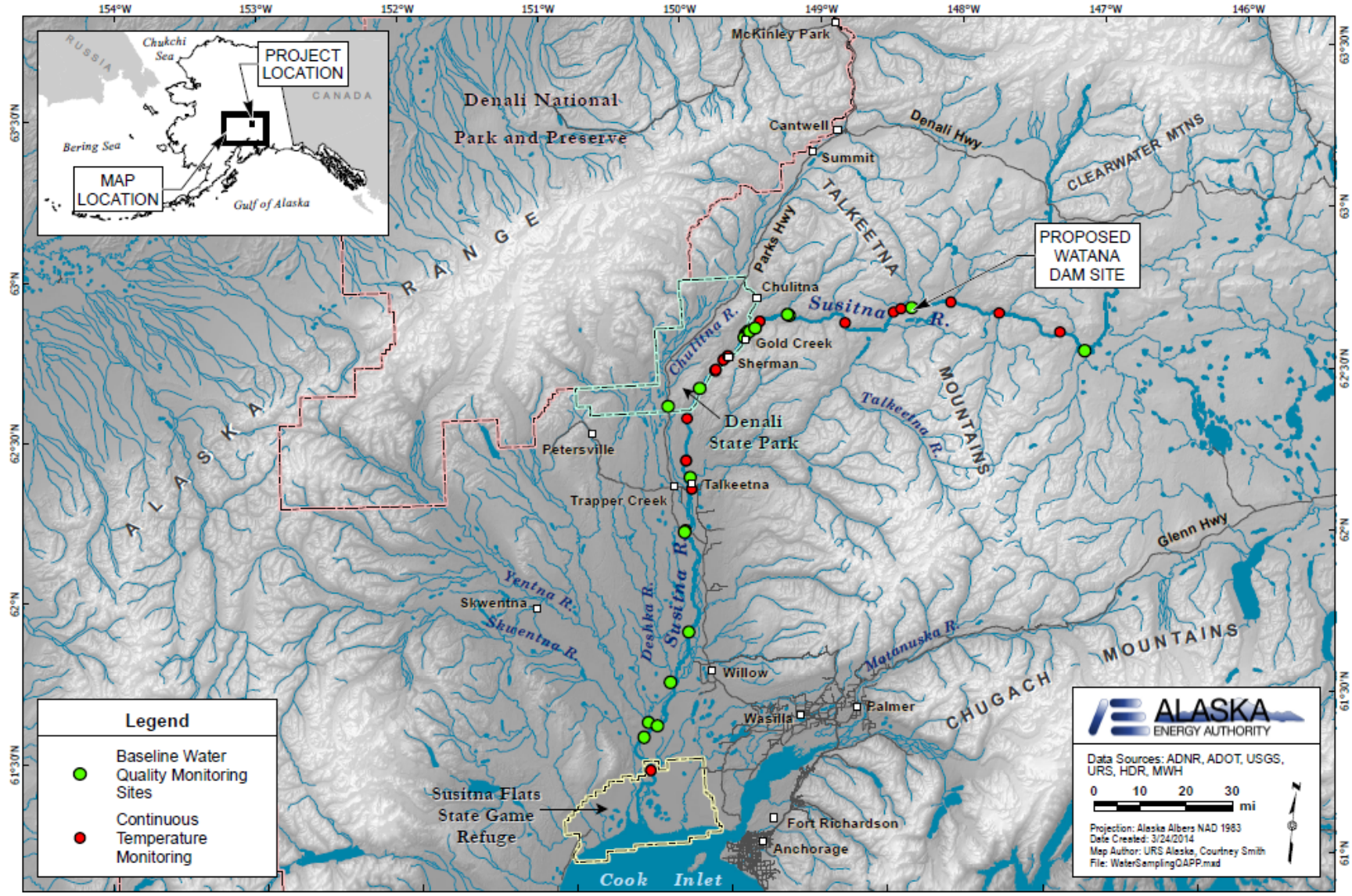


Figure 2b. Overview of Focus Area Water Quality Data Collection Sites

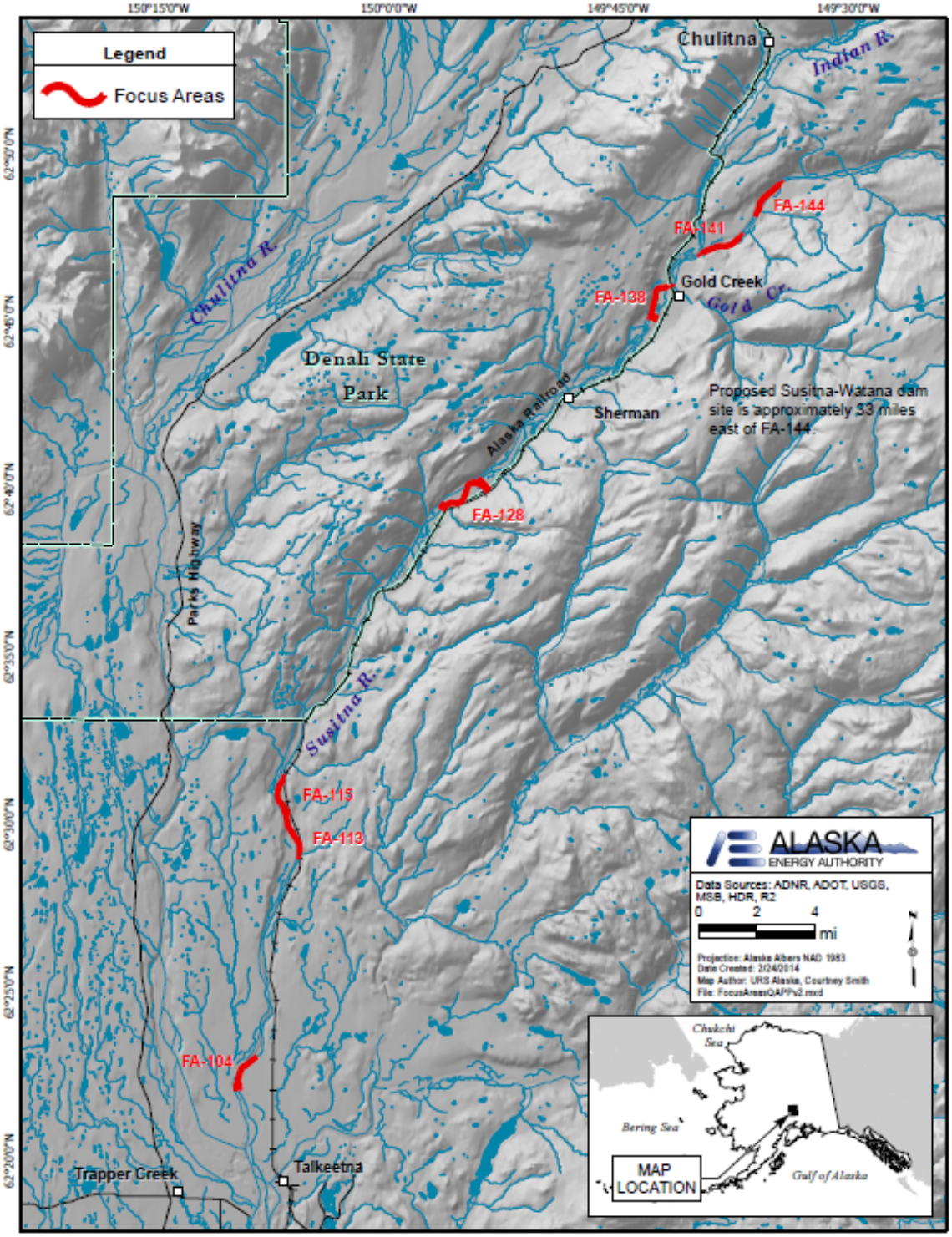


Table 4: Parameters to be Measured

In Situ Samples/Field Measurements	Grab Samples/Laboratory Measurements
Water Temperature	Hardness
Dissolved Oxygen (DO)	Alkalinity
pH	Nitrate/Nitrite
Specific Conductance	Ammonia as N
Redox Potential	Total Kjeldahl Nitrogen (TKN)
Color	Total Phosphorus
Residues	Ortho-Phosphate
	Chlorophyll-a
	Turbidity
	Total Dissolved Solids
	Total Suspended Solids
	Total Organic Carbon (TOC)
	Dissolved Organic Carbon (DOC)
	Fecal Coliform
	TAH: Sum of benzene, ethylbenzene, toluene & xylenes
	TAqH: Sum of EPA 610 Polynuclear Aromatic Hydrocarbons (PAHs) + TAH
	Radionuclides
	Aluminum
	Arsenic
	Barium
	Beryllium
	Cadmium
	Calcium
	Chromium (Total)
	Cobalt
	Copper
	Iron
	Lead
	Manganese
	Magnesium
	Mercury
	Methylmercury
	Molybdenum
	Nickel
	Selenium
	Thallium
	Vanadium
	Zinc
	Sediment Size
	Total Solids

A.6.2 Project Implementation Schedule

The Water quality and Mercury Monitoring Assessment began October 2012 and will continue through October 2014. Additional monitoring effort may occur in 2015 should it be required based on quality review of the data generated in 2013 and 2014. The exact scheduling of the monthly and seasonal sampling will be coordinated among AEA, URS, Tt, ABR, HDR, and LGL staff. Table 5 summarizes the schedule of activities and deliverables. Section B.1.3 further discusses the parameters, collection frequency, and total number of samples expected to be collected for each site.

Table 5: Project Implementation Schedule

Monitoring Activity	Timeline
Meteorological Station Installation and Data Collection (as part of the 2012 Water Temperature Monitoring and Meteorological Station Installation Study)	July 2012 & July 2014
Re-Deployment of Temperature Monitoring Apparatus (if removed before winter ice-up)	June 2013 (retrieve in October 2013) & June 2014 (retrieve in October 2014)
Water Quality Monitoring (monthly)	June 2013-September 2014 (one sampling event in each of January 2013 and March 2014)
Focus Area Surface Water Quality Sampling (every 2 weeks for 6 week period)	July-August 2013 & July-August 2014
Sediment Sampling (one survey)	September 2013 & September 2014
Fish Tissue Sampling (one survey)	August-September 2012/2013
Fur and Feather Sampling (one survey)	Summer 2015 (Will be implemented if results from pathways analysis indicate transfer of mercury/methylmercury from the aquatic to terrestrial environment)
Soil and Vegetation Sampling (one survey)	August-September 2013
Thermal Imaging (one survey)	October 2012/2013
Field Audit	August 2013 & August 2014
Data Analysis and Management	June 2013-March 2014 & June 2014-March 2015
Data QA Review	June 2013-March 2014 & June 2014-March 2015
QA Review of Draft Initial Study Report	December 2013
Draft and Final Initial Study Report	June 2014
QA Review of Updated Study Report	December 2015
Updated Study Report	February 2015

A.7 DATA QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

A.7.1 Data Quality Objectives (DQOs)

DQOs are qualitative and quantitative statements derived from the DQO process that clarify the monitoring objectives (i.e., determine water/wastewater pollutant concentrations of interest and how these values compare to water quality standards regulatory limits).

For this Tier 2 QAPP, the DQOs require attainment of sufficient data quality to demonstrate compliance with Alaska Water Quality Standards (AWQS). Data will meet all measurement quality objectives (MQOs) in order to ensure consistent quality for use in calibrating and running the water quality and pathway models for predicting outcomes of water quality scenarios under different Project operation scenarios.

Data Quality Objectives (DQOs, EPAQA/G4) are qualitative and quantitative statements derived from the DQO Process that:

- Clarify the monitoring objectives (i.e., determine water constituent concentrations of interest and how these values compare to water quality standards regulatory limits); and
- Define the appropriate type of data needed in order to achieve monitoring objectives. Data collection and analysis is determined to be appropriate when interpreted using current Water Quality Standards (WQS). Comparisons to WQS are made by using data that meet specific measurement requirements. The measurement system is designed to produce water quality results that are of the appropriate quantity and quality to assess compliance.

A.7.2 Measurement Quality Objectives (MQOs)

MQOs are designed to evaluate and control various phases (sampling, preparation, and analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the project's DQOs. MQOs define the acceptable quality (data validity) of field and laboratory data for the project. MQOs are defined in terms of the following data quality indicators:

- Detectability
- Precision
- Bias/Accuracy
- Completeness
- Representativeness
- Comparability

The MQOs for this project are presented in Table 6. Industry standard field methods will be used throughout this project to minimize measurement bias (systematic error) and to improve precision (to reduce random error).

Detectability is the ability of the method to reliably measure a compound concentration above background. ADEC Division of Water (DOW) uses two components to define detectability: method detection limit (MDL) and practical quantification limit (PQL) or reporting limit (RL).

- The MDL is the minimum value which the instrument can discern above background but with no certainty to the accuracy of the measured value. For field measurements, the manufacturer's listed instrument detection limit (IDL) can be used.
- The PQL or RL is the minimum value that can be reported with confidence (usually some multiple of the MDL).

Note: The measurement method of choice should at a minimum have a PQL or RL 3 times more sensitive than the respective AWQS and/or permitted pollutant level (for permitted facilities).

Typically, the laboratory determines the empirical detection limit for each method/matrix/instrument using the protocol outlined in 40 CFR 146. The highest MDL determined for an instrument for a method and media is used as the laboratory MDL. The LOQ (limit of quantitation, a.k.a. PQL or RL) is equal to 3x the MDL. To continuously affirm that the PQL or RL is reliably reported, the lowest calibration point for each analyte on an instrument is at or below the RL.

Sample data measure below the MDL, PQL, or RL is reported as non-detect (ND). Sample data measured above the PQL or RL is reported as reliable data unless otherwise qualified per the specific sample analysis.

Precision is the degree of agreement among repeated measurements of the same parameter and provides information about the consistency of methods. Precision is expressed in terms of the relative percent difference (RPD) between two measurements (A and B).

For field measurements, precision is assessed by measuring replicate (paired) samples at the same locations and as soon as possible to limit temporal variance in sample results. Overall project precision is measured by collecting blind (to the laboratory) field replicate samples. Laboratory precision is determined similarly via analysis of laboratory duplicate samples. For paired and small data sets, project precision is calculated using the following formula:

$$RPD = 100 * \frac{(A - B)}{\left({}^{(A+B)}/_{2} \right)}$$

Where: RPD = relative percent difference
A = primary sample
B = replicate field sample or laboratory duplicate sample

For larger paired precision data sets (e.g. overall project precision) or multiple replicate precision data, use the following formula:

$$RSD = 100 * \sigma / mean$$

$$\sigma = \int \frac{\Sigma d^2}{2k}$$

Where: RSD = relative standard deviation
σ = standard deviation
k = number of paired replicate samples (A and B)
d = A - B
A = primary sample
B = replicate field sample or laboratory duplicate sample

Field sample replicates for assessment of precision will be analyzed at no less than 10 percent frequency of the total number of samples. Laboratory replicates for assessment of precision will be analyzed at no less than at 5 percent frequency of the total number of samples submitted to the laboratory.

Laboratory established control limits for RPD are presented in Table 6. These criteria will be applicable to both field sample replicates and laboratory replicates. Sample replicate results will be compared to RPD criteria when results exceed the RL. Criteria are not applicable when results are below the RL. When one or more of the results is below the RL and one is above the RL, professional judgment will be used to assess compliance of the data to project requirements.

Bias (Accuracy) is a measure of confidence that describes how close a measurement is to its "true" value. Methods to determine and assess accuracy of field and laboratory measurements include, instrument calibrations, various types of QC checks (e.g., sample split measurements, sample spike recoveries, internal standards, blank results) and independent performance audit samples). Bias/Accuracy is assessed using the following formula:

$$Accuracy = \frac{MeasuredValue}{TrueValue} \times 100$$

Laboratory established control limits for sample spike and laboratory control sample recoveries are presented in Table 6. Other laboratory criteria to assess accuracy of results (calibration, internal standard, performance audit samples) will comply with method requirements and laboratory standard operating procedures (SOPs).

Completeness is a measure of the percentage of valid samples collected and analyzed to yield sufficient information to make informed decisions with statistical confidence. Completeness will be judged by the amount of valid data compared to the data expected. Valid data are those data in compliance with the data quality criteria as presented in this section, and in compliance within expected range of conditions and daily fluctuation patterns. While the goal for the criteria described above is 100 percent completeness, a level of 95 percent completeness will be considered acceptable. However, any time data are incomplete, decisions regarding re-sampling and/or re-analysis will be made. These decisions will take into account the project data quality objectives as presented above. Project completeness is determined for each parameter using the following formula:

$$\frac{T - (I+NC)}{T} \times (100\%) = \text{Completeness}$$

Where: T = Total number of expected sample measurements.

I = Number of rejected results.

NC = Number of sample measurements not completed (e.g. spilled sample, etc.).

Project % Data Completeness Goal = 95% /analyte for all project analytes

Representativeness assigns what parameters to sample for, where to sample, type of sample (grab, continuous, composite, etc.) and frequency of sample collection. Sample

representativeness is the degree to which data accurately and precisely represent the site conditions at the time of sample collection. Representativeness will be addressed at two distinct points in the data collection process. During sample collection, the use of generally accepted sampling procedures applied in a consistent manner throughout the project will help ensure that samples are representative of conditions at the point where the sample was taken. During subsampling (sample aliquot removal) in the laboratory, samples will be appropriately handled to ensure that the analytical subsample is well mixed and therefore representative of the sample container's contents.

Comparability is a measure of the confidence with which one dataset can be compared to another. This is a qualitative assessment and is addressed primarily by sampling design through use of comparable sampling procedures or, for monitoring programs, through consistent sampling of stations over time. In the laboratory, comparability is assured through the use of comparable analytical procedures and ensuring that project staff are trained in the proper application of the procedures. Within-study comparability will be assessed through analytical performance (quality control samples).

Table 6: Project Measurement Quality Objectives (MQOs)

Group	Analyte	Method	MDL	PQL	Most Stringent Water Quality Standards, Sediment Thresholds and Designated Use(s)	LCS/LCSD, MS/MSD Limits (Accuracy) (%)	Relative Percent Difference (%)
Water Quality (Field Measurements and Observations)	Color (NTU)	Hanna HI 727 Colorimeter	N/A	N/A	The greater of 15 units, or natural condition [drinking water supply and contact recreation]	N/A	N/A
	Dissolved Oxygen (DO) mg/L	Portable Multi-Parameter Field Meter (Sonde)	N/A	±0.01 mg/L	≥7.0 and ≤17.0 mg/L [growth and propagation of fish and shellfish, other aquatic life and wildlife; aquaculture	N/A	±20%
	pH	Portable Multi-Parameter Field Meter (Sonde)	N/A	±0.01 standard units	6.5-8.5 pH units (and ≤0.5 from natural) [growth and propagation of fish and shellfish other aquatic life and wildlife; aquaculture]	N/A	±0.1 standard units
	Redox Potential (ORP)	Portable Multi-Parameter Field Meter (Sonde)	N/A	1 millivolt	N/A	N/A	±10%
	Residues	Visual Observation	N/A	N/A	May not, alone or in combination with other substances or wastes, make the water unfit or unsafe for the use; cause a film, sheen, or discoloration on the surface of the water or adjoining shorelines; cause leaching of toxic or deleterious substances; or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines. Criteria are not applicable to groundwater. [water supply, growth and propagation of fish and shellfish, recreation]	N/A	N/A
	Specific Conductance	Portable Multi-Parameter Field Meter (Sonde)	N/A	0-1: 0.001 1-10: 0.01 10-100: 0.1 (µS/cm)	N/A	N/A	± 10%

Group	Analyte	Method	MDL	PQL	Most Stringent Water Quality Standards, Sediment Thresholds and Designated Use(s)	LCS/LCSD, MS/MSD Limits (Accuracy) (%)	Relative Percent Difference (%)
Water Quality (Field Measurements and Observations), cont.	Water Temperature	Portable Multi-Parameter Field Meter (Sonde)	N/A	0.1°C	13-20 ºC [growth and propagation of fish and shellfish, other aquatic life and wildlife; aquaculture] 15 ºC [migration routes, rearing areas; drinking water supply] 13 ºC [spawning areas and egg & fry incubation]	N/A	±0.2°C
	Turbidity	Portable Multi-Parameter Field Meter (Sonde)	N/A	0.01 NTU	Natural plus 5-15 NTU [contact and secondary recreation]	N/A	± 10%
Water Quality (Laboratory Analyses)	Alkalinity	SM21 2320B	310 µg/L	10,000 µg/L	20,000 µg/L minimum, or natural if lower [chronic for aquatic life]	85-115	N/A
	Chlorophyll a	10200H	N/A	N/A	N/A	N/A	20
	Hardness	SM21 2340B	2,000 µg/L	2,000 µg/L	N/A	NA	NA
	Total Dissolved Solids	SM21 2540C	3,100 µg/L	10,000 µg/L	500,000 µg/L [drinking water supply]	75-125	5
	Total Suspended Solids	SM21 2540D	150 µg/L	500 µg/L	N/A	75-125	5
	Turbidity	SM21 2130B	0.5 NTU	1.0 NTU	Natural plus 5-15 NTU [contact and secondary recreation]	90-110	± 10%
Fecal Coliforms	Fecal Coliform (cfu/100 mL)	SM21 9222D	1 cfu/100mL	1 cfu/100mL	20 cfu/100mL [drinking water supply]	N/A	N/A

Group	Analyte	Method	MDL	PQL	Most Stringent Water Quality Standards, Sediment Thresholds and Designated Use(s)	LCS/LCSD, MS/MSD Limits (Accuracy) (%)	Relative Percent Difference (%)
Nutrients (Water Analysis)	Ammonia-N	SM21 4500NH3-G	31 µg/L	100 µg/L	0.179-6.67[1] mg/L [chronic for aquatic life; temperature and pH dependent] (Total in mg/L as N)	75-125	25
	Dissolved Organic Carbon (DOC)	SM21 5310B	150 µg/L	500 µg/L	N/A	80-120	20
	Nitrate/Nitrite (combined)	SM21 4500NO3-F	6.2 µg/L	20 µg/L	10,000 µg/L [contact recreation; drinking water supply]	90-110	20
	Nitrogen, Total Kjeldahl (TKN)	SM21 4500N D	310 µg/L	1,000 µg/L	N/A	75-125	25
	Soluble Reactive Phosphorus (SRP)	SM21 4500P-B, E	3.1 µg/L	10 µg/L	N/A	75-125	25
	Total Organic Carbon (TOC)	SM21 5310B	150 µg/L	500 µg/L	N/A	80-120	20
	Total Phosphorus	SM21 4500P-B, E	3.1 µg/L	10 µg/L	N/A	75-125	25
Metals (Total and Dissolved)	Aluminum	EPA 200.8	0.62 µg/L	2.0 µg/L	87 or 750 µg/L [chronic aquatic life criteria; 750 µg/L if pH ≥7.0 and Hardness ≥ 50] (Total Recoverable)	85-115	20
	Arsenic	EPA 200.8	1.5 µg/L	0.5 µg/L	10 µg/L [drinking water supply] (Total)	85-115	20
	Barium	EPA 200.8	0.025 µg/L	0.25 µg/L	2000 µg/L [drinking water supply] (Total)	85-115	20
	Beryllium	EPA 200.8	0.025 µg/L	0.05 µg/L	4 µg/L [drinking water supply] (Total)	85-115	20

Group	Analyte	Method	MDL	PQL	Most Stringent Water Quality Standards, Sediment Thresholds and Designated Use(s)	LCS/LCSD, MS/MSD Limits (Accuracy) (%)	Relative Percent Difference (%)
Metals (Total and Dissolved), cont.	Cadmium	EPA 200.8	0.015 µg/L	0.05 µg/L	0.09-0.64[1] µg/L [chronic aquatic life criteria; Hardness dependent] (Dissolved)	85-115	20
	Calcium	EPA 200.8	15 µg/L	50 µg/L	SAR <2.5, Na% <60, RSC <1.25 m_{eq}/L [agricultural stockwater; agricultural irrigation]	85-115	20
	Chromium	EPA 200.8	0.062 µg/L	0.2 µg/L	100 µg/L [drinking water supply; agricultural irrigation; contact recreation] (Total Recoverable)	85-115	20
	Chromium III				24-230[1] µg/L [chronic aquatic life criteria; Hardness dependent in the range 25-400] (Dissolved)		
	Cobalt	EPA 200.8	0.01 µg/L	0.02 µg/L	50 µg/L [agricultural irrigation water]	85-115	20
	Copper	EPA 200.8	0.05 µg/L	0.5 µg/L	2.7-29[1] µg/L [chronic aquatic life criteria; Hardness dependent in the range 25-400] (Dissolved)	85-115	20
	Iron	EPA 200.8	6.2 µg/L	20 µg/L	1000 µg/L [chronic aquatic life criteria]	85-115	20
	Lead	EPA 200.8	0.031 µg/L	0.1 µg/L	0.54-11[1] µg/L [chronic aquatic life criteria; Hardness dependent in the range 25-400] (Dissolved)	85-115	20

Group	Analyte	Method	MDL	PQL	Most Stringent Water Quality Standards, Sediment Thresholds and Designated Use(s)	LCS/LCSD, MS/MSD Limits (Accuracy) (%)	Relative Percent Difference (%)
Metals (Total and Dissolved), cont.	Magnesium	EPA 200.8	6.2 µg/L	20 µg/L	SAR <2.5, Na% <60, RSC <1.25 m_{eq}/L [agricultural stockwater; agricultural irrigation]	85-115	20
	Manganese	EPA 200.8	0.015 µg/L	0.05 µg/L	50 µg/L [consumption of water + aquatic organisms]	85-115	20
	Mercury	EPA 1631E	0.0005 µg/L	0.001 µg/L	0.012 µg/L [chronic aquatic life (from 1999 AWQS)] (Total)	85-115	20
	Methylmercury	EPA 1630	0.020 ng/L	0.050 ng/L	N/A	70-130 / 65-135	30 / 35
	Molybdenum	EPA 200.8	0.015 µg/L	0.05 µg/L	10 µg/L [agricultural irrigation water]	85-115	20
	Nickel	EPA 200.8	0.062 µg/L	0.62 µg/L	16-170[1] µg/L [chronic aquatic life criteria; Hardness dependent in the range 25-400] (Dissolved)	85-115	20
	Selenium	EPA 200.8	0.31 µg/L	1.0 µg/L	5 µg/L [chronic aquatic life criteria] (Total Recoverable)	85-115	20
	Thallium	EPA 200.8	0.006 µg/L	0.02 µg/L	1.7 µg/L [consumption of water + aquatic organisms]	85-115	20
	Vanadium	EPA2 00.8	0.31 µg/L	1.0 µg/L	100 µg/L [agricultural irrigation]	85-115	20
	Zinc	EPA 200.8	0.4 µg/L	3.1 µg/L	36-380[1] µg/L [acute and chronic aquatic life criteria; Hardness dependent in the range 25-400] (Dissolved)	85-115	20

Group	Analyte	Method	MDL	PQL	Most Stringent Water Quality Standards, Sediment Thresholds and Designated Use(s)	LCS/LCSD, MS/MSD Limits (Accuracy) (%)	Relative Percent Difference (%)
Radionuclides (Surface Water)	Gross Alpha	EPA 900.0	NA	3.0 pCi/L	15 pCi/L [contact recreation; drinking water supply]	75-125 / 35-15-	40
	Gross Beta	EPA 900.0	NA	4.0 pCi/L	4 millirems/yr [contact recreation; drinking water supply]	75-125 / 89-143	40
	Gamma Photon Emitters (Cesium 137)	EPA 901.1	NA	20.0 pCi/L	N/A	90-111 (LCS/LCSD)	40
	Radium 226	EPA 903.0	NA	1.0 pCi/L	5 pCi/L [contact recreation; drinking water supply]	68-137 / 75-138	40
	Radium 228	EPA 904.0	NA	1.0 pCi/L	5 pCi/L [contact recreation; drinking water supply]	56-140 / 45-150	40
	Total Strontium	EPA 905.0	NA	3.0 pCi/L	8 pCi/L [contact recreation; drinking water supply]	68-117 / 70-130	40
TAH[2] (sum of benzene, ethylbenzene, toluene & xylenes) (Surface Water)	Benzene	EPA 624	0.12 µg/L	0.4 µg/L	5 µg/L [drinking water supply]	80-120	20
	Ethylbenzene	EPA 624	0.31 µg/L	1.0 µg/L	10 µg/L [growth and propagation of fish, shellfish, aquaculture]	75-125	20
	Toluene	EPA 624	0.31 µg/L	1.0 µg/L	10 µg/L [growth and propagation of fish, shellfish; aquaculture]	75-120	20
	Xylenes, total	EPA 624	0.62 µg/L	2.0 µg/L	10 µg/L [growth and propagation of fish, shellfish; aquaculture]	75-130	20
TAqH (sum of EPA 610 PAHs + TAH) (Surface Water)	Acenaphtthylene	625M SIMS	0.015 µg/L	0.05 µg/L	15 µg/L [growth and propagation of fish and shellfish; aquaculture]	50-105	30

Group	Analyte	Method	MDL	PQL	Most Stringent Water Quality Standards, Sediment Thresholds and Designated Use(s)	LCS/LCSD, MS/MSD Limits (Accuracy) (%)	Relative Percent Difference (%)
TAqH (sum of EPA 610 PAHs + TAH) (Surface Water), cont.	Acenaphthene	625M SIMS	0.015 µg/L	0.05 µg/L	15 µg/L [growth and propagation of fish and shellfish; aquaculture]	45-110	30
	Fluorene	625M SIMS	0.015 µg/L	0.05 µg/L	15 µg/L [growth and propagation of fish and shellfish; aquaculture]	50-110	30
	Phenanthrene	625M SIMS	0.015 µg/L	0.05 µg/L	15 µg/L [growth and propagation of fish and shellfish; aquaculture]	50-115	30
	Anthracene	625M SIMS	0.015 µg/L	0.05 µg/L	15 µg/L [growth and propagation of fish and shellfish; aquaculture]	55-110	30
	Fluoranthene	625M SIMS	0.015 µg/L	0.05 µg/L	15 µg/L [growth and propagation of fish and shellfish; aquaculture]	55-115	30
	Pyrene	625M SIMS	0.015 µg/L	0.05 µg/L	15 µg/L [growth and propagation of fish and shellfish; aquaculture]	50-130	30
	Dibenzo[a,h]anthracene	625M SIMS	0.015 µg/L	0.05 µg/L	0.028 µg/L [consumption of water + aquatic organisms]	40-125	30
	Benzo[g,h,i]perylene	625M SIMS	0.015 µg/L	0.05 µg/L	15 µg/L [growth and propagation of fish and shellfish; aquaculture]	40-125	30
	Naphthalene	625M SIMS	0.031 µg/L	0.1 µg/L	15 µg/L [growth and propagation of fish and shellfish; aquaculture]	40-100	30
	Benzo(a)anthracene	625M SIMS	0.015 µg/L	0.05 µg/L	0.028 µg/L [consumption of water + aquatic organisms]	55-110	30

Group	Analyte	Method	MDL	PQL	Most Stringent Water Quality Standards, Sediment Thresholds and Designated Use(s)	LCS/LCSD, MS/MSD Limits (Accuracy) (%)	Relative Percent Difference (%)
TAqH (sum of EPA 610 PAHs + TAH) **(Surface Water), cont.**	Chrysene	625M SIMS	0.015 µg/L	0.05 µg/L	0.028 µg/L [consumption of water + aquatic organisms]	55-110	30
	Benzo[b]fluoranthene	625M SIMS	0.015 µg/L	0.05 µg/L	0.028 µg/L [consumption of water + aquatic organisms]	45-120	30
	Benzo[k]fluoranthene	625M SIMS	0.015 µg/L	0.05 µg/L	0.028 µg/L [consumption of water + aquatic organisms]	45-125	30
	Benzo[a]pyrene	625M SIMS	0.015 µg/L	0.05 µg/L	0.028 µg/L [consumption of water + aquatic organisms]	55-110	30
	Indeno[1,2,3-c,d]pyrene	625M SIMS	0.015 µg/L	0.05 µg/L	0.028 µg/L [consumption of water + aquatic organisms]	45-125	30
Sediment	Arsenic	SW6020	0.31 mg/kg	1.0 mg/kg	5.9 mg/kg [SQuiRT: threshold effects level]	80-120	20
	Cadmium	SW6020	0.062 mg/kg	0.2 mg/kg	0.583 mg/kg [SQuiRT: assessment and remediation of contaminated sediments (Great Lakes)]	80-120	20
	Copper	SW6020	0.18 mg/kg	0.6 mg/kg	16.0 mg/kg [SQuiRT: lowest effects level]	80-120	20
	Iron	SW6020	3.1 mg/kg	10 mg/kg	2% [SQuiRT: lowest effects level]	80-120	20
	Lead	SW6020	0.062 mg/kg	0.2 mg/kg	31.0 mg/kg [SQuiRT: lowest effects level]	80-120	20
	Total Mercury	1631E	0.078 µg/kg	0.25 µg/kg	174 µg/kg [SQuiRT: threshold effects level]	80-120	20
	Nickel	SW6020	0.062 mg/kg	0.2 mg/kg	16 mg/kg [SQuiRT: lowest effects level]	80-120	20
	Selenium	SW6020	0.15 mg/kg	0.5 mg/kg	N/A	80-120	20

Group	Analyte	Method	MDL	PQL	Most Stringent Water Quality Standards, Sediment Thresholds and Designated Use(s)	LCS/LCSD, MS/MSD Limits (Accuracy) (%)	Relative Percent Difference (%)
Sediment, cont.	Zinc	SW6020	0.31 mg/kg	1.0 mg/kg	98 mg/kg [SQuiRT: assessment and remediation of contaminated sediments (Great Lakes)]	80-120	20
	Total Organic Carbon (TOC)	SW9060A mod	0.015%	0.05%	N/A	75-125	25
	Grain Size	ASTM D-422	NA	NA	N/A	NA	NA
Fish Tissue Inorganics[3]	Total Mercury	EPA 1631E	0.012 ng/g	0.40 ng/g	N/A	70 - 130	30
	Methylmercury	EPA 1630	1.0 ng/g	3.0 ng/g	N/A	65-135	35
	Arsenic	EPA 1638	0.014 mg/kg	0.040 mg/kg	N/A	70 - 130	30
	Cadmium	EPA 1638	0.003 mg/kg	0.010 mg/kg	N/A	70 - 130	30
	Selenium	EPA 1638	0.06 mg/kg	0.15 mg/kg	N/A	70 - 130	30
Vegetation & Soils	Total Mercury	EPA 1631E	0.12 ng/g (wet)	0.40 ng/g (wet)	N/A	75- 125 / 70 - 130	30
	Methylmercury	EPA 1630M	1.0 ng/g (wet)	3.0 ng/g (wet)	N/A	65-135	35
	%Total Solids	SM 2540G	0.3 (wet)	N/A	N/A	75-125	30
Fur and Feathers	Total Mercury	EPA 1631E	0.12 ng/g (wet)	0.40 ng/g (wet)	N/A	75 – 125 / 70 - 130	30

Notes:
ºC – degrees centigrade
EPA – US Environmental Protection Agency
LCS/LCSD – laboratory control sample/laboratory control sample duplicate
MDL – method detection limit
mg/kg – milligram per kilogram
mg/L – milligram per liter
m_{eq}/L – milliequivalents per liter
MS/MSD – matrix spike/matrix spike duplicate
N/A – not applicable or not available
ng/g – nanogram per gram
ng/L – nanogram per liter
NTU – nephelometric turbidity unit
µg/L – microgram per liter
pCi:/L – picocuries per liter
PQL – practical quantitation limit
µg/L – microgram per liter
SIMS – selective ion monitoring
SM21 – Standard Methods for the Examination of Water and Wastewater, 21st Edition, 2005; Example for Hardness in surface water is SM21 2340B (dissolved hardness as CaCO3 ICP-MS) for baseline and FA samples.

SQuiRT – Screening Quick Reference Tables (Source: NOAA-Fisheries)

[1] For metals standards for the protection of aquatic life that are hardness dependent and for ammonia that is pH and temperature dependent, formulas for calculating the appropriate standard are found in: Alaska Department of Environmental Conservation. Alaska WQS in 18 AAC 70.020(b) Alaska Water Quality Criteria Manual for Toxic And Other Deleterious Organic and Inorganic Substances. (December 12, 2008)
[2]Petroleum hydrocarbons will be assessed based on BETX as total aromatic hydrocarbons [TAH] and EPA 610 PAHs plus BETX as total aqueous hydrocarbons [TAqH], Alaska WQS – 18 AAC 70.020 (ADEC, 2012b; 2008) Alaska Drinking Water Standards – 18 AAC 80 (ADEC, 2012d)
[3]All targeted species fish samples will analyze fillet tissue for methylmercury and mercury. Burbot samples will also include liver tissue for analysis of all five parameters.

A.8 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

This QAPP and supporting materials will be distributed to all participants. The local Field Operations Project Manager, Mark Vania, will conduct a procedural review before the field team is mobilized for sampling. The procedural review will include the requirements of the QAPP and referenced SOPs, as well as instrument manufacturers' operation and maintenance instructions. It will be performed concurrently with a check that all equipment and sampling gear are fully functional and ready for deployment. In addition, there will be discussions and demonstrations of sampling method(s) to be used and discussions regarding specific health and safety concerns. Each sampling team will consist of, at a minimum, one sample collector and a scientist familiar with QC requirements, which will ensure strict adherence to the project protocols, check all documentation for completeness and correctness, and verify that no transcription errors or omissions have been made in preparing sample custody records and other project documentation.

All field team personnel must have completed first aid/CPR training as well as Swift Water Rescue prior to conducting any monitoring activities on the Susitna River. The Field Operations Project Manager will ensure that all field personnel meet these requirements.

Project training required for this study is summarized in Table 7.

Table 7: Project Training/Certification

Specialized Training/Certification	Field Staff	Lab Staff	Monitoring Supervisor	Lab Supervisor	Project QA Officer
Safety training – Swift Water Rescue Training	X		X		X
Safety training – Laboratory Procedures		X		X	X
Safety training – First Aid/CPR	X		X		X
Water sampling techniques (including modified EPA Method 1669; clean hands-dirty hands handling technique)	X		X		X
Instrument calibration and QC activities for field measurements	X		X		X
Instrument calibration and QC activities for laboratory measurements		X		X	X
QA principles			X	X	X
QA for water monitoring systems			X		X
Chain of Custody procedures for samples and data	X	X	X	X	X
Handling and Shipping of Hazardous Goods	X	X	X	X	X
Specific Field Measurement Methods Training	X		X		X
Lab Analytical Methods Training		X		X	

A.9 DOCUMENTS AND RECORDS

Thorough documentation of all field sample collection is necessary for proper processing of data and, ultimately, for interpreting study results. Field sample collection will be documented in writing, on forms as well as on the following forms and labels:

- A field log notebook for general observations and notes
- Field data forms that contain information about observations and measurements made and samples collected at the site
- Checklists for each sampling event, sampling point, and sampling time.

All analytical laboratory reports will be submitted electronically from SGS via an online secure portal. All data, including field and laboratory QC checks, will be provided in Microsoft Excel and Adobe portable document format (PDF). These electronic files will be made available to the URS principal manager for distribution to appropriate personnel (Tetra Tech PM and Tetra Tech Water Quality Lead) to conduct data verification, validation, and preparation for input to the project database. The project database is developed, organized, and managed by DES.IT, LLC. The electronic reports will be maintained in the URS and Tetra Tech project files.

The Analytical Data Validation Memorandum (checklist) is provided in Appendix B. Project Field Forms are provided in Appendix C. Field Activity Standard Operating Procedures are provided in Appendix D. Copies of the field log books and physical characterization/water quality data sampling forms, instrument calibration forms, and sampling checklists will be supplied to the Field Operations PM at the end of each sampling event. These data will be used in conjunction with inspection checklists to compile the sampling event reports.

The URS/Tetra Tech Water Quality Team will maintain files, as appropriate, as repositories for information and data used in preparing any reports and documents during the project and will supervise the use of materials in the project files (Table 8).

All field reports that are generated from the data will be subject to technical and editorial review before submission to AEA and will be maintained at URS's Anchorage, Alaska and Tetra Tech's Seattle, Washington offices in their central file (electronic media and hard copy). Data considered as final form will be posted as independent files (http://www.gina.alaska.edu/) and also linked with Study Reports through the Geographic Information Network of Alaska (GINA). The sampling event reports will include a summary of the types of data collected, sampling dates, and any problems or anomalies encountered during sample collection.

If subsequent revisions to the final DEC-approved QAPP are required during the study, AEA will contact DEC for additional review and approval of the proposed modification. A memo will be sent to each person on the distribution list describing the approved change(s). The memo will serve as an amendment and be attached to the QAPP.

All written records, data, QAPP documents, project reports, and any other document relevant to the sampling and processing of samples will be maintained at URS's Anchorage, Alaska and Tetra Tech's Seattle, Washington offices in the central file. URS and Tetra Tech will maintain records of all project documents until such documents are transferred to AEA. URS and Tetra Tech will transfer all project records to AEA upon AEA's request or the expiration of the contract. AEA will then maintain such records consistent with AEA's State Law record

retention requirements or for 10 years, whichever is greater. Records of all project documents will also be maintained at the AEA Anchorage, Alaska office. .

Access to results will be as independent data files as well as linked files to Study Reports and stored on servers at the Geographic Information Network of Alaska (GINA).

Any written report and finalized data collected for this study and reported on GINA will be submitted electronically, at ADEC's request, via a CD ROM, ZIP Disk or email ZIP file. All dates will be formatted as "MM-DD-YYYY".

Table 8: Project Documents and Records

Categories	Record/Document Types	Location	Retention Time
Site Information	Network Description	AEA Project Archive	Duration of Project
	Site characterization file	AEA Project Archive	Duration of Project
	Site maps	GIS Database, AEA Project Archive	Duration of Project
	Site pictures	AEA Project Archive, URS Network, Tt Network	Minimum of 10 years
Environmental Data Operations	QAPP	AEA Project Archive, URS Network	Duration of Project
	Field Method SOPs	QAPP, AEA Project Archive, URS Network	Minimum of 10 years
	Field Notebooks	AEA, URS and/or Tt Project Files	Minimum of 10 years
	Sample collection/measurement records	AEA, URS and/or Tt Project Files	Minimum of 10 years
	Sample Handling & Custody Records	AEA, URS and/or Tt Project Files	Minimum of 10 years
	Chemical labels, MSDS sheets	AEA, URS and/or Tt Project Files	Duration of Project
	Inspection/Maintenance Records	AEA, URS and/or Tt Project Files	Minimum of 10 years
Raw Data	Lab data (sample, QC and calibration) including data entry forms	AEA, URS and/or Tt Project Files GINA (Geographic Information Network of Alaska)	Minimum of 10 years
	Progress reports	AEA Project Archive, URS and Tt Project Files	Duration of Project
	Project data/summary reports	AEA Project Archive, URS and Tt Project Files	Minimum of 10 years
	Lab analysis reports	AEA, URS and/or Tt Project Files	Minimum of 10 years
	Inspection Report	AEA Project Archive, URS and	Minimum of 10 years

Categories	Record/Document Types	Location	Retention Time
		Tt Project Files	
Data Management	Data management plans/flowcharts	AEA Project Archive, URS and Tt Project Files	Duration of Project
	Data algorithms	AEA Project Archive, URS and Tt Project Files	Duration of Project
Quality Assurance	Data quality assessments	AEA Project Archive, URS and Tt Project Files	Minimum of 10 years
	Site audits	AEA Project Archive, URS and Tt Project Files	Minimum of 10 years
	Lab audits	AEA Project Archive, URS and Tt Project Files	Minimum of 10 years
	QA reports/corrective action reports	AEA, URS and/or Tt Project Files	Minimum of 10 years
	Response	AEA, URS and/or Tt Project Files	Minimum of 10 years
	Performance Evaluation Samples	AEA, URS and/or Tt Project Files	Duration of Project

B DATA GENERATION AND ACQUISITION

B.1 SAMPLING PROCESS DESIGN (Experimental Design)

The rationale for the Water Quality and Mercury Assessment is described in Study 5.5 and Study 5.7. This section of the QAPP documents how data for the Water Quality and Mercury Assessment will be collected to characterize existing and post-Project conditions within the Susitna River basin. Four types of water quality monitoring activities will be implemented under this QAPP: 1) routine monitoring for characterizing water quality baseline conditions, including continuous water temperature monitoring 2) a single, comprehensive survey for a larger array of parameters, 3) detailed monitoring and intensive investigation of current conditions at Focus Area site locations, and 4) mercury assessment studies and potential for bioaccumulation. Each type of monitoring activity varies by sampling frequency, parameters measured, and geography.

B.1.1 Define Monitoring Objectives(s) and Appropriate Data Quality Objectives

Data will be collected from multiple media including surface water, groundwater, porewater, sediment, fish tissue, soil, vegetation, and feathers or fur from piscivorous birds and mammals. As previously mentioned, water quality and continuous temperature monitoring data will be collected from historical monitoring locations as well as an expanded network that will include tributaries that 1) contribute significant flow to the lower river and 2) important spawning and rearing habitat for anadromous and resident fisheries. Data collected as part of this program will be used in the Water Quality Model Study (Study5.6) to predict how operational scenarios will impact water quality conditions in both a reservoir and riverine portion of the basin. Results from fish tissue analysis will also be used as a baseline for determining how the proposed Project may increase the potential of current metals concentrations to become bioavailable. The projected water conditions in the reservoir will be estimated and current results for metals concentrations re-evaluated for determining potential toxicities to resident and anadromous fish species. Results from previous monitoring efforts are presented in Tables 3a and 3b.

The DQOs described in Section A.7.1 prescribed generation of High Quality End-Use Tier 2 Monitoring Data used to compare against ADEC water quality standards. Data generated from field collection and from modeling results will be compared against applicable AWQS. In addition, thresholds for sediment toxicity from the National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRTs) will be used as defined in Buchman (2008). Toxicity Reference Values (TRVs) will be used for evaluating potential effects on ecological receptors in the aquatic environment. TRVs for surface water ecological receptors and TRVs calculated for community measurement receptors in sediment will be determined as outlined in EPA (1999).

B.1.2 Characterize the General Monitoring Location/s

Continuous Temperature and Baseline Water Quality Monitoring Locations

Table 9a lists locations for continuous temperature monitoring and baseline water quality data collection sites in the mainstem Susitna River, tributaries, and sloughs. Also included in Table 9a is rationale for each of the proposed sample locations. Areas of the mainstem with an upstream tributary that may influence the nearshore zone or that are well-mixed with the mainstem will be

characterized by collecting samples at two transect locations: in the tributary and in the mainstem upstream of the tributary confluence. An overview of monitoring locations is shown in Figure 2a.

The location of monitoring sites represent a variety of channel types and are co-located adjacent major tributaries so that the various factors that influence water quality conditions are captured and support the development (and calibration) of the water quality model. Frequency of sites along the length of the river is important for capturing localized effects from tributaries and from past and current human activity. Additionally, this proposed spacing for water quality and continuous temperature monitoring follows accepted practice when segmenting large river systems for development of Total Maximum Daily Load (TMDL) water quality models. Sampling during winter months will be focused on locations where flow data is currently collected (or was historically collected by the USGS) and will be used for water quality modeling.

Baseline water quality and continuous temperature monitoring sites were selected based on the following rationale:

- Adequate representation of locations throughout the Susitna River and tributaries above and below the proposed dam site for the purpose of a baseline water quality characterization;
- Major tributaries to the Susitna River that contribute large portions of the lower river flow (the Talkeetna, Chulitna, Deshka, and Yentna rivers);
- Sites near tributaries that represent important spawning and rearing habitat for anadromous and resident fisheries, including Gold, Portage, Tsusena and Watana creeks, and Oshetna River;
- A portion of the mainstem monitoring sites that were previously used for SNTEMP modeling in the 1980s;
- Location on tributaries where proposed access road-crossing impacts might occur during and after construction (upstream/downstream sampling points on each crossing);
- Preliminary consultation with licensing participants including co-location with other study sites (e.g., instream flow, ice processes); and
- Access and land ownership issues.

Table 9a: Site Location and Rationale for Temperature and Baseline Water Quality Monitoring

River Section	Susitna Project River Mile (PRM)	Site Identification	Description[2]	Latitude (WGS84)	Longitude (WGS84)	Water Temperature				Baseline Water Quality			Location Rationale
						Summer 2012	Winter 2012/2013	Summer 2013	Winter 2013/2014	Summer 2013	Winter 2014	Ongoing Studies	
Lower Susitna River	19.9	Susitna above Alexander Creek	M	61.439030	-150.48456	X	X	X	X				Mainstem; outer Project area site (above the "Beluga Line")
	29.9	Susitna Station	M	61.544280	-150.515560			X	X	X	X	X	Mainstem; influence of upstream tributary
	32.5	Yentna River	MT	61.587604	-150.483017	X	X	X	X	X		X	Major tributary
	33.6	Susitna above Yentna	M	61.575950	-150.427410	X	X	X	X	X		X	Mainstem; above major tributary
	45.1	Deshka River	MT	61.710142	-150.324700	X	X	X	X	X		X	Major tributary
	59.9	Susitna	M	61.862200	-150.184630	X	X	X	X	X		X	Mainstem; above major tributary. 1980s water quality or temperature monitoring site.
	87.8	Susitna at Parks Highway East	M	62.174531	-150.173677	X	X	X	X	X	X	X	Mainstem river site
	88.3	Susitna at Parks Highway West	M	62.181096	-150.167877	X	X	X	X				Mainstem; side channel habitat connected with the mainstem
Middle Susitna River	99.2	LRX 1	M	62.306018	-150.108764	X	X	X					Mainstem; below confluence of major tributary
	102.8	Talkeetna River	MT	62.342430	-150.112660	X	X	X	X	X		X	Major tributary
	107[1]	Talkeetna	M	62.397240	-150.137280	X		X	X	X		X	Mainstem above confluence; upstream of existing townsite; Historic (1980s) monitoring site
	116.6[1]	LRX 18	M	62.526527	-150.114671	X		X	X				Upstream of existing townsite
	118.6	Chulitna River	MT	62.567703	-150.237828	X	X	X	X	X		X	Major tributary
	124.2[1]	Curry Fishwheel Camp	M	62.617830	-150.013730	X		X	X	X		X	Mainstem; Important side channel habitat
	129.6	Slough 8A	SC	62.670479	-149.903241	X		X	X				Important side channel habitat
	129.9[1]	LRX 29	M	62.673914	-149.899025	X		X	X				Historic (1980s) monitoring site
	132.7	Slough 9	SC	62.702358	-149.841895	X		X	X				Important side channel habitat
	134.1[1]	LRX 35	M	62.713854	-149.808926	X		X	X				Historic (1980s) monitoring site

River Section	Susitna Project River Mile (PRM)	Site Identification	Description[2]	Latitude (WGS84)	Longitude (WGS84)	Water Temperature				Baseline Water Quality			Location Rationale
						Summer 2012	Winter 2012/2013	Summer 2013	Winter 2013/2014	Summer 2013	Winter 2014	Ongoing Studies	
Middle Susitna River, cont.	140.0	Susitna near Gold Creek	M	62.767054	-149.693532	X		X	X		X		Mainstem; below confluence of tributary with important spawning and rearing habitat for fish
	140.1	Gold Creek	M	62.767892	-149.689781	X		X	X	X		X	Mainstem, near tributary; important spawning and rearing habitat for fish
	141.0	Slough 16B	SC	62.780204	-149.685360	X		X	X				Important side channel habitat. 1980s water quality or temperature monitoring site.
	142.2	Indian River	M	62.78635	-149.658780			X	X	X		X	Mainstem near tributary
	142.3[1]	Susitna above Indian River	M	62.785776	-149.648900	X	X	X	X	X		X	Mainstem; historic (1980s) monitoring site
	143.6	Slough 19	SC	62.793819	-149.614255	X		X	X				Important side channel habitat
	143.6[1]	LRX 53	M	62.79427	-149.613270	X		X	X				Historic (1980s) monitoring site
	145.6	Slough 21	SC	62.814667	-149.575329	X		X	X				Important side channel habitat
	152.2	Susitna below Portage Creek	M	62.830397	-149.382743	X	X						Mainstem; downstream of major tributary
	152.3	Portage Creek	M	62.830379	-149.380289	X	X			X		X	Mainstem, near tributary; important spawning and rearing habitat for fish
	152.7	Susitna above Portage Creek	M	62.827002	-149. 827002	X	X			X		X	Mainstem; historic (1980s) monitoring site
Upper Susitna River	168.1	Susitna	M	62.791696	-148.993825		X						Mainstem; mid-point between neighboring sites. 1980s water quality or temperature monitoring site.
	174	Susitna below Watana Dam Site	M	62.76673	-148.85385					X		X	Mainstem; near Tsusena Creek
	183.1	Susitna below Tsusena Creek	M	62.813480	-148.656868	X							Downstream of major tributary. 1980s water quality or temperature monitoring site.
	184.8	Tsusena Creek	M	62.821783	-148.606809		X				X	X	Mainstem; near tributary; important spawning and rearing habitat for fish

River Section	Susitna Project River Mile (PRM)	Site Identification	Description[2]	Latitude (WGS84)	Longitude (WGS84)	Water Temperature				Baseline Water Quality			Location Rationale
						Summer 2012	Winter 2012/2013	Summer 2013	Winter 2013/2014	Summer 2013	Winter 2014	Ongoing Studies	
Upper Susitna River, cont.	187.2	Susitna at Watana Dam site	M	62.822600	-148.553000		X			X		X	Mainstem; boundary condition between the reservoir and riverine models. 1980s water quality or temperature monitoring site.
	196.8	Watana Creek	M	62.829600	-148.259000							X	Mainstem; near tributary stream to the proposed reservoir; important spawning and rearing habitat for fish
	209.2	Kosina Creek	M	62.782200	-147.940000	X	X	X				X	Mainstem; near tributary stream to the proposed reservoir; important spawning and rearing habitat for fish
	225.5	Susitna near Cantwell	M	62.705200	-147.538000						X	X	Mainstem; uppermost mainstem site in the proposed reservoir
	235.2	Oshetna Creek	M	62.639610	-147.383109	X	X	X	X	X		X	Mainstem; uppermost tributary in the Project area; important spawning and rearing habitat for fish

Notes:
[1] Susitna River temperature monitoring sites used in 1980s SNTEMP model evaluation.
[2] M = mainstem Susitna River; MT = major tributary; SC = side channel

Focus Area Water Quality Sampling Locations

A total of seven Focus Areas are proposed for detailed study within the Middle Segment of the river (Figure 2b; Table 9b). The Focus Areas are intended to serve as specific geographic areas of the river that will be the subject of intensive investigation by multiple resource disciplines including water quality. The proposed Focus Areas were selected during an interdisciplinary resource meeting that involved a systematic review of aerial imagery within each of the eight Geomorphic Reaches (MR1 through MR8) for the entire Middle Segment of the river. Focus areas were selected within MR1, MR2, MR5, MR6, MR7, and MR8. Focus Areas were not selected for MR3 or MR4 due to safety considerations related to Devils Canyon.

The selected Focus Areas are representative of the major features in the Geomorphic Reach and include mainstem habitat types of known biological significance (i.e., where fish have been observed based on previous and/or contemporary studies). The areas include representative side channels, side sloughs, upland sloughs, and tributary mouths. The Focus Areas will have a higher density of sampling locations, in contrast to the mainstem network, so that prediction of change in water quality conditions from Project operations can be made with a higher degree of resolution. The resolution expected for predicting conditions will be as short as 100-meter (m) longitudinal distances within the Focus Areas.

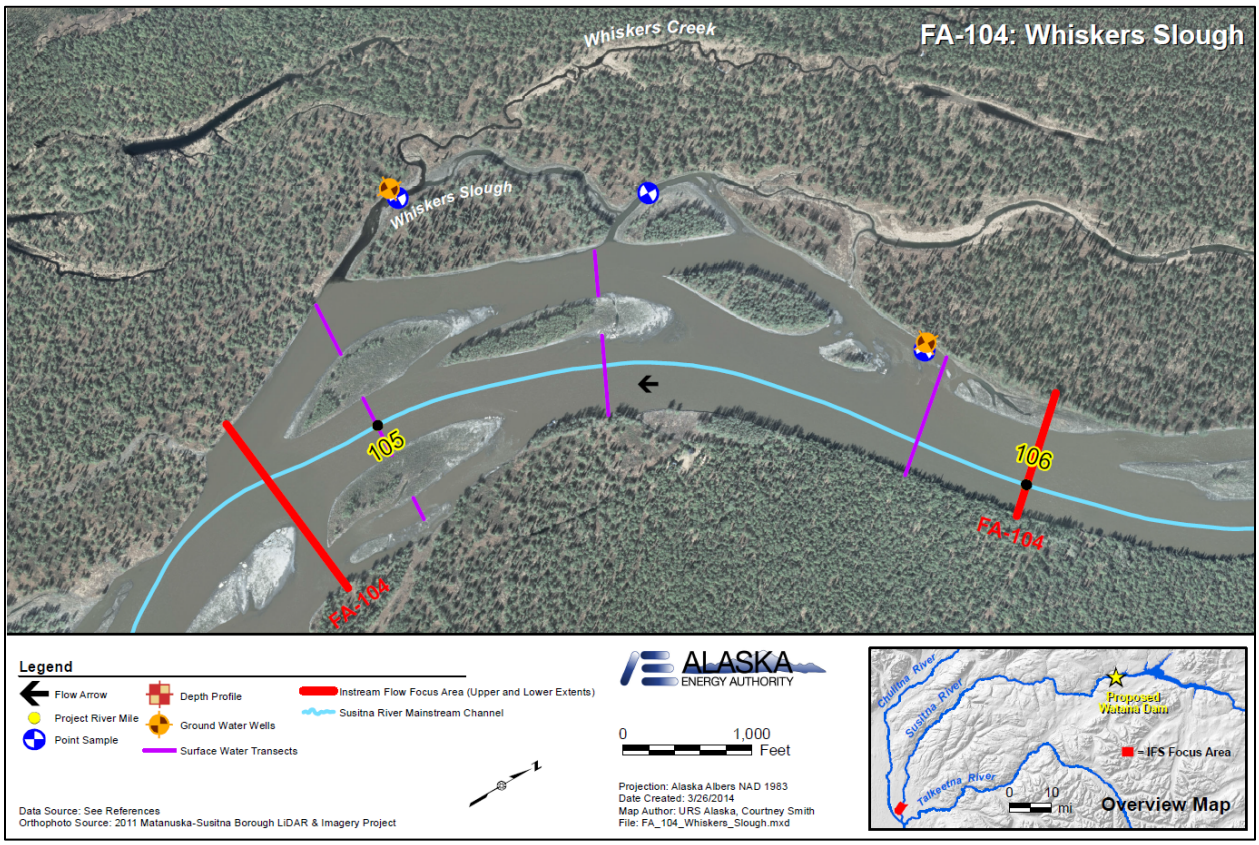
In selecting Focus Area sites, the following elements were considered:

- All major habitat types (main channel, side channel, side slough, upland slough, tributary delta).
- At least one Focus Area per geomorphic reach (excepting reaches associated with Devils Canyon) will be included that are representative of other areas.
- A replicate sampling strategy will be used for measuring habitat types within each Focus Area which may include random selection process.
- Areas that are known (based on existing and contemporary data) to be biologically important for salmon spawning/ rearing in mainstem and lateral habitats will be sampled (i.e., critical habitats) and
- Areas for which little or no fish use has been documented or for which information on fish use is lacking, will also be sampled.

Table 9b: Site Location and Rationale for Focus Area Monitoring

Focus Area (FA)	Description	Latitude (WGS84)	Longitude (WGS84)	Site Description and Rationale for Selection
104	Whiskers Slough	62.37297	-150.1572	FA-104 has a diverse range of habitats characteristic of this braided, unconfined reach. It supports juvenile and adult fish use, necessitating a variety of habitat modeling methods in side channel and side slough areas.
113	Oxbow I	62.48543	-150.09862	FA-113 was added in response to Agency comments that important fish habitat area was underrepresented in by FA-115 alone. Oxbow I is an important chum salmon rearing area.
115	Slough 6A	62.51405	-150.11248	FA-115 contains side channel and upland slough habitats that are representative of this reach. This reach is narrow with few braided channel habitats. Upland Slough 6A is a primary habitat for juvenile fish and habitat modeling was done in side channel and upland slough areas.
128	Slough 8A	62.66118	-149.94195	FA-128 consists of side channel, side slough and tributary confluence habitat features. Side channel and side slough habitats support high juvenile and adult fish use and habitat modeling was completed in side channel and side slough habitats.
138	Gold Creek	62.75487	-149.71795	The FA-138 primary feature is a complex of side channel, side slough and upland slough habitats, each of which support high adult and juvenile fish use. IFG modeling was performed in side channel habitats in the 1980s.
141	Indian River	62.78485	-149.66003	FA-141 includes the Indian River confluence and a range of main channel and off-channel habitats. High fish use of the Indian River mouth has been documented and DIHAB modeling was performed in main channel areas in the 1980s. Studies in the 1980s did not document high fish use of lateral habitats on the right bank upstream of the Indian River confluence.
144	Slough 21	62.80838	-149.59828	FA-144 contains a diversity of main channel and off-channel habitats common to this reach. Side Channel 21 is a primary salmon spawning area. This reach is characterized by a wide floodplain and complex channel morphology with frequent channel splits and side channels.

Figure 3: Example of Focus Area Sample Location: Focus Area 104--- Whiskers Slough



Groundwater Sampling Locations

Stainless steel groundwater piezometers will be installed in four Focus Area sites (Table 9c) to sample groundwater. As previously mentioned, Focus Area sites include mainstem habitat types of known biological significance. The location of open water transects and piezometers will be coordinated with the Instream Flow Study (Study 8) and the Groundwater Study (Study 7.5). A select number of groundwater sampling wells was visited for collection of water samples. Stainless steel casing was used for groundwater wells where water samples were extracted. These groundwater wells were established within a "cluster" of well sites and only one chosen within the cluster. Where feasible, groundwater sampling is intended to coincide with Focus Area sampling for those locations with piezometers.

Table 9c: Site Location and Rationale for Groundwater Monitoring

Focus Area (FA)	Description	Well ID	Latitude (WGS84)	Longitude (WGS84)	Site Description and Rationale for Selection
104	Whiskers Slough	ESGFA104-9-W2	62.37628	-150.17055	FA-104 contains diverse range of habitat, which is characteristic of this braided, unconfined reach. FA-104 habitats support juvenile and adult fish use and a range of habitat modeling methods were used in side channel and side slough areas. Groundwater level response to rain events is pronounced at this location.
		ESGFA104-10-W1	62.38398	-150.15119	
113	Oxbow I	ESGFA113-1-W2	62.48935	-150.10500	FA-113 was added in response to Agency comments that important fish habitat area was underrepresented in by FA-115 alone. Oxbow I is an important chum salmon rearing area. Groundwater input to surface water is influenced by beaver pond construction.
128	Slough 8A	ESGFA128-13-W1	62.66252	-149.90938	FA-128 consists of side channel, side slough and tributary confluence habitat features. Side channel and side slough habitats support high juvenile and adult fish use and habitat modeling was completed in side channel and side slough habitats. This FA has the highest intensity of groundwater study (Study 7.5) and is expected to show identifiable groundwater-surface water exchange.
		ESGFA128-18-W1	62.66538	-149.89693	
138	Gold Creek	ESGFA138-3-W1	62.75674	-149.70559	The FA-138 primary feature is a complex of side channel, side slough and upland slough habitats, each of which support high adult and juvenile fish use. IFG modeling was performed in side channel habitats in the 1980s. The abandoned sloughs in this FA are groundwater fed.
		ESGFA138-4-W1	62.76513	-149.70604	

Sediment and Porewater Samples for Mercury/Metals Sampling Locations

Sediment and sediment porewater samples will be collected in the mainstem Susitna River above and below the proposed dam site and near the mouths of large tributaries that contribute substantially flow to the mainstem Susitna (Table 9d; Figure 4). Samples will be collected downstream of landmasses, where water velocity is slowed and favors accumulation of finer sediment along the channel bottom.

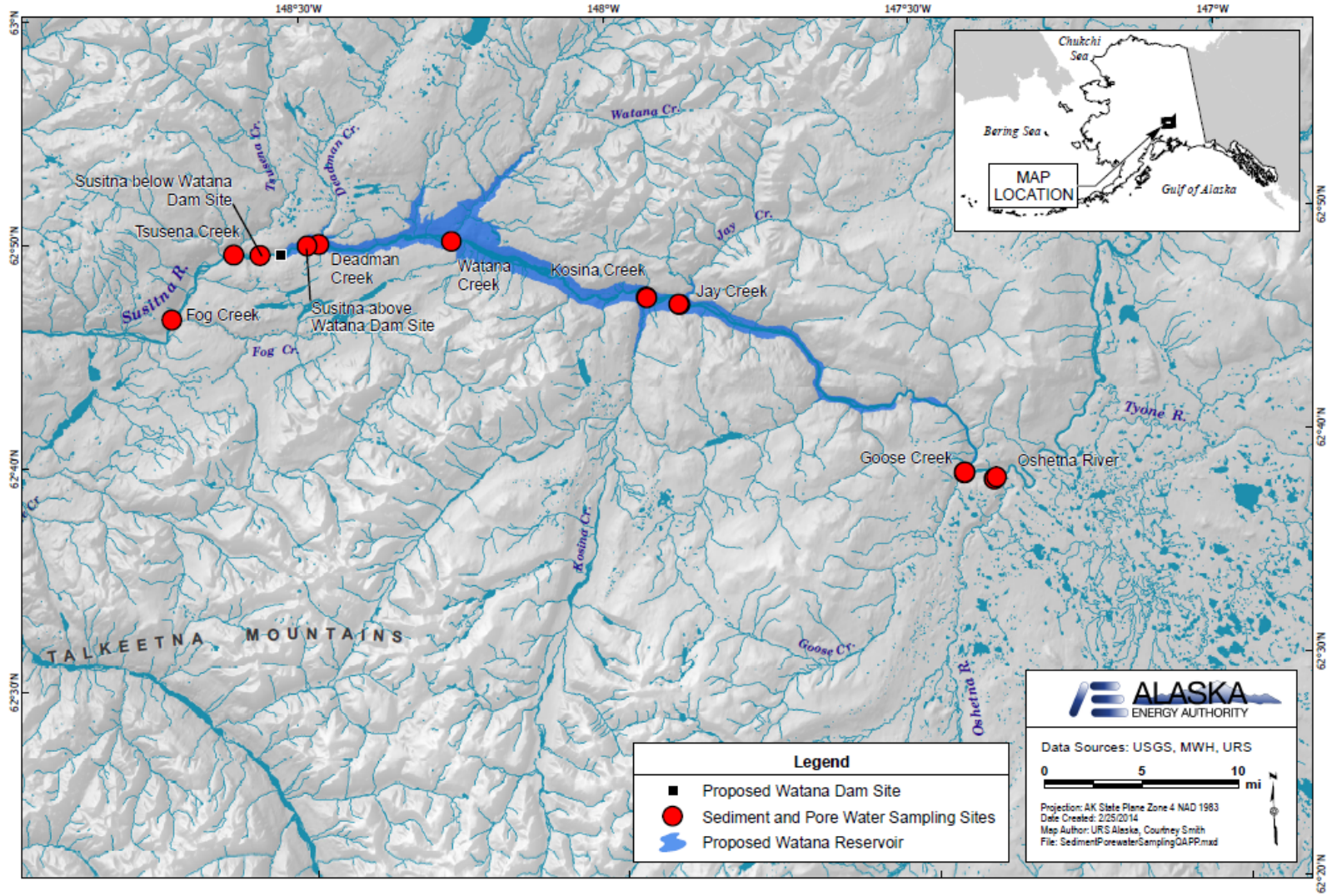
Table 9d: Site Location and Rationale for Sediment and Porewater Monitoring

Sample Site	Nearest PRM	Latitude (WGS84)	Longitude (WGS84)	Site Description and Rationale for Selection
Mouth of Fog Creek[1]	179.3	62.77566	-148.71722	Sites located where landmasses and water velocity favor the accumulation of fine sediment. Mouths of creeks are locations expected to form deltas following filling of the reservoir. A current estimate for delivery of sediment with associated metals will help project future areal extent of sediment dispersion and the potential for exposure.
Mouth of Tsusena Creek[1]	184.8	62.82330	-148.61493	
Below Watana Dam site[1]	187.0	62.82235*	-148.57168	
Above Watana Dam site[1]	187.2	62.82894*	-148.49432	
Mouth of Deadman Creek[1]	189.4	62.82958	-148.47525	
Mouth of Watana Creek[1]	196.9	62.82927	-148.25808	
Mouth of Kosina Creek	209.1	62.78342	-147.94299	
Mouth of Jay Creek	211.0	62.77729	-147.89046	
Mouth of Goose Creek	232.8	62.64426	-147.43553	
Mouth of Oshetna River	235.1	62.63880	-147.38757	

[1] Pending access

*Latitude/longitude from right bank

Figure 4: Sediment/Porewater Sampling Locations



Soil and Vegetation Sampling Locations

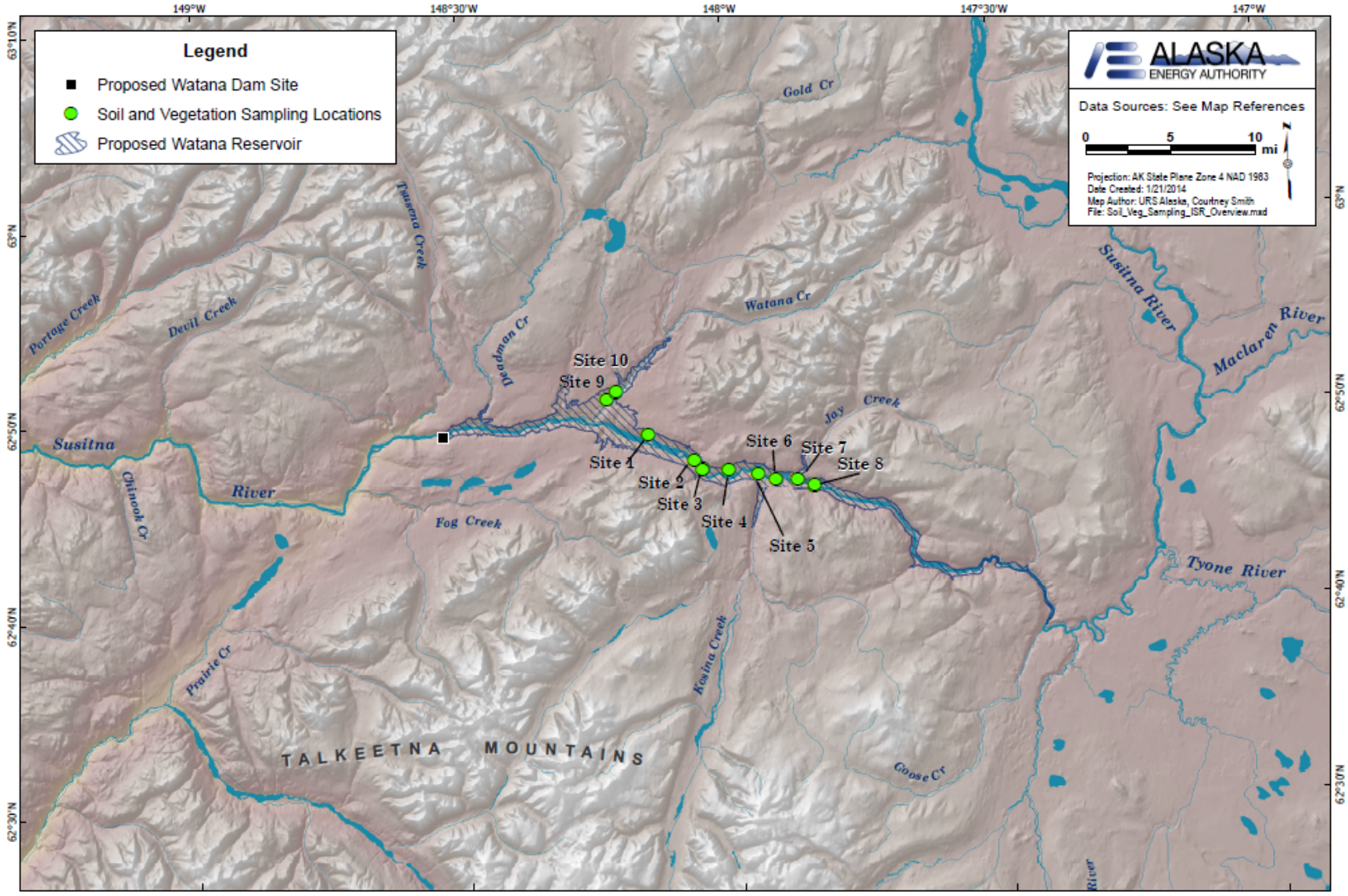
Soil and vegetation samples will be collected within the proposed inundation zone. Soil and vegetation samples will be collected at the same general locations (Table 9e; Figure 5).

Table 9e: Site Location and Rationale for Vegetation and Soil Monitoring

Sample Site	Nearest PRM	Latitude (WGS84)	Longitude (WGS84)	Site Description and Rationale for Selection
Site 1	200.3	62.8206	-148.1557	Sites from throughout the proposed reservoir area had been selected to represent several settings of the inundation zone. Vegetation patterns and soil types vary slightly among sites so are proposed for sampling in order to determine existing sequestered metals in plant tissue and soils. Soil and vegetation samples from the variety of representative sites inform on potential for release of metals to the reservoir once inundated through sources like vegetation decay and release from soils.
Site 2	203.8	62.7976	-148.0707	
Site 2	203.8	62.7974	-148.0704	
Site 3	208.0	62.7896	-148.0563	
Site 4	206.2	62.7884	-148.0074	
Site 5	208.2	62.7842	-147.9521	
Site 6	209.8	62.7790	-147.9189	
Site 7	211.5	62.7784	-147.8787	
Site 8	212.5	62.7728	-147.8483	
Site 9	NA	62.8509	-148.2314	
Site 10	NA	62.8574	-148.2131	

Note: Latitude and longitudes represent the approximate center of each site.

Figure 5: Soil and Vegetation Sampling Locations



Baseline Metals in Fish Tissue Sampling Locations

Target fish species in the vicinity of the Susitna-Watana Reservoir will include Dolly Varden, Arctic grayling, stickleback, longnose sucker, lake trout, whitefish species, burbot and resident rainbow trout. Other fish species (e.g., slimy sculpin) may be substituted if target species are not found or captured during the sampling effort. Sampling locations are proposed for various drainages, including Kosina, Oshetna, Susitna, and Watana as well as Deadman Lake, Sally Lake and Clarence Lake (for lake trout capture).

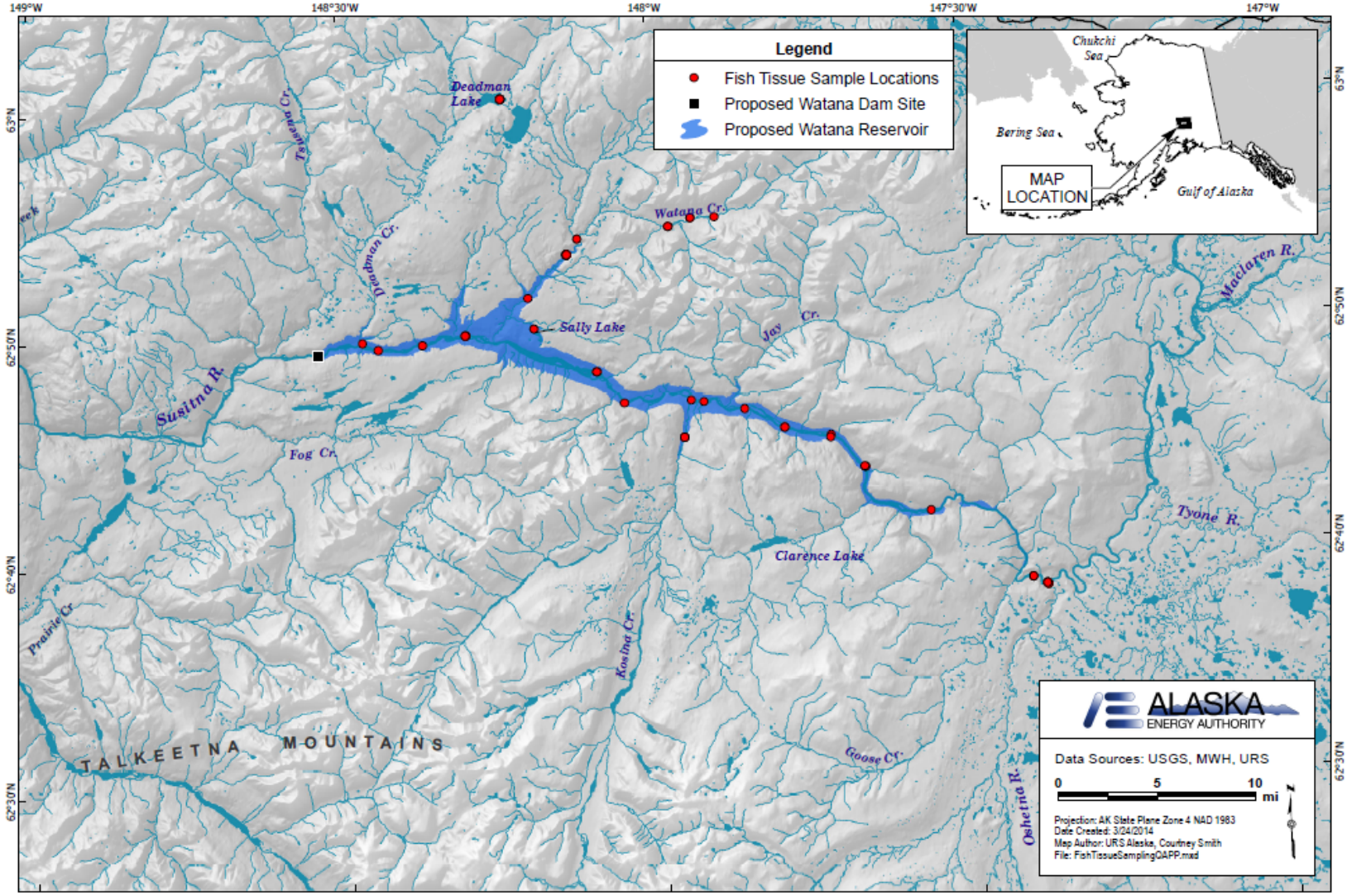
Fur and Feather Sampling Locations

A pathways analysis identifying potential for mercury and methylmercury bioaccumulation throughout the food chain in the proposed study area will be conducted using results from several media and by using both empirical and model output. Combining results from water quality modeling, sediment, vegetation, soil, and fish tissue data will be analyzed using the pathway model and determining if localized factors would promote mobilization in the food chain. If the model predicts the potential for mobilization of mercury and/or methylmercury in the food chain, determination for potential transfer between aquatic receptors to terrestrial receptors will be completed. Should a determination that mercury originating from the reservoir be transferred to the terrestrial food chain, mammal fur, piscivorous bird tissue, and feather sampling will be completed the subsequent year. If this sampling occurs, fur samples from river otters and mink will be sought from animals harvested by trappers in the study area. Feathers from piscivorous birds will be collected from nests of raptors (principally bald eagles, given that ospreys are rare in the study area), loons, grebes, arctic terns, and kingfishers. Analysis of fur and feathers from sites within the inundation will be used to establish pre-dam conditions. Specific location for collection of samples will be determined through wildlife bird surveys (Study Section 10.15.4.3) and from either Alaska Department of Fish and Game (ADF&G) records or harvested by trappers in the study area. Samples of fur and feathers will be collected opportunistically as known sites for nesting or migration changes. Study methods may be altered following discussions with the agencies and licensing participants. Sampling information for fur and piscivorous bird tissue and feather sampling may be found in Appendix D.

Table 9f: Site Location and Rationale for Fish Tissue Monitoring

Site ID	Drainage	Nearest Susitna Project River Mile ((PRM)	Latitude (WGS84)	Longitude (WGS84)	Site Description and Rationale for Selection
Kosina Creek	Kosina Creek	209.1 (Kosina-Susitna Confluence)	62.8921	-148.1365	Fish samples will be collected from several aquatic settings throughout the proposed reservoir area. Criteria for location of fish collection sites include the following: tributaries that host spawning and rearing, tributary mouths that may develop accumulation of fine sediments (and adsorbed metals) once becoming inundated, and longitudinal profile of metals in tissue as an indicator for mobility within the reservoir area.
Oshetna	Oshetna River	235.1 (Oshetna-Susitna Confluence)	62.6394	-147.3813	
Kosina Creek RST	Kosina Creek	209.1 (Kosina-Susitna Confluence)	62.75594	-147.95505	
Oshetna RST	Oshetna River	235.1 (Oshetna-Susitna Confluence)	62.6399	-147.38254	
SUS_02_193.1	Susitna River (PRM 193.1)	193.1	Approx. location	Approx. location	
WAT_02_13A	Near Watana Dam Site	187.2	Approx. location	Approx. location	
SUS_02_190.7	Susitna River (PRM 190.7)	190.7	Approx. location	Approx. location	
Upper Susitna 233.9	Susitna River	233.9	62.645192	-147.404906	
Upper Susitna 217.1	Susitna River	217.0	62.754311	-147.720273	
Upper Susitna 219.5	Susitna River	219.5	62.73017	-147.667198	
Upper Susitna 209.9	Susitna River	209.9	62.781483	-147.921807	
Upper Susitna 212.3	Susitna River	212.3	62.775465	-147.856967	
Upper Susitna 224.3	Susitna River	224.3	62.696507	-147.564476	
Upper Susitna 205.1	Susitna River	205.0	62.782348	-148.049316	
Upper Susitna 202.7	Susitna River	202.7	62.80059	-148.100572	
Upper Susitna 195.5	Susitna River	195.5	62.833004	-148.301838	
Watana 04	Watana Creek	196.9 (Watana-Susitna Confluence)	62.910724	-147.971448	
Upper Susitna WAT	Watana Creek	196.9 (Watana-Susitna Confluence)	62.916536	-147.896628	
Upper Susitna 214.7	Susitna River	214.7	62.76079	-147.793795	
Deadman Lake	Deadman Creek	189.4 (Deadman Creek – Susitna Confluence)	63.007603	-148.236442	
Clarence Lake	Kosina Creek	214.5	62.675729	147.825121	
Sally Lake	Watana Creek (HU10)	199.0	62.834768	148.184744	

Figure 6: Fish Tissue Sampling Locations



B.1.3 Identify the Site-Specific Sample Collection Location(s), Parameters to be Measured and Frequencies of Collection

Proposed sample collection locations for the Water Quality and Mercury Assessment are summarized in Figures 2a through 6 and Tables 9a through 9e. Table 10 summarizes the criteria for establishing site respresentiveness. Table 11 summarizes the proposed sample schedule, parameters, sample type, and frequency for samples collected in situ and grab samples collected for laboratory analysis.

Baseline Water Quality monitoring will occur at pre-defined PRMs (Figure 2a, Table 9a) on a monthly basis for four months in the summer (June to September) and at least two months during the winter (January and March) as part of ongoing studies. The period for collecting surface water samples will begin at ice break-up and extend to beginning of ice formation on the river. Limited winter sampling will be conducted where existing or historic USGS sites are located. For each sampling event, results of in situ samples will be recorded and grab samples will be collected for laboratory analysis per the schedule in Table 11.

Focus Area monitoring will occur at seven areas (Figure 2b; Table 9b) every two weeks from July to August as part of ongoing studies (Table 11). For surface water sampling, three to five discrete collection points will be collected in open water areas along a transect. At least one piezometer will be installed and remain in place in each of four Focus Areas to sample groundwater (Table 9c). Groundwater data will be used to evaluate the interaction between shallow unconfined groundwater and adjacent in-stream surface water. One groundwater sample will be collected from each piezometer during each of the three planned sampling events.

Mercury monitoring in sediment, porewater, fish tissue, fur, feathers, soil, and vegetation will occur as one-time sample events (Table 11).

Table 10: Criteria for Establishing Site Representativeness

River Section	Site Identification	Susitna Project River Mile (PRM)	Monitoring Purpose[1]	Criteria for Site Selection
Lower Susitna River	Susitna River above Alexander Creek	19.9	CT	• Very little data are available that describe current water quality conditions. • Metals data are not available for the mouth of the Chulitna River. The influence of major tributaries (Chulitna and Talkeetna rivers) on Susitna River water quality conditions is unknown. • Metals data are not available for the Skwentna River or the Yentna River. • Continuous temperature data, general water quality data, and metals data are not available for the Susitna River mainstem and sloughs potentially used for spawning and rearing habitat. • Monitoring of Susitna River mainstem and sloughs is needed for determining the potential for metal bioaccumulation in fishes. • The source(s) for metals detected at high concentrations in the mainstem Susitna River is unknown. • Current data reflects large spatial data gaps between the upper river and the mid to lower portions of the river. • Continuous temperature data are not available for the Susitna River mainstem, tributary, and sloughs potentially used for spawning and rearing. • Temperature data are not available above and below most tributaries on the mainstem Susitna River. • Overall, very limited surface water data are available for this reach. • Metals monitoring data do not exist or are limited. • Concentrations of metals in sediment immediately below the proposed Project are unknown. Metals in these sediments may become mobile once the Project begins operation. • Areas downstream of major tributaries with large landmasses favor the accumulation of fine sediment. • Upper reservoir tributary locations used to account for input of
	Susitna Station	29.9	CT, BWQ	
	Yentna River	32.5	CT, BWQ	
	Susitna River above Yentna River	33.6	CT, BWQ	
	Deshka River	45.1	CT, BWQ	
	Susitna	59.9	CT, BWQ	
	Susitna at Parks Hwy East	87.8	CT, BWQ	
	Susitna at Parks Hwy West	88.3	CT	
Middle Susitna River	LRX 1	99.2	CT	
	Talkeetna River	102.8	CT, BWQ	
	Talkeetna	107	CT, BWQ	
	LRX 18	116.6	CT	
	Chulitna River	118.6	CT, BWQ	
	Curry Fishwheel Camp	124.2	CT, BWQ	
	Slough 8A	129.6	CT	
	LRX 29	129.9	CT	
	Slough 9	132.7	CT	
	LRX 35	134.1	CT	
	Susitna River near Gold Creek	140.0	CT, BWQ	
	Gold Creek	140.1	CT, BWQ	
	Slough 16B	141.0	CT	
	Indian River	142.2	CT, BWQ	

River Section	Site Identification	Susitna Project River Mile (PRM)	Monitoring Purpose[1]	Criteria for Site Selection
Middle Susitna River, cont.	Susitna River above Indian River	142.3	CT, BWQ	conventional parameters and metals into the reservoir. • Data generated will be used to calibrate the reservoir water quality model by accounting for these additional sources of water input. • Areas downstream of major tributaries with large landmasses favor the accumulation of fine sediment.
	Slough 19	143.6	CT	
	LRX 53	143.6	CT	
	Slough 21	145.6	CT	
	Susitna River below Portage Creek	152.2	CT[2]	
	Portage Creek	152.3	CT[2], BWQ	
	Susitna River above Portage Creek	152.7	CT[2], BWQ	
Upper Susitna River	Susitna	168.1	CT[2]	
	Susitna below Watana Dam Site	174	BWQ	
	Mouth of Fog Creek	179.3	S[2], PW[2]	
	Susitna River below Tsusena Creek	183.1	CT[2]	
	Tsusena Creek	184.8	CT[2], BWQ[2], S[2], PW[2]	
	Susitna River at Watana Dam Site	187.2	CT[2], BWQ[2] , S[2], PW[2]	
	Mouth of Deadman Creek	189.4	S[2], PW[2]	
	Watana Creek	196.8	CT[2], BWQ[2], S[2], PW[2]	
	Mouth of Jay Creek	209.1	S, PW	
	Kosina Creek	211.1	CT[2] , BWQ[2], S, PW	
	Susitna River near Cantwell	225.5	CT[2], BWQ[2]	
	Mouth of Goose Creek	232.8	S, PW	
	Oshetna Creek	235.2	CT, BWQ, S, PW	
Focus Areas	Focus Area 144-Slough 21	144	SW	

River Section	Site Identification	Susitna Project River Mile (PRM)	Monitoring Purpose[1]	Criteria for Site Selection
	Focus Area 141-Indian River	141	SW	
	Focus Area 138-Gold Creek	138	SW, GW	
	Focus Area 128 (Slough 8A)	128	SW, GW	
	Focus Area 115 - Slough 6A	115	SW	
	Focus Area 113-Oxbow I	113	SW, GW	
	Focus Area 104-Whiskers Slough	104	SW, GW	

Notes:
[1] BWQ = Baseline Water Quality; CT = Continuous Temperature; P = Porewater; S = Sediment; SW = Surface Water; GW = Groundwater
[2] Pending access see Table 9a for additional information on continuous temperature and baseline water quality monitoring dates.

Table 11. Sample Schedule (Parameters, Sample Type, Frequency)

Parameter to be Measured	Baseline Water Quality	Focus Areas		Mercury Assessment				
	Collected monthly (June - Sept)	Three events; collected every 2 weeks (July – Aug)		One-time survey[2] (Aug - Sept)				
		Surface Water	Ground Water[5]	Sediment (Total Metals)	Porewater (Dissolved Metals)	Fish Tissue[6] (Total Metals)	Fur & Feathers	Soil & Vegetation
In Situ Samples								
Water Temperature	X	X	X		X			
Dissolved Oxygen (DO)	X	X	X		X			
pH	X	X	X		X			
Specific Conductance	X	X	X		X			
Redox Potential (ORP)	X	X	X					
Color	X							
Residues	X[1]							
Grab Samples/Laboratory Measurements								
Hardness	X	X	X					
Alkalinity	X				X			
Nitrate/Nitrite	X	X	X					
Ammonia as N	X							
Total Kjeldahl Nitrogen (TKN)	X	X	X					
Total Phosphorus (TP)	X	X	X					
Soluble Reactive Phosphorus (SRP)	X	X	X					
Chlorophyll-a	X	X						
Turbidity	X	X	X		X			

Parameter to be Measured	Baseline Water Quality	Focus Areas		Mercury Assessment				
	Collected monthly (June - Sept)	Three events; collected every 2 weeks (July – Aug)		One-time survey[2] (Aug - Sept)				
		Surface Water	Ground Water[5]	Sediment (Total Metals)	Porewater (Dissolved Metals)	Fish Tissue[6] (Total Metals)	Fur & Feathers	Soil & Vegetation
Total Dissolved Solids	X							
Total Suspended Solids	X							
Total Organic Carbon (TOC)	X[1]	X	X	X				
Dissolved Organic Carbon (DOC)	X	X	X		X			
Fecal Coliform	X[1]							
Polynuclear Aromatic Hydrocarbons (PAHs)[3]	X[1]							
Benzene, ethylbenzene, toluene, xylenes (BETX)[4]	X[1]							
Radionuclides	X[1]							
Grain Size				X				
Total Solids								X
Metals[7]								
Aluminum	X[1]	X	X		X			
Arsenic	X			X	X	X		
Barium	X							
Beryllium	X							
Cadmium	X			X	X	X		
Calcium	X		X (dissolved)	X	X			
Chromium (Total)	X[1]							

Parameter to be Measured	Baseline Water Quality	Focus Areas		Mercury Assessment				
	Collected monthly (June - Sept)	Three events; collected every 2 weeks (July – Aug)		One-time survey[2] (Aug - Sept)				
		Surface Water	Ground Water[5]	Sediment (Total Metals)	Porewater (Dissolved Metals)	Fish Tissue[6] (Total Metals)	Fur & Feathers	Soil & Vegetation
Cobalt	X							
Copper	X			X	X			
Iron	X	X	X	X	X			
Lead	X			X	X			
Manganese	X							
Magnesium	X		X (dissolved)		X			
Mercury	X	X (total)	X (total)	X	X	X	X	X
Methylmercury		X (dissolved)	X (dissolved)		X	X		X
Molybdenum	X							
Nickel	X			X	X			
Selenium	X[1]			X	X	X		
Thallium	X							
Vanadium	X							
Zinc	X			X	X			

Notes:
1 – One-time sample event
2 – Refer to Study 5.7 for details
3 - Total Aqueous Hydrocarbons (TAqH): TAH + EPA Method 610 Polynuclear Aromatic Hydrocarbons (PAHs)
4 - Total Aromatic Hydrocarbons (TAH): Benzene, ethylbenzene, toluene, xylenes (BETX)
5 – Where possible, groundwater will be sampled on the same schedule as surface water
6 - All targeted species fish samples will analyze fillet tissue for methylmercury and mercury. Burbot samples will also include liver tissue for analysis of all five parameter
7 – All metals were measured as dissolved and total fractions, unless otherwise noted.

B.2 SAMPLING METHOD REQUIREMENTS

The URS Field Operations PM will oversee all field activities with the assistance of field team leads from URS and Tt. Samples will be collected by URS and Tt staff. A description for calibration of probes and standards used for calibration are fully described. Samples will be transported each day to SGS North America Inc., (SGS) located in Anchorage, Alaska. Sampling methods are described in this section for each type of sample to be collected – surface water, groundwater, sediment, porewater, soil, vegetation, fish tissue, fur, and feathers. Ongoing work will use sampling and analysis protocols specified in this QAPP, but future sample collection effort at established sites may vary depending on data results and evolving program needs.

B.2.1 Sample Types

Samples collected as part of the Water Quality and Mercury Assessment, in accordance with this QAPP, will be one of the following types using the Field Standard Operating Procedures (SOPs) described in Appendix D of this QAPP:

- Continuous temperature monitoring
- In-situ; including all field measurements collected with a multi-parameter water quality sonde (i.e. Hydrolab®) and Hanna Instruments HI 727 Colorimeter.
- Grab; includes both water (surface-, pore-, and groundwater) and sediment samples.
- Fish Tissue; includes fish tissue samples collected from the eight target fish species: Dolly Varden, Arctic grayling, whitefish, burbot, longnose sucker, lake trout, and rainbow trout. Other fish species (e.g., slimy sculpin) may be substituted if target species are not found or captured during the sampling effort. Liver tissue from burbot will also be collected for analysis. Otoliths will be collected for age dating.
- Groundwater sampling will occur at four of the seven Focus Areas.

B.2.2 Sample Containers and Equipment

All sampling equipment and sample containers will be pre-cleaned or certified clean according to the equipment specifications and/or the analytical laboratory. To the extent possible, dedicated equipment will be used for sample collection and sample volumes will be transferred directly into sample containers to minimize potential cross-contamination in the field. Since low-level metals analysis is a component of this program, high density polyurethane (HDPE) tubing and filters used for field filtration be checked prior to use by submitting a section of tubing and a filter for each vendor lot to the laboratory for equipment and filter blank analysis using methods indicated for the field samples. In the field, all sampling equipment and sample containers for water that do not have preservative will be rinsed three times with sample water before collecting the final sample aliquot. Bottles with sample preservative supplied by the laboratorywill not be pre-rinsed and will be filled such that preservative remains in the container (i.e., not overfilled).

The analytical program includes three short hold time tests – fecal coliform (8 hours), SRP (48 hours), and turbidity (48 hours). To the extent possible, the field crews will attempt to maintain field logistics such that samples requiring these short hold time tests will be transported to the laboratory, received, and analyzed within the hold time. If hold times are exceeded, the data will

be evaluated to assess the impact to project objectives and procedures will be reviewed to see if improvements can be made to avoid ongoing issues.

Table 12a lists analyses, methods, container size and types, preservation and/or filtration requirements, and maximum holding times for parameters to be analyzed in current and future studies. Sample aliquots requiring filtration will be field filtered before placing in the associated sample containers.

Table 12a: Preservation and Holding Times for the Analysis of Samples

Analyses	Method	Matrix	Container	Preservative	Maximum Holding Time
Total Metals - Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, Se, Tl, V, Zn	Low level EPA 200.8	Water and groundwater (Al, Fe only)	250-ml HDPE	HNO_3 (pH<2), Cool to 0-6 °C	6 months (preserved)
Total low-level Mercury	EPA 1631E	Water, including porewater & groundwater	500-ml Teflon	HCl (pH<2), Cool to 0-6 °C	90 days
Dissolved Metals - Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, Se, Tl, V, Zn	Low-level EPA 200.8	Water, including porewater & groundwater (Al, Ca Fe, Mg only)	250-ml HDPE	HNO_3 (pH<2), Cool to 0-6 °C (field filter before preservation)	6 months for filtered/preserved
Hardness	SM21 2340B	Water, including porewater and groundwater	250-ml HDPE	HNO_3 (pH<2), Cool to 0-6 °C (field filter before preservation)	6 months for filtered/preserved
Dissolved low-level Mercury	EPA 1631E	Water, including porewater	500-ml Teflon	HCl (pH<2), Cool to 0-6 °C (field filter before preservation)	90 days
Dissolved Methylmercury	EPA 1630	Water and groundwater	250-ml Fluoropolymer w/ fluoropolymer-lined lids	HCl to 0.4%, 0-4 °C; protect from light	6 months
Alkalinity	SM21 2320B	Water, including porewater	500-ml HDPE	Cool to 0-6 °C	14 days
Total Dissolved Solids (TDS)	SM21 2540C	Water			7 days
Turbidity	SM21 2130B	Water and groundwater			48 hours
Total Suspended Solids (TSS)	SM21 2540D	Water	1-L HDPE	Cool to 0-6 °C	7 days

Analyses	Method	Matrix	Container	Preservative		Maximum Holding Time	
Nitrate+Nitrite	SM21 4500 NO3-F	Water and groundwater	500-ml HDPE	Field Preserved: H_2SO_4 (pH<2), Cool to 0-6 °C	Not Field Preserved: Cool to 0-6 °C	Field Preserved: 28 days	Not Field Preserved: 48 hours
Ammonia as N	SM21 4500NH3-G	Water					
Total Kjeldahl Nitrogen (TKN)	SM21 4500N-D	Water and groundwater					
Total Phosphorus (TP)	SM21 4500P-B,E	Water and groundwater					
Soluble Reactive Phosphorus (SRP)	SM21 4500P-B,E	Water and groundwater	125-ml HDPE	Cool to 0-6 °C (field filter)		48 hours filtered	
Chlorophyll a	SM10300	Water	1-L glass amber	Field filter, protect from light, freeze to -20C		21 days	
Total Organic Carbon (TOC)	SM21 5310B	Water, including porewater and groundwater	125-ml amber	HCl (pH<2) Cool to 0-6 °C		28 days	
Dissolved Organic Carbon (DOC)	SM21 5310B	Water, including porewater and groundwater	125-ml amber	HCl (pH<2) Cool to 0-6 °C (field filter before preservation)		28 days	
Fecal Coliform	SM21 9222D	Water	125-ml sterile	Na2S203; 0-6° C		8 hours	
Polynuclear Aromatic Hydrocarbons (PAHs)[1]	EPA 625 mod SIM	Water	2 x 1 liter Amber glass	Cool to 0-6 °C		7 days to extraction/40 days to analysis	
Benzene, ethylbenzene, toluene, xylenes (BETX)[2]	EPA 624	Water	3x40-ml amber VOA vials	HCl (pH<2) Cool to 0-6 °C		14 days	
Radionuclides	EPA 900 series	Water	10-Liter poly “cubie”	Cool to 0-6 °C (SGS will preserve w/ HNO_3 before shipping to subcontract lab)		6 months	

Analyses	Method	Matrix	Container	Preservative	Maximum Holding Time
Metals - As, Ca, Cd, Cu, Fe, Pb, Mg, Ni, Se, Zn	SW 6020	Sediment	4-oz amber glass	0-4°C during shipment, <15°C in lab	6 months 28 days for Hg
Total Organic Carbon (TOC)	SW 9060A mod	Sediment			28 days
Sediment Grain Size	ASTM D422	Sediment	8-oz amber glass if fine 5 gallon bucket if coarse	Cool to 0-6 °C	NA
Total Mercury	EPA 1631E	Sediment	Zip-type plastic bag	Cool to ≤6°C	28 days
Total Mercury, Methylmercury, As, Cd, Se	EPA Methods 1631E, 1630, 1638	Fish Tissue	Zip-type plastic bag (filet muscle tissue wrapped in polyethylene sheets)	Freeze same day as collection	1 year
Total Mercury, Methylmercury	EPA Methods 1631E, 1630	Vegetation	Zip-type plastic bag	0-4°C during shipment, <15°C in lab	1 year
Total Mercury, Methylmercury	EPA Methods 1631E, 1630	Soil	4 –oz glass or plastic wide mouth jar	0-4°C during shipment, <15°C in lab	1 year
Percent Total Solids	SM21 2540G	Soil	4 –oz glass or plastic wide mouth jar	0-4°C during shipment, <15°C in lab	1 year
Total Mercury	EPA 1631E	Fur & Feathers	Zip-type plastic bag	0-4°C during shipment, <15°C in lab	1 year

Notes:

1 - For Total Aqueous Hydrocarbons (TAqH): TAH + EPA Method 610 Polynuclear Aromatic Hydrocarbons (PAHs)

2 - For Total Aromatic Hydrocarbons (TAH): Benzene, ethylbenzene, toluene, xylenes (BETX)

B.2.3 Sampling Methods

Below are abbreviated descriptions of sampling methods used as part of the Water Quality and Mercury Assessment. Further details for each type of sampling method are summarized in the Field Activities SOPs (Appendix D). The elements for each aspect of monitoring are reported in the following sections to provide a general understanding for how monitoring activity will be completed.

Continuous Temperature Monitoring

Water temperatures will be recorded in 15-minute intervals using Onset TidbiT v2 water temperature data loggers. The TidbiT v2 has a precision sensor for plus or minus 0.4 degrees Fahrenheit (°F) (0.2 degrees Celsius [°C]) accuracy over an operational range of -4°F to 158°F (-20°C to 70°C). Data readout is available in less than 30 seconds via an Optic USB interface.

The method for deploying temperature loggers will depend on environmental conditions (e.g., ice, water velocity, access). Optional deployment systems include: anchor-and-buoy, bank-mounted, and overwinter. It was initially intended that redundant loggers would be installed at each location; however, that was deemed unnecessary and, in some cases unsafe, by the field crews. Details on calibration and deployment may be found in the SOP for Continuous Temperature Monitoring and (a companion Tech Memo) TidBiT Re-Install Procedures & Recommendations for 2013 Data Management, both in Appendix D.

Baseline Water Quality Sampling Methods

Baseline Water Quality sampling will occur as in situ monitoring and by collecting grab samples for laboratory analysis. A transect will be established at each Baseline Water Quality monitoring site. Monitoring at each site will occur at three equi-distant locations along each transect (i.e. 25% from left bank, 50% from left bank, and 75% from left bank). Additional details may be found in the Field Activities SOP for Baseline, Focus Area, and Groundwater Sampling in Appendix D.

<u>In-Situ Water Quality Monitoring</u>

During each site visit, in situ measurements of dissolved oxygen (DO), pH, specific conductance, redox potential, turbidity, water temperature, and color will be made at each location along the transect. Measurements will be collected at every 0.5 m depths until 0.5 m above the river bottom.

A Hanna Instruments HI 98703 Portable Turbidity Meter will be used to measure turbidity, a Hanna colorimeter will be used to measure color, and a Hydrolab® datasonde (MS5) will be used to measure the remaining field parameters during each site visit. Standard techniques for pre- and post-sampling calibration of in situ instrumentation will be used to ensure quality of data generation and will follow accepted practice and follow manufacturer's instructions (LINKED FILES: FIELD EQUIPMENT). Calibration of in situ parameters will occur at the beginning and end of each day's field activities. Calibration data, both pre- and post- sampling, will be recorded on a calibration form by field personnel. Standards for pH 7 and 10 will be used to perform the calibration of the pH probe on the Hydrolab® datasonde. For conductivity, a conductivity standard of 1412 µS/cm will be used. Parameters will be considered within calibration range if the instrument reading is within 10 percent of the calibration standard value.

If calibration failure is observed after a site visit, field data will be corrected according to equipment manufacturer's instructions and calibration records. Temperature probes on the Hydrolab® datasondes are calibrated at the manufacturer and will not be calibrated in the field.

In-situ measurements will be conducted as described in Field Activities SOP for Baseline, Focus Area, and Groundwater Sampling (Appendix D).

Grab Samples

Surface water grab samples will be collected using one of two methods dependent upon field conditions (e.g., water velocity and flow). Water quality sample containers will be filled using a high capacity peristaltic pump and non-reactive HDPE tubing tied to a davit cable attached to a 50 to 75 lb. weight and lowered into the water column. Once positioned at the right depth, the pump will be turned on and flushed for three minutes. Samples will be collected from the tubing and into the proper sample containers and labeled accordingly. Filtered samples will be collected after a 0.45 µm filter is attached to the tubing and flushed for one minute. Where sample locations are located in water depths less than 3 ft. (<1 m) deep and not accessible by boat, field personnel will collect samples by wading into the river, and using the HDPE tubing and peristaltic pump to collect the sample. In these instances, the HDPE tubing will be secured to an extendable aluminum boat pole and placed along the bottom of the river such that the tubing opening will face upstream at approximately mid-water column depth.

Samples will be collected from a depth of 0.5 meters below the surface as well as 0.5 meters above the bottom if water depth at that sample location is 5 ft (1.5 m) or greater. If water depth at the sample location is less than 5 ft (1.5 m) then only a surface sample (0.5 meters below the surface will be collected). This will ensure that variations in concentrations, especially metals, are captured and adequately characterized throughout the study area.

Collection of surface water samples that will be analyzed for mercury will be handled using the Clean Hands/Dirty Hands procedure (modified Method 1669; described in detail in the Field Activities SOP for Baseline, Focus Area, and Groundwater Sampling provided in Appendix D). One set of hands operates all equipment and materials that present potential for contamination of mercury in the sample. The other set of hands handles the sample container, lid, and preparation of the sample for storage and transport in the cooler (EPA 1996).

Sample numbers (IDs) will be recorded on field data sheets immediately after collection. Samples intended for the laboratory will be stored/preserved under refrigeration and kept under the custody of the field team at all times.

Focus Area Sampling Methods

Sampling in Focus Areas is distinguished from the large-scale program by a higher density of sampling within a pre-defined reach length and a higher frequency of sample collection. Similar sample collection techniques will be utilized for in situ and grab sampling efforts in the Focus Areas, scheduled every two weeks for a duration of six weeks (Table 11). Depending on the length of the Focus Area, transects will be spaced every 100 m to 500 m and water quality samples collected at three or more locations along each transect. The collection locations along a transect will be in open water areas and result in three to six collection points.

Point samples in Focus Areas will be collected at sites <3 ft. using a similar method to the Baseline Water Quality sampling. Field personnel will use a backpack equipped with pump and

tubing attached to an extendable boat pole. The pole will be held at mid-water column depth and samples will be collected in appropriate sample jars. Field crews will wade into streams only when flow is sufficient to avoid disrupting habitat. Filtered samples will be collected after a 0.45 µm filter is attached to the tubing and flushed for one minute. Using a flow-thru cell on the Hydrolab and the tubing/pump set up, parameters will be taken at ten meter increments 40 m upstream, and 50 m downstream of the point sample. Hydrolab parameters will be collected following the collection of the point sample to reduce possible contamination or stirring up of the sediment.

Focus Area sampling methods will be conducted as described in Field Activities SOP for Baseline, Focus Area, and Groundwater Sampling (Appendix D).

Groundwater Sampling Methods in Focus Areas

Groundwater (piezometer) sampling activities are intended to be performed concurrently with surface water sampling activities in the Focus Areas for determination of the influence of groundwater on surface water. Consequently, groundwater sampling will largely coincide with planned Focus Area sampling events. Groundwater samples will be analyzed for a subset of parameters and analytical suite as used for in-stream focus area transects (Table 11). Groundwater samples will be collected from each piezometer identified in Table 9d. Groundwater sampling will be conducted as described in Field Activities SOP for Baseline, Focus Area, and Groundwater Sampling (Appendix D).

Sediment and Porewater Samples for Mercury/Metals Sampling Methods

Sediment and porewater samples will be collected from sites identified in Table 9d. Suitable sampling locations within each of these sites will be identified upon site arrival, after which in situ parameters will be collected using a Hydrolab in the water column directly above the sediment sample locations. Porewater samples will be collected from each sediment sample location prior to the collection of sediment.

Porewater will be collected using stainless steel push points, a peristaltic pump, disposable tubing, and in-line 45 µm pore size filters. A PushPoint™ sampler, which typically consists of a pointed tubular stainless steel tube with a screened zone at one end and a sampling port at the other, will be used at all sediment locations. The pointed end with the screened zone consists of a series of very fine interlaced machined slots to allow porewater to enter the sampler. A removable guard rod adds rigidity to the sampler during sediment insertion. The length of the screened zone will depend on the site specific study design. Using Clean Hands/Dirty Hands collection techniques, a length of disposable tubing will be cut for each sampling location and attached to the sampling port of the PushPoint. Porewater is collected by connecting the tubing to a peristaltic pump to extract the sample. The peristaltic pump will be turned on and allowed to flush for one minute before placing the in-line filter on the discharge tube. Once the filter is in place the pump will be allowed to run such that one filter volume of water is passed through before sample collection.

Sediment samples will be collected from the same location as surface- and porewater samples. Sediment will be sampled using appropriate extraction tools for the conditions (e.g., Ekman dredge, modified Van Veen grab sampler, hand auger, or stainless spoon). To the extent possible, samples will consist of the top six inches (15 centimeters) of sediment. In addition, grain size and TOC will be included to evaluate whether these parameters are

predictors for elevated metal concentrations. Most of the contaminants of interest are typically associated with fine sediments, rather than with coarse-grained sandy sediment or rocky substrates. Therefore, the goal of the sampling will be to obtain sediments with at least 5 percent fines (i.e., particle size less than 0.0025 inches [63 micrometers], or passing through a #230 sieve). At some locations, however, larger-sized sediment may be all that are available. Field parameters (temperature, DO, pH, specific conductance, turbidity, and redox potential) will also be measured in water directly above sediment sampling locations during the time of sediment/pore water sample collection (Table 11a). Most of the contaminants of interest are typically associated with fine sediments, rather than with coarse-grained sandy sediment or rocky substrates. Therefore, the goal of the sampling will be to obtain sediments with at least 5 percent fines (i.e., particle size less than 0.0025 inches [63 micrometers], or passing through a #230 sieve). At some locations, however, larger-sized sediment may be all that are available.

Sediment and porewater samples will be stored in cooler and kept under the custody of the field crews at all times. Samples will be transported to the laboratory in coolers with ice and cooled to approximately 4 °C. Chain of custody records and other sampling documentation will be kept in sealed plastic bags (e.g., zip-type) and taped inside the lid of the coolers prior to shipment. Packaging, marking, labeling, and shipping of samples will be in compliance with all regulations promulgated by the U. S. Department of Transportation in the Code of Federal Regulations, 49 CFR 171-177.

A summary of sediment and porewater sample analyses are summarized in Table 11a.

Soil and Vegetation Sampling Methods

Soil samples will be collected by advancing a hand dug test pit through the organic layer to the soil layers. Using gloved hands, approximately 20 g of soil organic material will be removed from the central portion of the mass and placed in an 8 oz. sample jar and sent for analyses. Vegetation samples will be collected from various plants, including trees and shrubs (e.g., alder, willow, spruce, and salmonberry) and herbaceous species (e.g., fireweed, bush cinquefoil). Vegetation samples will be collected within a 10-foot radius of soil samples using gloved hands. Samples will be stored in zip-type plastic bags. At least 50 samples of each will be collected from at least 10 sites in the inundation zone.

Baseline Metals in Fish Tissue Sampling Methods

The fish tissue collection will be conducted as part of the Study 7.5 and Study 7.6 (Study of Fish Distribution and Abundance in the Upper Susitna River and the Middle/Lower Susitna River, respectively).

As previously mentioned, target fish species in the vicinity of the Susitna-Watana Reservoir will be Dolly Varden, Arctic grayling, stickleback, whitefish species, burbot, longnose sucker, lake trout, and resident rainbow trout. If possible, filets will be sampled from seven adult individuals from each species. Body size targeted for collection will represent the non-anadromous phase of each species life cycle (e.g., Dolly Varden will be 3.5 to 5 inches [90 to 125 millimeters] total length to represent the resident portion of the life cycle). Collection times for fish samples will occur in late June to early October during sampling years. Filet samples will be analyzed for methylmercury and total mercury. Liver samples will also be collected from burbot and analyzed for mercury, methylmercury, arsenic, cadmium, and selenium.

Field procedures will be consistent with those outlined in applicable ADEC and/or EPA sampling protocols (EPA 2000) and further outlined in the Field Activities SOP for Fish Collection and Otolith Extraction in Appendix D. Clean nylon nets and polyethylene-gloves will be used during fish tissue collection. The species, fork length, and weight of each fish will be recorded. Fish will be placed in Teflon® sheets and into zipper-closure bags and placed immediately on ice. Fish samples will be submitted to SGS for transfer to Brooks Rand for analysis. Results will be reported with respect to applicable state and federal standards.

Fur and Feather Sampling Methods

Feathers from piscivorous birds will be sought during the wildlife bird surveys (Study10.15). When nests of obligate piscivorous waterbirds (e.g., loons, grebes, terns) are observed during the breeding aerial surveys, the locations will be recorded as GPS waypoints and marked on field survey maps. The locations of broods of piscivorous waterbirds will also be recorded during brood and fall migration surveys. The results from observed species will include identification of location and collection of samples for the Mercury Assessment Study as described in the Study 10.15.

Fur samples from river otters and mink from animals will be harvested by trappers in the study area. Based on a preliminary review of ADF&G records there are no appreciable harvests of target species like mink or river otter in this area for the last several years. If samples are not collected from these species based on absence in the study area they will not be replaced with an alternate species for fur analysis.

Details on the methods for collection of fur and feather samples are summarized in the Field Activities SOP for Fur and the SOP for feathers, respectively, both in Appendix D.

Quality Assurance/Quality Control (QA/QC) and Blank Samples and Frequency

Quality control activities in the field will consist of the following items:

- Adherence to documented procedures in this QAPP;
- Cross-checking of field measurements and recording to ensure consistency and accuracy; and
- Comprehensive documentation of field observations, sample collection and sample identification information.

Multiple field quality control samples will be collected:

- Filter Blanks – each vendor filter lot
- Blind Field Duplicates – one per ten samples per media
- Field blank – one per ten samples per media
- Trip blanks – one set for each cooler with samples requiring BETX analysis total/dissolved mercury, methylmercury analysis in water
- Rinsate blanks – one per ten samples per media. Do not need for dedicated sampling system.

Field Sampling Deviations

Field sampling decisions to deviate or modify field sampling locations or methods will only be made with the approval of the field crew chief. The field crew chief will document the decision on the field note sheets, and email a copy of the sheet or telephone the information to the URS Field Operations PM who will notify URS QA officer and task leads as deemed appropriate. If the field decision is large enough in scale to significantly affect the study's data, scope, schedule or budget, the field crew chief is authorized to stop work until further contact and coordination with the URS Field Operations PM.

B.3 SAMPLE HANDLING AND CHAIN OF CUSTODY REQUIREMENTS

B.3.1 Sampling Procedures

See Section B.2 of this QAPP – Sampling Method Requirements.

Samples will be transported to the laboratory in coolers with ice and cooled to approximately 4 °C. Chain of custody (COC) records and other sampling documentation will be kept in sealed plastic bags (zip-type) and taped inside the lid of the coolers prior to shipment. Packaging, marking, labeling, and shipping of samples will be in compliance with all regulations promulgated by the U. S. Department of Transportation in the Code of Federal Regulations, 49 CFR 171-177.

Field Logbook and Field Log Forms

Field sample collection will be documented on forms provided in Appendix C, as well as on the following forms and labels:

- A field log notebook for general observations and notes
- A Field Data Record Form that contains information about observations and measurements made and samples collected at the site
- Checklists for each sampling event, sampling point, and sampling time.

Copies of the field log books and physical characterization/water quality data sheets and sampling checklists will be supplied to the Field Operations Project Manager at the close of each sampling day during sampling events.

Photographic Records

Recording of sampling locations will be documented with photographs using a conventional photo-point procedure. Photographs will be taken at each sampling location and the photograph number and the associated date, description of the photograph, site identification number and GPS coordinates will be recorded on the Field Data Form for each site. The photos will be stored as digital images and maintained as files, as appropriate, in repositories for information and data used in preparing any reports and documents during the project. Digital photos will be submitted to the URS Field Operations PM with an index for each set of photographs, identifying the project, site identification number and a description of the photograph.

Field Data Recording

In-situ field data measurements will be recorded immediately following collection, both, electronically (stored within Hydrolab Surveyor, or equivalent) and on the field data form for

each sampling event (Appendix C). Field data sheets will be printed on *Rite in the Rain* paper. Promptly following each sample event, field data sheets will be scanned and stored electronically.

Each sample bottle will have a waterproof sample identification label, tag, or permanent marker identification. All sample bottles will be labeled with an indelible marker before the time of collection with as much information as possible and completed at the time of sample collection. Sample labels will include station designation, date, time, collector's initials, and sample/analysis type. Special analyses to be performed and any pertinent remarks will also be recorded on the label.

B.3.2 Sample Custody Procedures

Chain of custody (COC) can be defined as a systematic procedure for tracking a sample from its origin to its final use. Chain of custody procedures are required to ensure thorough documentation of handling for each sample, from field collection to data analysis. The purpose of this procedure is to minimize errors, maintain sample integrity, and protect the quality of data collected.

Samples will be kept in the possession of the field team until transfer to a courier or delivery to the laboratory and will be accompanied at all times by a COC form documenting the sample identification, type, and date/time sampled. COC forms are provided in Appendix E. The URS Field Operations Project Manager or designated field staff will hand deliver samples to the analytical laboratory. Each batch of samples will have a separate completed COC sheet that will document and track sample possession at all times. The COC will be relinquished by signature, date and time by field personnel and accepted by the laboratory.

A data sample is considered to be under a person's custody if it is:

- In the individual's physical possession
- In the individual's sight
- Secured in a tamper-proof way by that person, or
- Secured by the person in an area that is restricted to authorized personnel

Elements of chain-of-custody include:

- Sample identification
- Security seals and locks
- Security procedures
- Chain-of-custody record

The analytical laboratory will provide blank COCs with each bottle order and provide scanned copies of finished COCs with sample results. Each batch of samples will have a separate completed COC sheet that will document and track sample possession at all times.

B.3.3 Shipping Requirements

Where applicable, packaging, marking, labeling, and shipping of samples will comply with all regulations promulgated by the U.S. Department of Transportation in 49 CFR 171-177.

All samples will be immediately placed in coolers and packed with frozen gel ice after sampling. Samples will remain chilled to 4°C (±2°C) during transportation to the contract laboratory. All samples will be accompanied with completed COC forms when shipped, and coolers will be sealed with signed and dated fiber tape for shipment.

B.4 ANALYTICAL METHODS AND REQUIREMENTS

The parameters to be measured, methods, and the project MQOs are defined in Tables 4 and 6 (Section A.6 and Section A.7, respectively). The selected laboratories will conduct analyses by the methods identified in these tables in compliance with this QAPP, method requirements, laboratory SOPs, and the respective laboratory QA programs. Samples will be submitted to SGS, an ADEC certified and ISO17025 and DOD ELAP accredited laboratory, located in Anchorage, Alaska. SGS will conduct all analyses with the following exceptions: Northern Lake Services located in Crandon Wisconsin (chlorophyll a), Test America Laboratories, Inc. located in St. Louis, Missouri (radionuclides), Alaska Test Lab in Anchorage, Alaska (grain size), and Brooks Rand in Seattle, Washington (methylmercury in all media and metals in fish tissue). Samples requiring these analyses will be subcontracted by SGS to laboratories approved under the requirements of SGS' laboratory quality assurance plan. Northern Lake Services, Test America, and Brooks Rand are all NELAP accredited for the tests they will perform except for chlorophyll a, which does not have a specified accreditation. Alaska Test Lab does not have an accreditation, but is a laboratory that meets SGS subcontract requirements. A summary of applicable analytical laboratory certifications are on file with AEA.

The analytical methods, calibration procedures, QC measurements and criteria are based on current analytical protocols contained in the EPA documents *Test Methods for Evaluation of Solid Waste* (SW846, Update IVB, EPA 2005), specific published EPA methods (200 series, 600 series, 1600 series), and Standard Methods for the Examination of Water and Wastewater, 21st Edition, (APHA 2005) and are documented in the laboratory's quality control manuals (on file with ADEC). A summary of each laboratory's SOPs are summarized in Table 12b.

Before sample submittal, the laboratory will be provided with the following information:

- Number of samples from each matrix to be analyzed
- Required analysis turnaround time
- Identification of analytical methods and equipment
- Description of special sample preparation procedures, if applicable
- Frequency and type of QC analyses
- Precision and accuracy criteria
- Required data RLs and units
- Laboratory documentation and reporting requirements

The laboratory will provide fully validated data packages to URS through their electronic reporting system. The data will be validated by a Tt chemist, or equivalent, and a technical memo describing data qualifiers assigned to the data, if any, will be submitted to the URS Principal Manager (following the Data Validation Checklist provided in Appendix B).

If the data review determines the analytical data to be unreliable or incomplete, the laboratory will be responsible for correcting the errors. If the laboratory cannot provide data of adequate accuracy and precision, the samples may need to be recollected.

To assess laboratory performance, the analytical laboratory uses a series of QC samples specified in each analytical method and laboratory SOP. Analyses of laboratory QC samples are performed for samples of similar matrix type and concentration and for each sample batch. The types of laboratory QC samples are matrix spike/matrix spike duplicates (MS/MSDs), laboratory control samples (LCSs), laboratory duplicates, method blanks, and surrogates and are described in Section B.5. All method-required QC will be completed by the laboratory conducting the analyses and reported along with the analytical results.

Laboratory data results will be recorded on laboratory data sheets, bench sheets and/or in laboratory logbooks for each sampling event. These records as well as control charts, logbook records of equipment maintenance records, calibration and quality control checks, such as preparation and use of standard solutions, inventory of supplies and consumables, check-in of equipment, equipment parts and chemicals will be kept on file at the laboratory.

Table 12b: Summary of Laboratory Standard Operating Procedures

Parameter	Method Ref.	SOP Title	Laboratory	SOP Number	SOP Rev #	SOP Rev Date
Soil/Sediment Parameters						
Metals – Total	SW846 6020	Determination of Metals by ICP-MS	SGS	342	18	12/12/13
Metals Digestion	SW846 3050B	Acid Digestion of Soils, Sludges & Sediments for ICP/MS	SGS	361	12	06/12/13
Total Organic Carbon (TOC)	SW846 9060A	Total Organic Carbon in Soil	SGS	320	08	6/10/13
Sediment Grain Size	ASTM-D422	Standard Test Method for Particle Size Analysis of Soils	DOWL HKM	ASTM-D422-63(07)	10	2007
Percent Solids	SM21 2540G	Determination of % Solids for Soils	SGS	115	13	3/28/13 *in revision*
Monthly and Focus Area Water Quality Parameters						
Turbidity	SM21 2130B	Turbidity	SGS	305	08	03/10/14
Total Dissolved Solids	SM21 2540C	Filterable & Non-Filterable Residue (TDS, TSS & VSS)	SGS	329	08	5/16/13
Total Suspended Solids	SM21 2540D	Filterable & Non-Filterable Residue (TDS, TSS & VSS)	SGS	329	08	5/16/13
Alkalinity	SM21 2320B	Alkalinity, Acidity, pH & Conductivity by Auto-Titrator	SGS	394	04	1/20/14
Chlorophyll a	SM 10200 H	Chlorophyll-a By Colorimetry	ALS-Kelso	GEN-CHLOR	1	4/30/11
Nitrogen, Total Kjeldahl	SM21 4500N-D	TKN b AquaKem	SGS	380	06	8/20/13
Ammonia-N	SM21 4500NH3-G	Ammonia Nitrogen by AquaKem	SGS	378	08	7/1/13
Nitrate/ Nitrite	SM21 4500NO3-F	Nitrate + Nitrite Nitrogen	SGS	351	07	1/7/14
Total Organic Carbon (TOC) Diss. Organic Carbon (DOC)	SM21 5310B	Total Organic Carbon and Dissolved Organic Carbon in Water	SGS	321	12	6/10/13
Soluble Reactive Phosphorus	SM21 4500P-B,E	Soluble Reactive Phosphorus	SGS	381	04	5/24/13
Total Phosphorus	SM21 4500P-B,E	Total Phosphorus by AquaKem	SGS	381	04	5/24/13
Hardness	SM21 2340B	(calculated by LIMS from Ca & Mg results)	SGS	385	05	9/16/13
Metals – Low Level Total Recoverable and Dissolved	EPA 200.8-LL	Determination of Metals in Drinking Water and Waste Water by ICP-MS (Low Level Method)	SGS	375	04	7/2/13

Parameter	Method Ref.	SOP Title	Laboratory	SOP Number	SOP Rev #	SOP Rev Date
Metals Digestion	EPA 200.2-LL	Total Recoverable Metals (Low Level Preparation)	SGS	375	04	7/2/13
Mercury (Low Level)	EPA 1631E	Mercury in Water and Soil by Oxidation, P&T and CVAFS	SGS	354	09	6/14/14
Methyl Mercury	EPA 1630	Determination of Methyl Mercury by Aqueous Phase Ethylation, Trap Pre-Collection, Isothermal GC Separation, and CVAFS Detection	BR	BR-0011	013f	3/7/14
Single Event Water Quality Parameters						
Fecal Coliforms	SM21 9222D	Fecal Coliform (Membrane Filter Method)	SGS	452	11	7/18/13
BTEX (TAH)	EPA 624	Purgeable Organic Compounds Analyzed by GC/MS	SGS	720	13	9/16/13
PAH (TAqH)	EPA 625M-SIM	Polynuclear Aromatic Hydrocarbons by GC/MS-SIM	SGS	727	06	6/12/13
Semivolatiles Extraction	SW846 3550C	Continuous Liq-Liq Extraction for Semi-Volatile Compounds	SGS	759	11	2/11/14
Gross Alpha/Beta	EPA 900.0	n/a	TA	n/a	n/a	n/a
Gamma Photon Emitters (Cesium)	EPA 901.1	n/a	TA	n/a	n/a	n/a
Radium 226	EPA 903.0	n/a	TA	n/a	n/a	n/a
Radium 228	EPA 904.0	n/a	TA	n/a	n/a	n/a
Strontium 89/90	EPA 905.0	n/a	TA	n/a	n/a	n/a
Fish Tissue Parameters						
Arsenic, Cadmium, Selenium	EPA 1638	Total Recoverable Metals Digestion for Biota Matrices	BR	BRL SOP 0070	003bc	5/29/12
Arsenic, Cadmium, Selenium	EPA 1638	Determination of Trace Elements by Inductively Coupled Plasma - Mass Spectrometry using a Perkin-Elmer ELAN DRC II	BR	BRL SOP 0060	003c	5/24/2010
Total Mercury	EPA 1631	BRL Procedure for EPA Method 1631, Appendix to (1/01): Total Mercury in Tissue, Sludge, Sediment, and Soil by Acid Digestion and BrCl Oxidation by Cold Vapor Atomic Fluorescence Spectrophotometry (CVAFS)	BR	BRL SOP 0002	010e	11/1/12
Methyl Mercury	EPA 1630	Determination of Methyl Mercury by Aqueous Phase Ethylation, Trap Pre-Collection, Isothermal GC Separation, and CVAFS Detection: BRL Procedure for EPA Method 1630 (Aqueous Samples) and EPA Method 1630, Modified (Solid Samples)	BR	BRL SOP 0011	013f	3/7/14

Notes: BR – Brooks Rand Lab; EPA – US Environmental Protection Agency; n/a – not available; NLS – Northern Lake Services located in Crandon, Wisconsin; SGS – SGS North America Inc.; SM21 – Standard Methods for the Examination of Water and Wastewater, 21st Edition, 2005; SOP –standard operating procedure; TA – Test America Laboratories, Inc

B.5 QUALITY CONTROL REQUIREMENTS

Quality Control (QC) is the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the monitoring project's data quality objectives.

Data quality is addressed, in part, by consistent performance of valid procedures documented in the laboratory SOPs. It is enhanced by the training and experience of project staff and documentation of project activities. This QAPP, including its appendices, will be distributed to all sampling personnel. Prior to the start of sampling activities all field personnel will be trained and debriefed on field collection procedures, field documentation requirements, and all types of data/samples to be collected during the sampling period. A QC Officer (or equivalent) will ensure that samples are taken according to the established protocols and that all forms, checklists, and measurements are recorded and completed correctly during the sampling event.

Quality Control Protocol

There will be five levels of data QC, named QC1 to QC5, each of which is tracked within Excel data files. QC1 through QC 3 are to be completed by the study team, QC4 by the Program Lead team, and QC5 by senior professionals during analysis and reporting. The QC levels are as follows:

QC1 – Field Review: QC review performed by the person collecting field data, whether recorded on paper field forms or directly into electronic data collection tools, and then by the field team leader. This is also the QC level of raw data collected via field equipment such as thermistors, cameras, GPS units, etc.

The goal of QC1 is to identify errors and omissions and correct them under similar field conditions prior to leaving the field.

Review is done on 100% of data and includes completeness, legibility, codes, and logic on all information recorded. This is typically completed in the field daily. Once completed, QC1 notations are made directly on the field form in an entry named "QC1", containing the date and responsible staff and formatted as "YYYYMMDD FLastname" (example: "20120631 JDoe").

QC2 – Data Entry: Data from paper forms are entered into an electronic format, followed by verified by a second party against the field forms.

The goal of QC2 is to verify correct, complete, and consistent data entry.

Verification is done on 100% of data entered and includes extrapolation of shorthand codes that might be used in the field into longhand or standard codes during data entry. Data entry errors are corrected at this time indicating date and responsible staff and formatted as "YYYYMMDD FLastname" (example: "20120631 JDoe").

QC3 – Senior Review: Data are reviewed by a senior professional on the consultant team, checking for logic, soundness, and adding qualifiers to results if warranted. Calculated results can also be added at this time (formulas must be documented in the data dictionary). This is the final review before submitting field data to the Program Lead, and is recorded in the "QC3" column in the same format as QC2. This is also the QC

level of raw files that have been "cleaned up" or otherwise processed for delivery to AEA.

QC4 – Database Validation: Electronic data files are submitted to and verified by the Program Lead's data resources manager. The deadline for this delivery is negotiated with the team Data Coordinator (Dana Stewart, DES.IT, LLC) in consideration of the study due date.

Data are verified for completeness, project standards (codes, field name conventions, date formats, units, etc.), calculated and derived fields, QC fields, etc. The data files are incorporated into the project database schema, splitting into normalized tables as necessary and all primary and foreign keys checked. An error report is generated for the study consultant, who is expected to make corrections and resubmit data. The process is repeated until verification is clean and records are marked in column "QC4" (such as "20121001 DStewart").

QC5 – Technical Review: Data revision and qualification may be applied by senior professionals when analyzing data for reports, trends, and FERC applications. Data calculations may be stored with the data. Some data items may get corrected or qualified within the database, while others are only addressed in report text. QC5 may be iterative, as data are analyzed in multiple years.

If a data item is revised directly, it's recorded in two columns, QC5 (date and staff) and QC5Edit (what is revised and why). This will serve as adequate documentation of the revisions, so maintenance of additional documentation is not usually necessary. QC5 revisions will be physically made by the Data Resource Manager (DES.IT, LLC), directed by the senior professional.

B.5.1 Field Quality Control (QC) Measures

QC measures that field personnel will perform in the field include but are not limited to:

- Proper cleaning of sample containers and sampling equipment.
- Maintenance, cleaning and calibration of field equipment/kits per the manufacturer's and/or laboratory's specification, and field SOPs.
- Chemical reagents and standard reference materials used prior to expiration dates.
- Proper field sample collection and analysis techniques.
- Correct sample labeling and data entry.
- Proper sample handling and shipping/transport techniques.
- Collection of field replicate samples (blind to the laboratory), e.g. 1 replicate/10 samples).
- Field replicate measurements (e.g. 1 replicate measurement/10 field measurements).

Field Data Collection, Processing, and Delivery Standards to Water Resources Program Lead

In general, the process for preparing and submitting field data includes the following steps:

1. Create field forms

2. In the field, record data on field forms and do QC1 and QC2.
3. Backup field forms and books (cameras, GPS, thermistors, etc.) nightly.
4. Submit these raw deliverables to AEA on a monthly basis. AEA considers these to be interim deliverables.
5. Process the raw data to prepare for the AEA project database: convert raw file to a submittal format, perform remaining QC levels 1 to 3, flag unusable records, apply database naming and codes, perform data reduction, etc.
6. Submit final processed (QC3) data files to the Project Data Coordinator or via hard drive, as done for raw data. (Refer to the GIS User Guide for delivery of GIS data.)
7. For data being delivered for storage in the project database, data must be accompanied by a data dictionary. Data reported in the Study Reports will be uploaded to GINA.
8. The project's data resource manager will perform QC4 review and coordinate revisions with the consultant's Data Coordinator.
9. Data and dictionary are incorporated into the Susitna project relational database. No more revisions can be made in the data by consultants, as the data is considered Final for the study year.
10. If data revisions are needed later, such as for QC5, they'll be coordinated by the project's data manager. The appropriate QC columns will be updated, which will serve as adequate documentation.

Table 13 summarizes the field QC requirements for this project.

Table 13: Field Quality Control Sample Requirements

Field Quality Control Sample	Measurement Parameter	Frequency		QC Acceptance Criteria Limits
		Frequency of Occurrence	Total # of QC Type Samples	
Filter Blank	Metals, methylmercury, DOC analyzed in filtered sample	1/filter lot	Depends upon number of filter lots	< PQL and no impact if between MDL and PQL
Calibration verification check standard for field meters	DO	1 per sampling day	depends on number of sample days	±10%
	pH			±0.1 units
	Specific conductance			±3%
	Turbidity			±10%
Field Blank	All laboratory-analyzed parameters	1 set/20 sites	depends on number of sample days	< PQL and no impact if between MDL and PQL for each analyte
Trip Blank	BETX/dissolved mercury, methylmercury	1 set in each cooler with samples for BETX total/dissolved mercury, methylmercury analysis	depends on number of coolers	< PQL and no impact if between MDL and PQL for each analyte

Field Quality Control Sample	Measurement Parameter	Frequency		QC Acceptance Criteria Limits
		Frequency of Occurrence	Total # of QC Type Samples	
Field Replicate (Blind to Lab)	All laboratory-analyzed parameters	1 for every 10 samples	depends on number of samples	Within the RPD limits shown on Table 6 for each analysis
Field Replicate Measurement	Temperature	1 replicate measurements per 10 field measurements (each day)	depends on number of primary measurements	±0.2°C
	DO			±10%
	pH			±0.1 units
	Specific conductance			±3 %
	Turbidity			±10%
	Redox Potential			±10%

B.5.2 Laboratory Quality Control Measures

In this section, the Laboratory QC Measures including QC samples collected in the field for subsequent laboratory analysis as well as method-specific laboratory QC activities are prescribed in each analytical method's SOP.

Laboratory QC includes the following:

- Laboratory instrumentation calibrated with the analytical procedure
- Laboratory instrumentation maintained in accordance with the instrument manufacturer's specifications, the laboratory's QAP and Standard Operating Procedures (SOPs)
- MS/MSD, sample duplicates, calibration verification checks, surrogate standards, external standards, etc. per the laboratory's QAP and SOPs
- Specific QC activities prescribed in the project's QAPP
- Laboratory verification and validation of analytical results prior to submitting the laboratory reports to the requestor
- Verification that electronic data deliverables match hard copy reported results

Contracted laboratories will provide analytical results after verification and validation by the laboratory QA Officer. The laboratory must provide all relevant QC information with its summary of data results so that the project manager and project QA officer can perform field data verification and validation and review the laboratory reports. The Principal Manager, or designee, reviews these data to ensure that the required QC measurement criteria have been met. If a QC concern is identified in the review process, the Project Manager and Project QA Officer will seek additional information from the contracted laboratory to resolve the issue and take appropriate corrective action.

Table 14 summarizes the laboratory QC sample requirements for this project.

Table 14: Laboratory Quality Control Samples

Quality Control Sample	Measurement Parameter	Frequency		QC Acceptance Criteria Limits
		Frequency of Occurrence	Total # of QC Type Samples	
Field Blank	All	1 set/20 sites	depends on number of sample days	< PQL and no impact if between MDL and PQL for each analyte
Trip Blank	BETX total/dissolved mercury, methylmercury	1 set in each cooler with samples for BETX total/dissolved mercury, methylmercury analysis	depends on number of coolers	< PQL and no impact if between MDL and PQL for each analyte
Field Replicate	All laboratory-analyzed parameters	1 for every 10 samples	depends on number of samples	Within the RPD limits shown on Table 6 for each analysis
Laboratory Control Sample (LCS)/Laboratory Control Sample Duplicate (LCSD)	Alkalinity, TDS, TSS, Turbidity, Nutrients, Metals, BETX, PAHs, Radionuclides	1 per 20 samples or every analytical batch, whichever is more frequent	Dependent upon number of samples and submittal to laboratory	See Table 6
Calibration Verification Check	All	Every analytical batch, per the method and laboratory SOP	Dependent upon number of samples to be analyzed	Refer to Method or Laboratory SOP
MS/MSD	TDS, TSS, Nutrients, Metals, BETX, PAHs, Radionuclides (except Cs 137)	1 per 20 samples or every analytical batch, whichever is more frequent	Dependent upon number of samples and submittal to laboratory	See Table 6
Laboratory Duplicate	Alkalinity, TDS, TSS, Turbidity, Nutrients, Metals, BETX, PAHs, Radionuclides	1 per 20 samples or every analytical batch, whichever is more frequent	Dependent upon number of samples and submittal to laboratory	See Table 6
Surrogates	BETX/PAHs	Every sample, lab QC sample	Depends on number of samples	Refer to lab SOPs and current control limits at time of analysis
Method Blank	All	Every preparation/analytical batch	Dependent upon number of samples to be analyzed	< PQL and no impact if between MDL and PQL

B.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTIONAND MAINTENANCE REQUIREMENTS

Periodic regular inspection of equipment and instruments is needed to ensure the satisfactory performance of the systems. Equipment to be used during the sampling event is listed in the appropriate SOPs. Before any piece of sampling or measurement equipment is taken into the field, it will be inspected to ensure that the equipment is appropriate for the task to be performed, all necessary parts of the equipment are intact, and the equipment is in working order. In addition, the equipment will be visually inspected before its use. Broken equipment will be labeled "DO NOT USE" and returned to the URS or Tt office to receive necessary repairs, or it will be disposed of. Backup field equipment will be available during all field activities in the event of equipment failure.

Field staff will document that required acceptance testing, inspection, and maintenance have been performed. Records of this documentation will be kept with the instrument/equipment kit. The objective of preventive maintenance is to ensure the availability and satisfactory performance of the measurement systems. All field measurement instruments will receive preventive maintenance in accordance with the manufacturer's specifications (LINKED FILES: HYDROLAB MS5 MANUAL).

Contracted and sub-contracted laboratories will follow the testing, inspection and maintenance procedures documented in their respective QAPs and SOPs.

B.7 INSTRUMENT CALIBRATION AND FREQUENCY

Calibrated field instruments will be used for in situ, instantaneous measurement of temperature, DO, specific conductance, pH, turbidity, and redox potential. Instruments will be calibrated in accordance with manufacturer's specifications (LINKED FILES: FIELD EQUIPMENT) every day prior to the beginning of sampling activities. Post-calibration verification will be performed on each sampling date following sampling activities. All calibration activities will be performed at the field office in Talkeetna, AK. Verification of pH measurement accuracy will be checked against standard solutions (buffer pH 7 and 10) in the field (if pH drift is noticeable by field staff) and adjustments made to the meter prior to the next measurement, if necessary. Field calibrations will be recorded on a calibration form (LINKED FILES: FIELD EQUIPMENT). Individual sensors will be considered to be operating correctly if the instrument reading is within 10 percent of the calibration standard value for DO, turbidity and redox potential, 3% for specific conductance, and +/- 0.1 units for pH. If the criteria are not met, the calibration will be redone and checked. If not met upon the second try, the associated probe will be cleaned and recalibrated. If the checks are still outside of criteria, the probe will be taken out of service and replaced.

B.8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Supplies and consumables are those items necessary to support the sampling and analysis operation, including sample containers, calibration solutions, hoses, decontamination supplies, preservatives, and various types of water (e.g., potable, deionized, organic-free). Upon delivery of supplies, field crews will ensure that types and quantities of supplies received are consistent with what was ordered, and with what is indicated on the packing list and invoice for the material. If any discrepancies are found, the supplier will be contacted immediately. Other

materials must also meet specific requirements as indicated by the appropriate manufacturer; for example, only certified standard solutions will be used for the multi-probe calibration. Buffers and standards will be checked for expiration dates and appearance (correct color).

Field task leaders will clean all non-dedicated sampling equipment (pump and tubing system, multi-probe, depth sounder, etc.) at the end of each day's sampling activities with de-ionized water. Field task leaders will inspect sampling equipment each day prior to the start of sampling activities to ensure all sampling equipment has been cleaned and prepared for the day.

All sample containers, tubing, filters, etc. provided by a laboratory or by commercial vendor will be certified clean for the analyses of interest (low level metals and toxics analysis) either by vendor certification or blanks performed by the laboratory. The sampling team will take note of the information on the certificate of analysis that accompanies sample containers to ensure that they meet the specifications and guidance for contaminant-free sample containers for the analyses of interest. Records will be kept at the Talkeetna field office and then transferred to the URS-Anchorage office once field operations are complete.

No standard solutions, buffers, or other chemical additives shall be used if the expiration date has passed. The Field Operations Project Manager or his/her designee is responsible to maintain appropriate records (e.g. logbook entries, checklists, etc.) to verify inspection/acceptance of supplies and consumables, and restock these supplies and consumables when necessary. These records will be kept at the field office and at URS's Anchorage, AK office.

Contracted and sub-contracted laboratories will follow procedures in their laboratory's QAP and SOPs for inspection/acceptance of supplies and consumables.

B.9 DATA ACQUISITION REQUIREMENTS (NON-DIRECT MEASUREMENTS)

Successful implementation of the Water Quality and Mercury Assessment will provide the necessary information for the Water Quality Model (Study 5.6). Evaluation of historical records and accompanying documentation for information on quality objectives will be used to determine comparability and usability in development of the models. Historical data will be useful for describing expected range of conditions for each water quality parameter at select locations throughout the drainage as data are being generated.

Available existing water quality information was collected and evaluated in Water Quality Data Gap Analysis (URS, 2011). This data was further examined for its potential relevance and completeness, and whether the methods used produced information that could be applicable to the anticipated environmental analysis for the proposed Project. Other sources of information used in the analysis included that derived from contacts with agency project leaders and database searches. Where information was determined to be likely insufficient for satisfying environmental analysis requirements, a potential data gap was identified. The final analysis and identification of data gaps was used to inform site selection in this project as reported in Section B.1.2.

A review of existing data generated by governmental agencies and organizations was used as background information to evaluate current and past water quality conditions in the Susitna River drainage. Natural resource agencies were identified and lead staff contacted for location of relevant information and web sites searched for general description of drainage conditions as

well as for water quality data that could be further analyzed. The following agencies were initially identified for available information from the Susitna River drainage and contiguous areas:

- Alaska Department of Environmental Conservation
- Alaska Department of Fish and Game
- Alaska Department of Natural Resources
- U.S. Environmental Protection Agency, Region 10
- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- National Oceanic and Atmospheric Administration-Fisheries
- Alaska Energy Authority/Alaska Power Authority
- American Geophysical Union

Generally, most of the data discovered and used in the data gap analysis was more than 20 years old. Many of the documents did not report data quality expressions and so an evaluation for comparability of data sets was not possible. The exception was the USGS data where long-term monitoring at select stations was completed in the drainage. The comparability of data among USGS stations was not in question, but the lack of DQOs from older data did not enable a comparison between USGS and other existing data sets. Any interpretations of data close to AWQS concentration criteria were interpreted as exceeding the standard. This conservative approach was taken in order to preserve the intent of water quality criteria and to suggest additional studies that should be conducted in order to advance definitive decisions.

B.10 DATA MANAGEMENT

The success of a monitoring project relies on data and their interpretation. It is critical that data be available to users and that these data are:

- Of known quality;
- Reliable;
- Aggregated in a manner consistent with their prime use, and
- Accessible to a variety of users.

QA/QC of data management begins with the raw data and ends with a defensible report, preferably through the computerized messaging of raw data.

Data management encompasses and traces the path of the data from generation to final use or storage [e.g., from field measurements and sample collection/recording through transfer of data to computers (laptops, data acquisition systems, etc.), laboratory analysis, data validation/verification, QA assessments and reporting of data of known quality]. Data management will include/discuss all errors detected during the QA review process and the impact to project objectives. Results generated by the laboratory will be accompanied by a Laboratory Results Report that provides Quality Assurance performance information for each of

the lab analyses in a batch of samples. Data qualifiers will be assigned as appropriate and carried through project reporting and entry to the project database.

A Data Management Flow Chart of the data flow/management process for environmental data collected in support of the Watana Hydroelectric Project Licensing process is presented in Figure 7.

Various people are responsible for separate or discrete parts of the data management process:

- The sampling team is responsible for field measurements/sample collection and recording of data and subsequent shipment of samples to laboratories for analyses. They assemble data files, which includes raw data, calibration information and certificates, QC checks (routine checks), data flags, sampler comments and metadata where available. These files are assembled and forwarded for secondary data review by the sampling manager or supervisor.
- Laboratories are responsible to comply with the data quality objectives specified in the QAPP and as specified in the laboratory QAP and method specific SOPs. Validated sample laboratory data results with respective analytical method QA/QC results and acceptance criteria are reported to the sampling manager or project supervisor.
- Secondary reviewers (sampling coordinator/supervisor/project supervisor) are responsible for QA/QC review, verification and validation of field and laboratory data and data reformatting as appropriate for reporting to R2 Resources (if necessary), and reporting validated data to the project manager.
- The project QA officer is responsible for performing routine independent reviews of data to ensure the data quality objectives are being met. Findings and recommended corrective actions (as appropriate) are reported directly to project management.
- The URS principal manager is responsible for final data certification.
- URS/Tt Project Managers/Project QAO conduct a final review (tertiary review) and submits the validated data to R2 Resources as appropriate.

Field Team

Samples will be documented and tracked on Field Data Record forms, Sample Identification labels, and COC records. The Field Task Leaders will be responsible for ensuring that these forms are completed and reviewed for correctness and completeness by the designated field QC Officer. Each Field Team Lead will check field forms following work at a site to ensure all entries have been completed. The URS Field Operations PM will maintain copies of these forms in the project files. The URS Field Operations PM or designee(s) will identify a staff member from one of the field teams to manually check data entered into any spreadsheet or other format against the original source to ensure accurate data entry. If there is any indication that requirements for sample integrity or data quality have not been met, the URS Field Operations PM and the project QA officer will be notified to initiate a review of procedures and a potential corrective action.

Laboratory

Laboratory analytical data reduction, review and reporting will be conducted by the laboratory in accordance with their SOPs and QAPP. In general, all data will be reviewed by the laboratory to

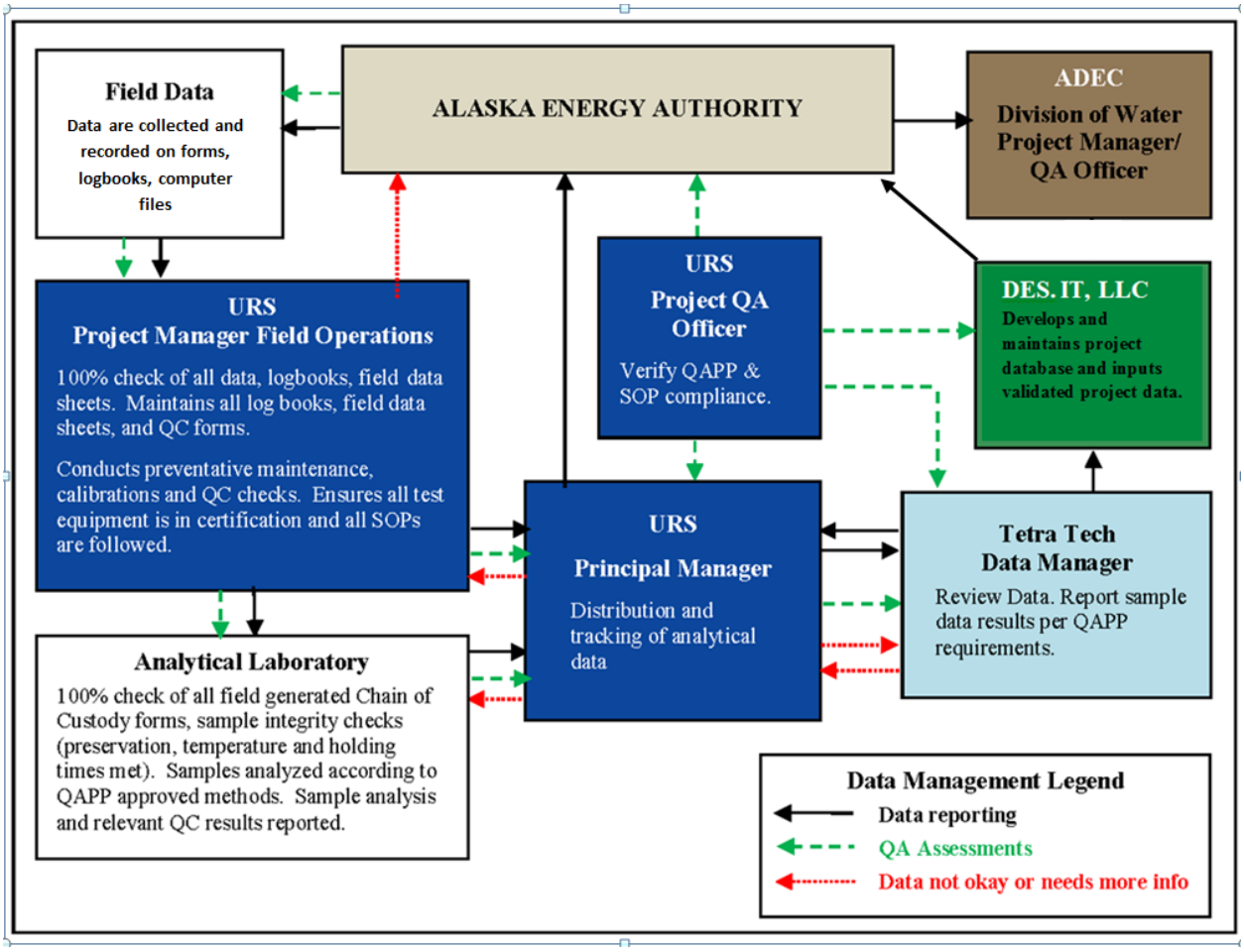
ensure that the data reported in the final report have been calculated correctly from raw data, transcribed correctly to the final report, and have been generated using appropriate methods and procedures as described in the QAPP. Data deliverables will include the project sample results and QC results in electronic format and PDF. The data will be submitted to URS electronically for data quality assessment and database entry. The laboratory will maintain all associated raw data in archive for a period of 10 years after completion of the contract

The laboratory data reports will consist of the following:

- Case narrative or cover letter, as appropriate, identifying the laboratory analytical work order; matrix and number of samples included; analyses performed and analytical methods used; description of any problems or exceedances of QC criteria and corrective action taken. The laboratory manager or their designee must sign the narrative or cover letter.
- Copy of COC for all samples reported in the work order, sample inspection records, shipping records.
- Tabulated sample analytical results with units, laboratory data qualifiers, sample weight or volume, dilution factor, laboratory batch and sample number, field sample number, and dates sampled, received, extracted, and analyzed all clearly specified. Surrogate percent recoveries will be included for organic analyses.
- Blank summary results indicating samples associated with each blank.
- MS/MSD result summaries, if performed, with calculated percent recovery and relative percent differences.
- Laboratory duplicate sample results.
- LCS results with calculated percent recovery.
- All associated raw data for the contents described in the previous bullets.
- Electronically formatted data deliverable results.

The information provided must allow for independent confirmation that the results reported by the laboratory are compliant with the methods used, the QAPP requirements, and are accurately reported.

Figure 7: Project Data Management Flow Chart



B.10.1 Data Storage and Retention

Data management files will be stored on a computer or on a removable hard drive that can be secured. Laboratory records must be retained by the contract laboratory for a minimum of 10 years. Project records must be retained as described in Section A.9. Site location and retention period for the stored data is summarized in Table 8 in Section A.9. As well, data reported in the Initial Study Report will be stored in GINA.

C ASSESSMENTS

C.1 ASSESSMENTS AND RESPONSE ACTIONS

The QA program under which this task order will operate includes technical system audits, with independent checks of the data obtained from sampling, analysis, and data-gathering activities. Formal field audits and technical system audits will be conducted after 30 days of active water quality sampling. In addition, laboratory split samples will be collected to address accuracy of laboratory results. The URS Quality Assurance Officer (QAO) and the Tt Quality Control Lead (QCO) will review the project documentation during the course of the project to confirm work is performed as prescribed by the QAPP, and that information and data are complete, accurately recorded, and usable for project objectives. The essential steps in the QA program are as follows:

- Review and determine if problems are apparent
- Identify and define the problem
- Assign responsibility for investigating the problem
- Investigate and determine the cause of the problem
- Assign and accept responsibility for implementing appropriate corrective action
- Establish the effectiveness of and implement the corrective action
- Verify that the corrective action has eliminated the problem

Many technical problems can be solved immediately by the staff members involved; for example, by modifying the technical approach, repairing instrumentation that is not working properly, or correcting errors or deficiencies in documentation. Immediate corrective actions form part of normal operating procedures and are noted in records for the project. Other problems may require formalized, long-term corrective action. If quality problems that require attention are identified, the URS QAO will work with the field task leads, Field Operations PM, and URS Principal Manager to resolve the issue, determine a corrective action, document the action, including if changes are necessary to the QAPP procedures, and follow-up on the success of the corrective action.

The URS Quality Assurance Officer and the Tt QC Lead have primary responsibility for monitoring the activities of this project and identifying or confirming any quality problems. The URS QAO has the authority to stop work on the project if problems affecting data quality are identified and require extensive effort to resolve. The URS Principal Manager and all task leads will be notified of major corrective actions and stop work orders. The URS Principal Manager will notify the AEA PM of any major corrective actions and stop work orders within 48 hours of identification.

Corrective actions might include the following:

- Re-emphasizing to staff the project objectives, the limitations in scope, the need to adhere to the agreed-upon schedule and procedures, and the need to document QC and QA activities
- Securing additional commitment of staff time to devote to the project

- Retaining outside consultants to review problems in specialized technical areas
- Changing procedures
- Replacement of staff members or subcontractors, as appropriate, if it is in the best interest of the project to do so.
- The URS QAO and Tt QC Lead are responsible for overseeing work as it is performed and periodically conducting checks during the data entry and analysis phases of the project. The Tt QC Lead will alert the URS QAO if any issues arise that may compromise data quality and leave the URS QAO to independently evaluate the situation and determine next steps. As data entries, calculations, or other activities are checked, the person performing the check will sign and date a hard copy of the material or complete a review form, as appropriate, and provide this documentation to appropriate task lead for inclusion in the project files.

C.1.1 High Quality End-Use Tier 2 Monitoring Data

Generally, this project will require high end-use quality data results for comparison to applicable state and federal standards and will need more frequent and varied assessments to provide a more thorough and independent validation that the monitoring project does capture high end-use quality data. This monitoring project collects samples for subsequent laboratory analysis and will need more types of assessments than just project field measurements to independently evaluate the overall monitoring system. Example QA Assessments include the following:

Field Assessments (each parameter)

- Precision (replicate) sample measurements. Project will have a minimum of three paired measurements/project or 10% of project samples, whichever is greater. Replicate measurements will be evenly spaced over project timeline. Precision criteria are specified in the project's Measurement Quality Objectives (MQO) table, see section A7.

Field samples collected for subsequent laboratory analysis (each parameter)

- Blind replicate samples for each parameter will be measured. The project will have a minimum of three paired measurements/project or 10% of project samples, whichever is greater. Replicate samples will be evenly spaced over the life of the project. Precision criteria are specified in project's MQO table, see section A.7.
- Sample splits (one split will be sent to laboratory analyzing project samples, the other split will be sent to a reference lab). This will be determined based on the laboratory SOP.
- Matrix spike duplicates (MSD) (assesses total measurement bias for project – both precision and accuracy). Frequency of MSDs is usually specified by the analytical method. Accuracy and precision of criteria for each constituent and analytical method are specified in the project's MQO table, see section A.7.
- Third party performance evaluation samples (PE samples also called performance test (PT) samples) for water quality analytes of interest. PT water/wastewater sample participation is at a frequency of 1/year from a National Environmental Laboratories Accreditation Conference (NELAC) certified vendor. For Alaska Pollutant Discharge

Elimination System (APDES) permit monitoring, these are called Discharge Monitoring Report Quality Assurance (DMRQA) samples.

- Microbiological samples will be analyzed by a current ADEC Division of Environmental Health Drinking Water certified lab for the methods of interest. Laboratory third party microbiological PT samples results will be submitted directly to the DEC Water QA Officer and the Monitoring Project's QA Officer.

Note 1: It is the laboratory's responsibility to enroll itself in these blind PT studies with the results mailed/emailed directly to the ADEC DOW Water QA Officer and the Monitoring Project's QA Officer. Routine laboratory performance in the blind PT sample studies will be used to assess overall laboratory data quality, as well as monitoring project data quality.

Note 2: It is the responsibility of the Project Manager and project QA Officer to ensure the selected laboratory is annually self-enrolled in a NELAC certified PT water/wastewater study for those analytes required in the monitoring project.

On-Site Assessments include the following:

- Inspection of field monitoring operations for compliance with QAPP requirements.
- Laboratory Audit (if concerns arise regarding laboratory data quality)
- Audit of project field measurement data results.

Project Data Assessments include the following elements:

- Audits of Monitoring Data for reproducibility of results from recalculation/reconstruction of field/lab unprocessed data.
- Calculation of monitoring project's overall achieved precision, accuracy and data completeness compared to QAPP defined precision, accuracy and data completeness goals. Measurement parameters, as described in Table 15, are based on a sub-set or the full set of analyte results from water sample collection (e.g., analyte) and performance measures for each type of assessment as identified by measurement quality objectives in Section A.7 (e.g., method).

Table 15: Project Assessments

Assessment Type	Measurement Parameters		Frequency	Acceptance Criteria Limits
	Analyte	Method		
Field Split Sample (sent to different labs for comparison analysis)	Prescribed for parameters based on laboratory SOP	As per Section A.7	1/monitoring season	Per Laboratory Protocol
On-site Field Audit/Inspection	All water samples collected for each set of analytes	As per Section A.7	1/site/monitoring season	Site technicians in compliance with QAPP sampling protocols, sample sites meet sample design criteria

Assessment Type	Measurement Parameters		Frequency	Acceptance Criteria Limits
	Analyte	Method		
On-site Technical System Laboratory audit	Indicated by inability to meet individual performance criteria for an analyte	As per Section A.7	If concerns arise regarding laboratory data quality	Per Laboratory Protocol
Independent Data Review Audit	All data	As per Section A.7	10% of reported data	>90% Completeness
Project Precision, Accuracy and Data Completeness Assessment	All water sample results analyzed in the laboratory	As per Section A.7	end of project and at least 1/year	Defined in Section A.7 and Table 6

C.2 REVISIONS TO QAPP

Annually the QAPP will be reviewed and revised as needed by the URS Principal Manager, Tt Water Quality Lead, and reviewed by the URS project QA officer. Minor revisions may be made without formal comment. Such minor revisions may include changes to identified project staff (but not lead project staff, QA project officer, project manager, field technical lead, or contracted laboratories), QAPP distribution list and/or minor editorial changes.

Revisions to the QAPP that affect stated monitoring DQOs, MQOs, method specific data validation "*critical*" criteria and/or inclusion of new monitoring methods must seek review and pre-approval by ADEC DOW QA Officer/ADEC Project Management before being implemented.

Revision to the QAPP will be reported in a separate document as an amendment to the original QAPP. The independent amendment will be referenced to the original QAPP document by citation and dated to reflect methods that supersede the original approach.

C.3 QA REPORTS TO MANAGEMENT

A draft data report will be prepared and forwarded to the AEA for data analysis completed during Q1 of each monitoring year. This data will accompany the Interim Study Report and be verified and validated prior to finalization. Subsequent data reports will be completed by Q1and include data generated from the previous year. Data summaries will include results from the previous season using field data collection, processing, and delivery standards for this project. Results included in this report will be reviewed by a senior scientist and be considered Level QC3. This report will include the following as prescribed by these guidelines:

- Description of the project purpose, goals, and objectives.
- Map(s) of the study area and sampling sites.
- Description of data collection, backup, and delivery.
- Quality Control protocol.
- Field data collection guidelines.

- Data attributes and databases.
- Data attributes.
- Attribute data values.
- Location and site identifiers.
- Data Quality Control Protocol.

A summary of QA report to management is provided in Table 16.

Table 16: QA Reports to Management

QA Report Type	Contents	Presentation Method	Report Issued by	Reporting Frequency	
				As Required	Year
On-site Field Inspection Audit Report	Description of audit results, audit methods and standards/equipment used and any recommendations	Written text and tables, charts, graphs displaying results	Project QA Officer/auditor	✔	
Field Split Sample Report	Evaluation/comparison of result of split sample results from different laboratories, audit method	Written text and tables, charts, graphs displaying results	Project QA Officer/auditor	✔	
On-site Laboratory Audit Report	Description of audit results, audit methods and standards/equipment used and any recommendations	Written text and tables, charts, graphs displaying results	Project QA Officer/auditor	✔	
3rd Party PT (DMRQA, etc.) Audit Report	Description of audit results, methods of analysis and any recommendations	Written text and charts, graphs displaying results	Project QA Officer/auditor	✔	✔
Corrective Action Recommendation	Description of problem(s), recommended corrective action(s), time frame for feedback on resolution of problem(s)	Written text/table	QA Officer/auditor	✔	
Response to Corrective Action Report	Description of problem(s), description/date corrective action(s) implemented and/or scheduled to be implemented	Written text/table	Project Manager overseeing sampling and analysis	✔	
Data Quality Audit	Independent review and recalculation of sample collection/analysis (including calculations, etc.) to determine sample result. Summary of data audit results; findings; and any recommendations	Written text and charts, graphs displaying results	Project QA Officer	✔	
Quality Assurance Report to Management	Project executive summary: data completeness, precision, bias/accuracy	Written text and charts, graphs displaying results	Project QA Officer	✔	✔

D DATA VALIDATION AND USABILITY

D.1 DATA REVIEW, VERIFICATIONAND VALIDATION REQUIREMENTS

The purpose of this section is to define the criteria used to review and validate monitoring data generated from field sampling at locations on the Susitna River and tributaries. Criteria adopted for validation will be used to accept, reject or qualify data in an objective and consistent manner. Data review, verification and validation are a way to decide the degree to which each data item has met its quality specifications (i.e., analyte-specific QC criteria and overall project measurement quality objectives). Data validation and verification have associated decision-criteria that will enable a reviewer to determine strengths and weaknesses of the data set (see Appendix B). The final product will be a technical memorandum that reports results from comparison with performance criteria for each analyte group: sample receipt, organic analyses, metals analysis, conventional, microbiology, and other analysis. An overall assessment of the data will be made and any qualifiers used in this assessment will be listed as part of this technical memorandum. Content of this technical memorandum will comply with preparation of a Data Validation/Verification Report described by the Alaska Department of Environmental Conservation.

D.1.1 Data Verification and Data Review

Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. Data review is the process that evaluates the overall data package to ensure procedures were followed and that reported data are reasonable and consistent with associated QA/QC results. Data validation and review services provide a method for determining the usability and limitations of data and provide a standardized data quality assessment.

Data review includes comparison of results from this project to expected ranges of conditions described from historic results. Section A.5 in this QAPP contains expected ranges of conditions for select water quality parameters that are associated with data generated from water quality monitoring programs beginning the year 1986 through year 2011. This review process evaluates data for ecological significance and is intended to confirm believability of results based on past work in the basin and on known published studies. This data review process differs from verification and validation in that decision criteria are not based on process, but are based on the historical record that establishes an expectation for water quality conditions (i.e., accuracy).

Field Data

All Field Data forms will be reviewed by the URS Field Operations PM or designee (assisted by the QAO, as needed) for completeness and correctness. Data quality will be assessed by confirming sample procedures are properly documented including field equipment calibrations, sample descriptions and locations, field measurements, and other field observations as described in Section B of this QAPP. Data that have been transcribed from original field documents to spreadsheets or other data reduction media will be checked by comparing that all transcription is accurate. All measurements will be compared to measurement performance criteria for field measurements as described with sampling methodology to determine if the data are acceptable,

should be rejected, or need to be qualified for use. Results of the review and validation processes will be reported to the URS Principal Manager and all Project Technical Leads.

Laboratory Data

All laboratory data will be reviewed to confirm that methods have been appropriately followed and that the work performed meets the MQOs presented in Table 6, Section A.7, data are accurately recorded, and that the sample results are properly qualified, if necessary, based on the data review.

D.1.2 Data validation

Data validation means determining if data satisfy QAPP-defined user requirements, that is, that the data refer back to the overall data quality objectives. Data validation is an analyte and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set to ensure that the reported data values meet the quality goals of the environmental data operations (analyte and method specific data validation criteria) and the data will be usable for continued project assessments.

D.2 VERIFICATION AND VALIDATION METHODS

D.2.1 Verification Methods

The primary goal of verification is to document that applicable method, procedural and contractual requirements were met in field sampling and laboratory sample analysis. Verification checks to see if the data are complete, if sampling and analysis matched QAPP requirements, and if Standard Operating Procedures (SOPs) were followed.

Verification of data is the responsibility of the Project QA Officer or designee. All data, field and laboratory, will be verified that it meets the QAPP, method, and field/laboratory SOP requirements.

The following procedures will be used to determine if data meet the measurement and data quality objectives and criteria specified in Section A.7. A checklist for the data validation/verification procedure is included in Appendix B (Analytical Data Validation Checklists) and used to determine if all elements of the review are met. If data QA/QC procedures do not meet the specified criteria, the URS Quality Assurance Officer and Tt Quality Control Lead will review all field and laboratory records to determine the cause. If equipment failures are limiting the usability of the data, calibration and maintenance procedures will be reviewed and changed as needed. If sampling or analytical procedures are the source of failures, methods will be reviewed to resolve the errors. Any changes or modifications to quality control procedures will be approved by the URS Principal Manager and Project QAO prior to inclusion in the QAPP.

Review of Sample Handling

Proper sample handling techniques are required to ensure sample integrity. Specific performance requirements are outlined in Section B.3 and used to determine if sample handling did not meet minimum requirements and how this affects data quality. During data review, the sample handling procedures identified below are evaluated to determine potential effects on data quality.

- Review of field sample collection and preservation procedures to determine whether they were completed in accordance with the requirements specified by the analytical methods.
- Review of chain-of-custody documentation to ensure control and custody of the samples was maintained.
- Review of sample conditions upon receipt at the laboratory. Condition of the sample prior to analysis will be noted and used to qualify data if laboratory results indicate results are outside of acceptance limits.
- Review of sample holding times between sample collection, extraction, and analysis (see Table 12, Section B.2).

Review of QA/QC samples. Specific procedures for review of QA/QC samples are included in the sections below.

Initial and Continuing Calibrations

Laboratory instrument calibration requirements are summarized in the appropriate methods. The laboratory is required to follow the method criteria. If calibrations fail, the laboratory is expected to take corrective action to achieve an acceptable calibration prior to sample analysis. Sample data will not be reported from analytical runs with unacceptable calibrations that affect data quality.

Surrogate Spikes

Accuracy of an analytical measurement for organic analyses (BETX and PAHs) is evaluated by using surrogate spikes. Surrogate compounds are compounds not expected to be found in environmental samples; however, they are chemically similar to several compounds analyzed in the methods and behave similarly in extracting solvents. Samples will be spiked with surrogate compounds consistent with the requirements described in the laboratory SOPs. Percent recovery of surrogates is calculated concurrently with the analytes of interest. Since sample characteristics will affect the percent recovery, the percent recovery is a measure of accuracy of the overall analytical method on each individual sample. Surrogate recoveries will be evaluated based on the laboratory's most current calculated control limits at the time samples are submitted to the laboratory.

Laboratory Blank Samples

Laboratory blank samples (method and instrument blanks) are laboratory-prepared, analyte-free samples used to detect the introduction of contamination or other artifacts into the laboratory sample handling and analytical process. These blanks play an important role in sampling programs involving trace-level analyses or analytes that are common solvents found in a laboratory.

Laboratory Control Samples

Laboratory control samples are used to assess analytical performance under a given set of standard conditions. Synthetic samples, containing some or all of the analytes of interest at known concentrations, are prepared independently from calibration standards. The samples consist of laboratory control samples (LCS) and laboratory control sample duplicates (LCSD). Laboratory control samples will be analyzed with each analytical batch. LCS/LCSD may be used to estimate analytical accuracy and precision by comparing measured results to actual

concentrations. LCS/LCSD percent recoveries and relative percent difference (RPD) will be checked on laboratory reports to ensure they are within the limits established in the QAPP (Table 6, Section A.7).

Matrix Spike and Matrix Spike Duplicates

Matrix spike samples are actual field samples to which known amounts of select compounds (one, or more, of the analytes of interest) are added. Both spiked and un-spiked aliquots (sample portions) are analyzed. The difference between the concentration of the spike compound(s) in the spiked and un-spiked aliquots is compared to the amount of spike added before the extraction process. Since actual samples are used for the recovery determination, the matrix effects on analysis can be evaluated. When matrix spike recovery is outside of acceptance limits remedial action including laboratory sample splits will be initiated. Usually expressed as a percentage of the mass of the spiked amount, spike recovery is the measurement of accuracy anticipated for the sample matrix. Matrix spike samples are also duplicated in the laboratory and then analyzed in an identical manner by the laboratory to assess sample reproducibility and the laboratory's internal precision. The analytical precision is expressed by the RPD between the measurement results of the two duplicate samples. Analytical precision and accuracy should meet the criteria provided in Table 6, Section A.7. MS/MSD samples will be included at 1 pair per 20 samples per media.

Field Duplicate Samples

Field duplicate samples will be collected simultaneously with a primary project sample. Duplicates are treated in the same manner as the primary sample during all phases of sample collection, handling, and analysis. Duplicate sample results are used to assess precision, including variability associated with both the laboratory analysis and the sample collection process (i.e., QC purposes). At least one duplicate field sample will be collected for every 10 samples collected per media and submitted blind to the laboratory for this program.

Analytical results will be reviewed for agreement with each other or their respective RLs and evaluated for comparability. Estimated results quantified below the RL and qualified with a "J" flag by the laboratory are not considered significant for the purpose of data agreement. During the laboratory QA/QC process, these data were further "U" – qualified and considered "non-detect". The comparison between project and field duplicate sample results should meet RPD (relative percent difference) criteria for each method listed in Table 6, Section A.7.

Reporting Limits

The RLs are the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory conditions. For many analytes, the RL analyte concentration is selected by the laboratory as the lowest non-zero standard in the calibration curve. Sample RLs vary based on sample matrix and dilution of the samples during analysis. RLs should be equal to or below the PQLs provided in Table 6, Section A.7 for each method. The laboratory will report to the MDL and MDL and RL will be included in the laboratory report. Results reported below the RL and above the MDL will be qualified by the laboratory as estimated values and flagged with a "J". Again, results below the RL were further "U"- qualified as non-detect following post-laboratory QA/QC.

Data Qualification

Data will be evaluated based on the analytical method and QAPP requirements. If there are QC results that are outside of criteria or acceptance limits, the affected data may be qualified based on the potential effect of the out of compliance item on the data quality. The guidance for assigning data qualifiers is outlined in two documents, EPA (2008) and EPA (2010), and will be used to determine the most appropriate qualifier. The laboratory is expected to provide fully validatable packages, but the verification will be based on review of summary QC forms and sample result forms for the following elements:

- Verification that sample numbers and analyses match the chain-of-custody request.
- Verification that sample preservation and holding times are met.
- Verification that instrument performance checks were performed and acceptable.
- Verification that calibrations were performed at the appropriate frequency and met method criteria.
- Verification that field and laboratory blanks were performed at the proper frequency and that no analytes were present in the blanks.
- Verification that field and laboratory duplicates, matrix spikes, and laboratory control samples were run at the proper frequency and that control limits were met.
- Verification that surrogate compound analyses have been performed, where appropriate, and that results met the QC criteria.
- Verify that internal standards results were acceptable.
- Verification that project RLs have been achieved.
- Review of ICPMS/GCMS (chromatograms/spectra) to confirm target analytes were properly identified.

Qualifiers will be added to data during the review as necessary. Qualifiers applied to the data as a result of the data review will include at least the following:

- U The analyte was not detected above the RL.
- J (+, -) The analyte was positively identified; the associated numerical value is an estimate of the concentration of the analyte in the sample.
- UJ The analyte was not detected above the sample RL. However, the RL is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.

Additional qualifiers may be used by the laboratory and will be fully defined where finalized data are included in a report.

Results of the data review will be included in a data quality review report that will provide a basis for meaningful interpretation of the data quality and evaluate the need for corrective actions and/or comprehensive (raw data review and calculation checks) data validation. Data reviews will be performed by a project chemist, senior water quality scientist, or equivalent, for all laboratory analysis.

If the results of verification indicate potential problematic areas within a data set, a more detailed review will be conducted that requires spot-checking the laboratory's raw data package and calculations. The Water Quality Technical Lead and/or project chemist will contact the laboratory to discuss the problematic areas; however, if questions still exist, the project chemist may elect to conduct a "standard" review of the data.

Completeness

Completeness is calculated after the QC data have been evaluated, and the qualifiers have been applied to the sample data. Invalid results, broken or spilled samples, and samples that are unable to be analyzed for other reasons are included in the assessment of completeness. The criteria and calculation to determine completeness are provided in Section A.7. The data completeness goal for the project is 95% usable data.

D.2.2 Validation Methods

Data validation determines whether the data sets meet the project-specific requirements as described in the QAPP. That is, were the data results of the right type, quality, and quantity to support the intended use. Data validation also evaluates the effects of data anomalies and assigned data qualification from verification procedures of field and laboratory results on data usability. The results of verification including data qualifiers and indications of systematic errors in field data or lab data, field observations, and completeness of sample collection and analysis provides a basis to assess if the data have significant limitations such that resampling may be necessary to meet project objectives or if the data, as qualified, is appropriate to use for future assessments.

D.3 RECONCILIATION WITH USER REQUIREMENTS

After the field work and final analyses have been completed and reviewed, data review reports, field notes and any corrective actions associated with the project will be reviewed by the URS Principal Manager, Project QAO and technical leads to assess if the project objectives have been met. If the project objectives have been met, the field information and analytical data and review will be incorporated into project reports and the project database as required. If project objectives have not been achieved, the problem will be identified and resolved. Appropriate corrective actions will be implemented and documented before additional work proceeds.

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PART B – ATTACHMENT 1 - APPENDIX A

STATE AND FEDERAL WATER QUALITY CRITERIA AND THRESHOLDS

PARAMETER Criteria expressed as µg/L, unless noted otherwise Shaded cells indicate controlling standard and use	**WATER SUPPLY**		**WATER RECREATION**		**GROWTH & PROPAGATION**		**AQUATIC LIFE**		**HUMAN HEALTH**		**CONTROLLING STANDARD**
	Drinking Water, Culinary and Food Processing (1)(A)(i)	**Agriculture: Stockwater[a], Irrigation Water[b], or Both[c] (1)(A)(ii)**	**Aquaculture (1)(A)(iii)**	**Industrial (1)(A(iv)**	**Contact[a] and Secondary[b] Recreation Both[c] (1)(B)(i) and (ii)**	**Growth & Propagation of Fish, Shellfish, Other Aquatic Life, and Wildlife (1)(C)**	**Acute Criteria (CMC)**	**Chronic Criteria (CCC)**	**For Consumption of Water Plus Aquatic Organisms** Risk Level for Carcinogens at 10^{-5} Per 40 CFR 131.36	**For Consumption of Aquatic Organisms Only** Risk Level for Carcinogens at 10^{-5} Per 40 CFR 131.36	**Most Stringent Numerical Standard** **See adjacent shaded cells for details and designated use**
Acenaphthylene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH)					**15 µg/L** TAqH limit (sum of EPA 610 PAHs + TAH)
Acenapthene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**1,200**	**2,700**	**15 µg/L** TAqH limit (sum of EPA 610 PAHs + TAH)
Alkalinity								**≥ 20,000, or natural if lower** *as CaCO3,* See note 8			**20,000 µg/L minimum, or natural if lower** *as CaCO3*
Aluminum		**5,000[b]** *as total recoverable*					**750** (1-hr avg) See notes 11, 20, 31 *as total recoverable*	**87 or 750** CCC value is **750** if pH is ≥7.0 and hardness is ≥50 (4-day avg) See notes 12 ,13, 14, 20, 31 *as total recoverable*			**87 or 750 µg/L** *as total recoverable*
Ammonia							**0.885 - 32.6** Range with Salmonids present and pH of 9.0 - 6.5 Species and pH dependent - See Table B (1-hr avg) See note 11 *total as mg/L N*	**0.179 - 6.67** Range with early life stage fish present, pH of 9.0 - 6.5, and temperature of 0 - 30 °C Fish life stage, temperature, and pH dependent See Tables C & D (30-day avg) *See note 15 total as mg/L N*			**0.179 - 6.67 mg/L** *total as mg/L N*
Anthracene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**9,600**	**110,000** *See note 5*	**15 µg/L** *TAqH limit (sum of EPA 610 PAHs + TAH)*

Arsenic	**10** *as total* See notes 1, 17	**50**[a] **100**[b]			**10**[a] *as total* See notes 1, 17		**340** (1-hr avg) See notes 11, 18, 19, 20 *dissolved*	**150** (4-day avg) *See notes 12, 19, 20, 21 dissolved*			**10 µg/L** *as total*
Barium	**2,000** *as total* See note 1				**2,000**[a] *as total* See note 1						**2,000 µg/L** *as total*
Benzene	**5** See note 1		**10** TAH limit (sum of benzene, ethylbenzene, toluene & xylenes)		**5**[a] See note 1	**10** TAH limit (sum of benzene, ethylbenzene, toluene & xylenes)			**12** carcinogen	**710** carcinogen	**5 µg/L**
Benzo(a)Anthracene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**0.028** carcinogen	**0.31** carcinogen	**0.028 µg/L**
Benzo(a)Pyrene	**0.2** *See note 1*		**15** TAqH limit (sum of EPA 610 PAHs + TAH)		**0.2**[a] *See note 1*	**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**0.028** carcinogen	**0.31** carcinogen	**0.028 µg/L**
Benzo(b)Fluoranthene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**0.028** carcinogen	**0.31** carcinogen	**0.028 µg/L**
Benzo(ghi)Perylene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH)					**15 µg/L** TAqH limit (sum of EPA 610 PAHs + TAH)
Benzo(k)Fluoranthene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**0.028** carcinogen	**0.31** *carcinogen*	**0.028 µg/L**
Beryllium	**4** *as total* See note 1	**100**[b]			**4**[a] *as total* See note 1						**4 µg/L** *as total*
Bicarbonate		**RSC< 1.25**[c] From TDS criteria *as dissolved*									**RSC <1.25 meq/L** From TDS criteria *as dissolved*
Calcium		**SAR< 2.5, Na%< 60, and RSC< 1.25 m_{eq}/L**[c] From TDS criteria *as dissolved*									**SAR <2.5, Na% <60, and RSC <1.25 meq/L** From TDS criteria *as dissolved*
Cadmium	**5** *as total* See note 1	**10**[c]			**5**[a] *as total* See note 1		**0.52 - 7.7** Hardness dependent - range shown for 25 - 400 See Table A (1-hr avg) See notes 11, 20, 25, 41 *as dissolved*	**0.09 - 0.64** Hardness dependent - range shown for 25 - 400 See Table A (4-day avg) See notes 12, 20, 25, 41 *as dissolved*			**0.09 - 0.64 µg/L** *as dissolved*

Chloride	**250,000** From TDS criteria *as dissolved*						**860,000** (1-hr avg) See notes 30 , 31 *for dissolved chloride when associated with sodium*	**230,000** (4-day avg) See notes 12, 30, 31 *for dissolved chloride when associated with sodium*			**230,000 µg/L** *as dissolved*
Chromium III							**180-18000** Hardness dependent - range shown for 25 - 400 See Table A (1-hr avg) See notes 11, 20, 25 *as dissolved*	**24-230** Hardness dependent - range shown for 25 - 400 See Table A (1-hr avg) See notes 12, 20, 25 *as dissolved*			**24-230 µg/L** *as dissolved*
Chromium (Total)	**100** *as total recoverable* See note 1	**100**[b] *as total recoverable*			**100**[a] *as total recoverable* See note 1						**100 µg/L** *as total recoverable*
Chrysene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**0.028** *carcinogen*	**0.31** *carcinogen*	**0.028 µg/L**
Cobalt		**50**[b]									**50 µg/L**
Color	**15** The greater of 15 color units or the natural condition. See note H		**50** The greater of 50 color units or the natural condition. See note H	May not cause detrimental effects on established water supply treatment levels.	**15**[a] The greater of 15 color units or the natural condition. See note H May[b] not interfere with or make the water unfit or unsafe for the use.	**50** Color or apparent color may not reduce the depth of the compensation point for photosynthetic activity by more than 10% from the seasonally established norm for aquatic life. For waters without a seasonally established norm, color may not exceed the greater of 50 color units or the natural condition. See note H					**The greater of 15 color units, or natural condition**
Copper		**200**[b]					**3.6 - 50** Hardness dependent - range shown for 25 - 400 *See Table A* (1-hr avg) See notes 11, 20, 25, 38 *as dissolved*	**2.7 - 29** Hardness dependent - range shown for 25 - 400 See Table A (4-day avg) See notes 12, 20, 25, 38 *as dissolved*	**1,300**		**2.7 - 29 µg/L** *as dissolved*
Dibenzo(ah)Anthracene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			15 TAqH limit (sum of EPA 610 PAHs + TAH)			**0.028** carcinogen	**0.31** carcinogen	**0.028 µg/L**

Dissolved Gas	**4 mg/L dissolved oxygen (DO)***Minimum*	**3 mg/L DO** [c]*Minimum*	**7 mg/L DO**D.O. must be > 7 mg/L in surface waters and total dissolved gas <110% saturation at any point of sample collection.	May not cause detrimental effects on established water supply treatment levels.	**4 mg/L DO**[c]Minimum	**5 - 7 minimum as mg/L DO17 maximum as mg/L DOand total dissolved gas ≤ 110 % saturation**DO must be > 7 mg/L in waters used by anadromous or resident fish. In no case may DO be < 5 mg/L to a depth of 20 cm in the interstitial waters of gravel used by anadromous or resident fish for spawning (*see note B)*. For waters not used by anadromous or resident fish, DO must be ≥ 5 mg/L. In no case may DO > 17 mg/L. The concentration of total dissolved gas must be ≤ 110% of saturation at any point of sample collection.					**7 - 17 mg/L DO in surface waters5 mg/L DO minimum (spawning gravels)Total dissolved gas ≤ 110 % saturation**
Dissolved Inorganic Substances	**500,000** A*s total dissolved solids (TDS).TDS from all sources may not exceed 500 mg/L. Neither chlorides nor sulfates may exceed 250mg/L.*	**1,000,000**[c] As TDS. Sodium adsorption ratio must be less than 2.5, sodium percentage less than 60%, and residual carbonate less than 1.25 milliequivalents/liter *(see note F).*	**1,000,000** As TDS. TDS may not exceed 1,000 mg/L. A concentration of TDS may not be present in water if that concentration causes or reasonably could be expected to cause an adverse effect to aquatic life (*see note L*).	No amounts above natural conditions that can cause corrosion, scaling, or process problems.		**1,000,000** As TDS. TDS may not exceed 1,000 mg/L. A concentration of TDS may not be present in water if that concentration causes or reasonably could be expected to cause an adverse effect to aquatic life (*see note L*).					**500,000 µg/L** as total dissolved solids
Ethylbenzene	**700** *See note 1*		**10** TAH limit (sum of benzene, ethylbenzene, toluene & xylenes)		**700**[a] See note 1	**10** TAH limit (sum of benzene, ethylbenzene, toluene & xylenes)			**3,100**		**10 µg/L** TAH limit (sum of benzene, ethylbenzene, toluene & xylenes)

Fecal Coliforms	**20** *as 30 day geometric mean FC/100mL* The 30-day geometric mean must be ≤ 20 FC/100 mL, and not more than 10% of the samples may be > 40 FC/100 mL. For groundwater the FC concentration must be <1 FC/100mL (using membrane filter) or <3 FC/100mL (using most probable number). See note A	**200**[c] *as 30-day geometric mean FC/100 mL* The 30-day geometric mean must be ≤ 200 FC/100 mL, and no more than 10% of the samples may be > 400 FC/100 mL. Drinking water criteria apply for products not normally cooked and for dairy sanitation of unpasteurized products. See note A	**200** *as 30-day geometric mean FC/100 mL* For products normally cooked, the 30-day geometric mean must be ≤ 200 FC/100 mL, and no more than 10% of the samples may be > 400 FC/100 mL. Drinking water criteria apply for products not normally cooked. See note A	**200** *as 30-day geometric mean FC/100 mL* Where worker contact is present, the 30-day geometric mean must be ≤ 200 FC/100 mL, and no more than 10% of the samples may be > 400 FC/100 mL. See note A	**100**[a] **200**[b] *as 30-day geometric mean FC/100 mL* For Contact, the 30-day geometric mean must be ≤ 100 FC/100 mL, and no more than one sample or ≤ 10% of the samples if there are more than 10, may be > 200 FC/100 mL. For Secondary, the 30-day geometric mean must be ≤ 200 FC/100 mL, and no more than 10% of the samples may be > 400 FC/100 mL. See note A						**20 FC/100mL** *30 day geometric mean* **For groundwater the concentration must be <1 FC/100mL.**
Fluoranthene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**300**	**370**	**15 µg/L** TAqH limit (sum of EPA 610 PAHs + TAH)
Fluorene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**1,300**	**14,000**	**15 µg/L** TAqH limit (sum of EPA 610 PAHs + TAH)
Gross alpha	**15** as *pCi/L*. See notes 1, 45				**15**[a] as *pCi/L*. See notes 1, 45						**15 pCi/L**
Gross beta	**4** as *millirems/yr* See note 1				**4**[a] as millirems/yr See notes 1, 45						**4 millirems/yr**
Indeno(1,2,3-cd)Pyrene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**0.028** carcinogen	**0.31** carcinogen	**0.028 µg/L**
Iron		**5000**[b]						**1,000**			**1,000 µg/L**
Lead		**50**[a] **5000**[b]					**14 - 280** Hardness dependent - range shown for 25 - 400 See Table A (1-hr avg) See notes 11, 25, 41, 47 *as dissolved*	**0.54 - 11** Hardness dependent - range shown for 25 - 400 See Table A (4-day avg) See notes 12, 25, 41, 47 *as dissolved*			**0.54 - 11 µg/L** *as dissolved*
Magnesium		**SAR< 2.5, Na%< 60, and RSC< 1.25 meq/L**[c] From TDS criteria *as dissolved*									**SAR <2.5, Na% <60, and RSC <1.25 meq/L** From TDS criteria *as dissolved*

Manganese		**200**[b]							**50** See note 50	**100** See note 50	**50 µg/L**
Mercury (FOR STATE ACTIONS))	**2** *as total* See note 1				**2**[a] See note 1		**1.4** FOR STATE ONLY See Table A (1-hr avg) See notes 11 20, 51 , 52 *as dissolved*	**0.77** FOR STATE ONLY See Table A (4-day avg) See notes 12, 20, 52, 53 *as dissolved*	**0.050** See note 5	**0.051** See note 5	**0.050 µg/L** FOR STATE ONLY
Mercury (FOR FEDERAL ACTIONS)	**2** *as total* See note 1				**2**[a] See note 1		**2.4** FOR FEDERAL (i.e., CWA) From 1999 AWQS (1-hr avg) *as total recoverable*	**0.012** FOR FEDERAL (i.e., CWA) From 1999 AWQS (4-day avg) *as total recoverable*	**0.050** *See note 5*	**0.051** *See note 5*	**0.012 µg/L** FOR FEDERAL (i.e., CWA) from 1999 AWQS *as total recoverable*
Molybdenum		**10**[b]									**10 µg/L**
Naphthalene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH).					**15 µg/L** *TAqH limit (sum of EPA 610 PAHs + TAH)*
Nickel	*See note 57*	**200**[b]			See note 57[a]		**140 - 1,500** Hardness dependent - range shown for 25 - 400 See Table A (1-hr avg) See notes 11, 20, 25 *as dissolved*	**16 - 170** Hardness dependent - range shown for 25 - 400 See Table A (4-day avg) See notes 12 20, 25 *as dissolved*	**610**	**4,600**	**16 - 170 µg/L** *as dissolved*
Nitrate and Nitrite (as N), Total	**10,000** *See note 1*				**10,000**[a] See note 1						**10,000 µg/L** *total as N*
pH	**6.0 - 8.5***as pH units* Variation of pH for water naturally outside the specified range must be toward the range.	**5.0 - 9.0**[c]*as pH units*Variation of pH for water naturally outside the specified range must be toward the range.	**6.5 - 8.5***as pH units*May not vary more than 0.5 unit from natural conditions. Variation of pH for water naturally outside the specified range must be toward the range.	**5.0 - 9.0***as pH units*Variation of pH for water naturally outside the specified range must be toward the range.	**6.5 - 8.5**[a]**5. 0 - 9.0**[b]*as pH units*.If the natural condition pH is outside this range, substances may not be added that cause an increase in the buffering capacity of the water. Variation of pH for water naturally outside the specified range must be toward the range.	**6.5 - 8.5***as pH units*May not vary more than 0.5 unit from natural conditions. Variation of pH for water naturally outside the specified range must be toward the range.					**6.5 - 8.5 pH units (and ≤0.5 pH units from natural)**
Phenanthrene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH).					**15 µg/L** *TAqH limit (sum of EPA 610 PAHs + TAH)*
Potassium		**Na%<60**[b] From TDS criteria *as dissolved*	**110,000** From TDS criteria *as dissolved*			**110,000** From TDS criteria (see note L) *as dissolved*					**110,000** From TDS criteria (see note L) *as dissolved*

Pyrene			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**15** TAqH limit (sum of EPA 610 PAHs + TAH)			**960**	**11,000**	**15 µg/L** TAqH limit (sum of EPA 610 PAHs + TAH)
Radioactivity	See individual radionuclides. May not exceed the concentrations specified in Table I of the Alaska Water Quality Criteria Manual (*see note E*) for radioactive contaminants and may not exceed limits specified in 10 C.F.R. 20 (*see note I*) and National Bureau of Standards, Handbook 69 (*see note J*).	See individual radionuclides.[c] May not exceed the concentrations specified in Table I of the Alaska Water Quality Criteria Manual (*see note E*) for radioactive contaminants and may not exceed limits specified in 10 C.F.R. 20 (*see note I*) and National Bureau of Standards, Handbook 69 (*see note J*).	See individual radionuclides. May not exceed the concentrations specified in Table I of the Alaska Water Quality Criteria Manual (*see note E*) for radioactive contaminants and may not exceed limits specified in 10 C.F.R. 20 (*see note I*) and National Bureau of Standards, Handbook 69 (*see note J*). Concentration factors for organisms involved may not exceed maximum permissible limits for specific radioisotopes and unidentified mixtures as established by 10 C.F.R. 20 and National Bureau of Standards, noted above.	See individual radionuclides. May not exceed the concentrations specified in Table I of the Alaska Water Quality Criteria Manual (*see note E*) for radioactive contaminants and may not exceed limits specified in 10 C.F.R. 20 (*see note I*) and National Bureau of Standards, Handbook 69 (*see note J*).	See individual radionuclides.[c] May not exceed the concentrations specified in Table I of the Alaska Water Quality Criteria Manual (*see note E*) for radioactive contaminants and may not exceed limits specified in 10 C.F.R. 20 (*see note I*) and National Bureau of Standards, Handbook 69 (*see note J*).	See individual radionuclides. May not exceed the concentrations specified in Table I of the Alaska Water Quality Criteria Manual (*see note E*) for radioactive contaminants and may not exceed limits specified in 10 C.F.R. 20 (*see note I*) and National Bureau of Standards, Handbook 69 (*see note J*). Concentration factors for organisms involved may not exceed maximum permissible limits for specific radioisotopes and unidentified mixtures as established by 10 C.F.R. 20 and National Bureau of Standards, noted above.					See individual radionuclides
Radium-226 and -228 (combined)	**5** *as pCi/L* See note 1				**5**[a] *as pCi/L* See note 1						**5 pCi/L**
Residues (FOR STATE ACTIONS)	Residues are not allowed in surface waters of the state, in concentrations or amounts that have the following effects: may impair designated uses; cause nuisance or objectionable conditions; result in undesirable or nuisance species; or produce objectionable odor or taste. Criteria are not applicable to groundwater. (*see note M*).	Residues[c] are not allowed in surface waters of the state, in concentrations or amounts that have the following effects: may impair designated uses; cause nuisance or objectionable conditions; result in undesirable or nuisance species; or produce objectionable odor or taste. Criteria are not applicable to groundwater. (*see note M*).	Residues are not allowed in surface waters of the state, in concentrations or amounts that have the following effects: may impair designated uses; cause nuisance or objectionable conditions; result in undesirable or nuisance species; or produce objectionable odor or taste. Criteria are not applicable to groundwater. (*see note M*).	Residues are not allowed in surface waters of the state, in concentrations or amounts that have the following effects: may impair designated uses; cause nuisance or objectionable conditions; result in undesirable or nuisance species; or produce objectionable odor or taste. Criteria are not applicable to groundwater. (*see note M*).	Residues[c] are not allowed in surface waters of the state, in concentrations or amounts that have the following effects: may impair designated uses; cause nuisance or objectionable conditions; result in undesirable or nuisance species; or produce objectionable odor or taste. Criteria are not applicable to groundwater. (*see note M*).	Residues are not allowed in surface waters of the state, in concentrations or amounts that have the following effects: may impair designated uses; cause nuisance or objectionable conditions; or result in undesirable or nuisance species. Criteria are not applicable to groundwater. (*see note M*).					Narrative FOR STATE ONLY

Residues (FOR FEDERAL ACTIONS)	From 2003 AWQS, May not, alone or in combination with other substances or wastes, make the water unfit or unsafe for the use; cause a film, sheen, or discoloration on the surface of the water or adjoining shorelines; cause leaching of toxic or deleterious substances; or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines. Criteria are not applicable to groundwater.	From 2003 AWQS. May[c] not be present in quantities to cause soil plugging or reduced crop yield, or to make the water unfit or unsafe for the use. Criteria are not applicable to groundwater.	From 2003 AWQS. May not, alone or in combination with other substances or wastes, make the water unfit or unsafe for the use. Criteria are not applicable to groundwater.	From 2003 AWQS. May not, alone or in combination with other substances or wastes, make the water unfit or unsafe for the use. Criteria are not applicable to groundwater.	From 2003 AWQS. May[c] not, alone or in combination with other substances or wastes, make the water unfit or unsafe for the use; cause a film, sheen, or discoloration on the surface of the water or adjoining shorelines; cause leaching of toxic or deleterious substances; or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines. Criteria are not applicable to groundwater.	From 2003 AWQS. May not, alone or in combination with other substances or wastes, make the water unfit or unsafe for the use, or cause acute or chronic problem levels as determined by bioassay or other appropriate methods. May not, alone or in combination with other substances, cause a film, sheen, or discoloration on the surface of the water or adjoining shorelines; cause leaching of toxic or deleterious substances; or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines. Criteria are not applicable to groundwater.					Narrative FOR FEDERAL (i.e., CWA) from 2003 AWQS
Selenium (FOR STATE ACTIONS)	**50** *as total* See note 1	**10**[a] **20**[b]			**50**[a] See note 1		**13 - 186** FOR STATE ONLY Calculation - based on fractions of selenite and selenate (1-hr avg) See notes 11, 63, 64 , 65 *as total recoverable*	**5.0** (4-day avg) See notes 12, 65 *as total recoverable*	**170**	**11,000**	**5.0 µg/L** *as total recoverable*
Selenium (FOR FEDERAL ACTIONS)	**50** *as total* See note 1	**10**[a] **20**[b]			**50**[a] See note 1		**20** FOR FEDERAL (i.e., CWA) From 1999 AWQS (1-hr avg) *as total recoverable*	**5** FOR FEDERAL (i.e., CWA) From 1999 AWQS (4-day avg) *as total recoverable*	**170**	**11,000**	**5 µg/L** *as total recoverable*
Sodium		**SAR<2.5, Na%<60, RSC<1.23**[b] From TDS criteria *As dissolved*									**SAR<2.5, Na%<60, RSC<1.23b** From TDS criteria *As dissolved*
Strontium-90	**8** *as pCi/L.* See note 1				**8**[a] *as pCi/L.* See note 1						**8 pCi/L**

Sulfate		**250,000** From TDS criteria *as dissolved*									**250,000** From TDS criteria *as dissolved*
Thallium	**2** *as total* See note 1				**2**[a] *as total* See note 1				**1.7**	**6.3**	**1.7 µg/L** *as total*
Toluene	**1000** See note 1		**10** TAH limit (sum of benzene, ethylbenzene, toluene & xylenes)		**1,000**[a] See note 1	**10** TAH limit (sum of benzene, ethylbenzene, toluene & xylenes)			**6,800**	**200,000**	**10 µg/L** TAH limit (sum of benzene, ethylbenzene, toluene & xylenes)
Total Dissolves Solids (TDS)	**500,000**	**1,000,000**[b]									**500,000 µg/L**
Turbidity	**natural plus 5 - 25** *as nephelometric turbidity units (NTU)* Limited to 5 NTU increase when natural turbidity is 50 NTU or less. Limited to 10% increase (up to 25 NTU) when natural turbidity is more than 50 NTU.	May[c] not cause detrimental effects on indicated use.	**natural plus 5 - 25** *as nephelometric turbidity units (NTU)* May not exceed 25 NTU above natural conditions; may not exceed 5 NTU above natural conditions in all lake waters.	May not cause detrimental effects on established water supply treatment levels.	**natural plus 5 - 15**[a] **natural plus 10 - 15**[b] **natural plus 5 in lakes**[c] *as nephelometric turbidity units (NTU)* Limited[a] to 5 NTU increase when natural turbidity is ≤50 NTU and to 10% increase (up to 15 NTU) when natural turbidity is >50 NTU. Limited[b] to 10 NTU increase when natural turbidity is ≤50 NTU and to 20% increase (up to 15 NTU) when natural turbidity is >50 NTU. May[c] not exceed 5 NTU increase above natural turbidity in lake waters.	**natural plus 5 - 25** *as nephelometric turbidity units (NTU)* May not exceed 25 NTU above natural conditions; may not exceed 5 NTU above natural conditions in all lake waters.					**Natural plus 5 - 15 NTU**
Vanadium		**100**[b]									**100 µg/L**

Water Temperature	**15** *as degrees C*	**30**[c] *as degrees C*	**13 - 20** *as degrees C* May not exceed 20° C at any time. The following maximum temperatures may not be exceeded, where applicable: 15° C - migration routes and rearing areas, 13° C - spawning areas and egg & fry incubation	**25** *as degrees C*	**30**[a] *as degrees C*	**13 - 20** *as degrees C* May not exceed 20° C at any time. The following maximum temperatures may not be exceeded, where applicable: 15° C - migration routes and rearing areas, 13° C - spawning areas and egg & fry incubation					**13 - 15** *as degrees C*
Xylenes (total)	**10,000** See note 1		**10** TAH limit (sum of benzene, ethylbenzene, toluene & xylenes)		**10,000**[a] See note 1	**10** TAH limit (sum of benzene, ethylbenzene, toluene & xylenes)					**10 µg/L** TAH limit (sum of benzene, ethylbenzene, toluene & xylenes)
Zinc		**2000**[b]					**36 - 380** Hardness dependent - range shown for 25 - 400 See Table A (1-hr avg) See notes 11, 20, 25 *as dissolved*	**36 - 380** Hardness dependent - range shown for 25 - 400 See Table A (4-day avg) See notes 12 20, 25 *as dissolved*	**9,100**	**69,000**	**36 - 380 µg/L** *as dissolved*

References for Water Quality Standards and Criteria

ADEC (Alaska Department of Environmental Conservation), 18 AAC 70 Water Quality Standards, amended as of April 8, 2012 (and the Alaska Water Quality Criteria Manual, incorporated by reference, therein). See note E.

ADEC (Alaska Department of Environmental Conservation),. Comparison of Federally Approved Water Quality Standards Current as of July 26, 2012.
EPA (U.S. Environmental Protection Agency). National Primary Drinking Water Regulations. EPA 816-F-09-004, May 2009.
EPA (U.S. Environmental Protection Agency). 40 CFR 131.36 - Toxics Criteria for Those States Not Complying With Clean Water Act Section 303(c)(2)(B). [40 CFR Ch. 1 (7-1-10 Edition)]

Abbreviations used in Tables:

AWQS	Alaska Water Quality Standards
CCC	criteria continuous concentration (chronic)
CMC	criteria maximum concentration (acute)
DO	dissolved oxygen
FC	fecal coliform
Na%	sodium percentage
NTU	nephelometric turbidity units
PAHs	Polynuclear aromatic hydrocarbons
RSC	residual sodium carbonate
SAR	sodium adsorption ratio
TAH	total aromatic hydrocarbons
TAqH	total aqueous hydrocarbons
TDS	total dissolved solids

Reference notes from AWQS converted to alpha notation (i.e., A = 1, etc.):

A 1. Wherever criteria for fecal coliform bacteria are provided in this section, fecal coliform bacteria enumeration must be determined by the membrane filter technique or most probable number procedure according to any edition of Standard Methods for the Examination of Water and Wastewater, adopted by reference in (c)(1) of this section, and adopted by reference, or in accordance with other standards approved by the department and the United States Environmental Protection Agency (EPA).

B 2. Wherever criteria for dissolved oxygen (DO) are provided in this chapter, dissolved oxygen (DO) concentrations in interstitial waters of gravel beds will be measured using the technique found in Variations in the Dissolved Oxygen Content of Intragravel Water in Four Spawning Streams of Southeastern Alaska, by William J. McNeil, United States Department of the Interior, United States Fish and Wildlife Service, Special Scientific Report - Fisheries No. 402, February 1962, adopted by reference.

C 3. Wherever criteria for fine sediments are provided in this chapter, fine sediments must be sampled by the method described in An Improved Technique for Freeze Sampling Streambed Sediments, by William J. Walkotten, United States Department of Agriculture, United States Forest Service, Forest Service Research Note PNW-281, October 1976, adopted by reference, or by the technique found in Success of Pink Salmon Spawning Relative to Size of Spawning Bed Materials, by William J. McNeil and W.H. Ahnell, United States Department of the Interior, United States Fish and Wildlife Service, Special Scientific Report - Fisheries No. 469, January 1964, pages 1 - 3, adopted by reference.

D 4. Wherever criteria for fine sediments are provided in this chapter, percent accumulation of fine sediments will be measured by the technique found in the Manual on Test Sieving Methods, Guidelines for Establishing Sieve Analysis Procedures, by the American Society for Testing and Materials (ASTM), STP 447A, 1972 edition.

E 5. Wherever cited in this subsection, the Alaska Water Quality Criteria Manual means the Alaska Water Quality Criteria for Toxic and Other Deleterious Organic and Inorganic Substances, dated December 12, 2008, adopted by reference in this subsection.

F 6. The Report of the Committee on Water Quality Criteria, United States Department of the Interior, Federal Water Pollution Control Administration, Washington, D.C., April 1, 1968, is adopted by reference.

G 7. Samples to determine concentrations of total aromatic hydrocarbons (TAH) and total aqueous hydrocarbons (TAqH) must be collected in marine and fresh waters below the surface and away from any observable sheen; concentrations of TAqH must be determined and summed using a combination of: (A) EPA Method 602 (plus xylenes) or EPA Method 624 to quantify monoaromatic hydrocarbons and to measure TAH; and (B) EPA Method 610 or EPA Method 625 to quantify polynuclear aromatic hydrocarbons listed in EPA Method 610; use of an alternative method requires department approval; the EPA methods referred to in this note may be found in Appendix A of 40 C.F.R. 136, Appendix A, as revised as of July 1, 2003 and adopted by reference.

H 8. Color is as measured in color units on the platinum-cobalt scale according to any edition of Standard Methods for the Examination of Water and Wastewater, adopted by reference in (c)(1) of this section.

I 9. Wherever cited in this chapter, 10 C.F.R. 20 means the Standards for Protection Against Radiation as of January 1, 1978, adopted by reference.

J 10. Wherever cited in this chapter, National Bureau of Standards, Handbook 69 means Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and Water for Occupational Exposure, United States Department of Commerce, National Bureau of Standards Handbook 69, June 5, 1959, adopted by reference.

K 11. Volumetric measurements of settleable solids must be determined according to the following procedure: (A) first, an Imhoff cone must be filled to the one-liter mark with thoroughly mixed sample; (B) second, the sample must settle for 45 minutes; (C) third, the sides of the cone must be gently stirred with a rod or by spinning; (D) fourth, the sample must settle 15 minutes longer, and the volume of settleable matter in the cone must be recorded as milliliters per liter; (E) fifth, if the settled matter contains pockets of liquid between large settled particles, the volume of these pockets must be estimated and subtracted from the volume of settled matter.

L 12. If a permit applicant proposes to raise the total dissolved solids (TDS) levels in the receiving water to result in a concentration in the waterbody between 500 mg/l and 1,000 mg/l for all sources or above 110 mg/l for the potassium ion, the department will require a permit applicant to provide information that the department identifies as necessary to determine if the proposed TDS level will cause or can reasonably be expected to cause an adverse effect to aquatic life; based on its analysis, the department will limit the TDS level in the waterbody as necessary to prevent an adverse effect, and will set permit effluent limits accordingly; the burden of proof to demonstrate no adverse effect is on the permit applicant; implementation of the "no adverse effect" criterion is not subject to 18 AAC 70.235.

M 13. Considerations in deciding what constitutes a nuisance or an objectionable condition, an undesirable or nuisance species, or objectionable odor or taste, include whether the presence of residue (A) results in complaints from existing users; or (B) is consistent with the intended use of the area as designated in a land use or other resource management plan adopted by a federal, state or local government.

References from "endnotes " in the Alaska Water Quality Criteria Manual:

1 Criteria in this table were obtained from ADEC, Alaska Drinking Water Regulations, as amended through November 9th, 2006 in 18 AAC 80.300(b). The drinking water primary maximum contaminant levels are used as water quality criteria to protect the drinking water and contact recreation uses. The criteria for metals will be measured using the total method that is consistent with drinking water regulations measurement protocol.

5 This criterion has been revised to reflect the Environmental Protection Agency's q1* or RfD, as contained in the Integrated Risk Information System (IRIS) as of April 8, 1998. The fish tissue bioconcentration factor (BCF) from the 1980 Ambient Water Quality Criteria document was retained in each case.

8 Alkalinity is the sum total of components in the water that tend to elevate the pH of the water above about 4.5. It is measured by titration with standardized acid to a pH value of about 4.5 and it is expressed commonly as milligrams per liter of CaCO3. Alkalinity is a measure of the buffering capacity of the water, and since pH has a direct effect on organisms as well as an indirect effect on the toxicity of some pollutants in the water, it is important to water quality.

11 Acute criteria are based on the average concentration of chemical pollutants during a one-hour period. One hour was chosen because it is a substantially shorter period than the length of most acute toxicity tests. Acute and chronic criteria are used together to develop water quality-based effluent limits.

12 Chronic criteria are based on the average concentration of chemical pollutants during a four-day period. A four-day averaging period was chosen because it is substantially shorter than most chronic toxicity tests. Chronic criteria are typically stricter than the acute criteria and are therefore used to protect ambient waters.

13 Where the pH is greater than or equal to 7.0 and the hardness is greater than or equal to 50 ppm as $CaCO_3$, the chronic aluminum standard will then be equal to the acute aluminum standard, 750 µg/L as total recoverable aluminum.

14 There are three major reasons why the use of Water-Effect Ratios might be appropriate. (1) The value of 87 g/l is based on a toxicity test with the striped bass in water with pH= 6.5-6.6 and hardness <10 mg/L. Data in "Aluminum Water-Effect Ratio for the 3M Plant Effluent Discharge, Middleway, West Virginia" (May 1994) indicate that aluminum is substantially less toxic at higher pH and hardness, but the effects of pH and hardness are not well quantified at this time. (2) In tests with the brook trout at low pH and hardness, effects increased with increasing concentrations of total aluminum even though the concentration of dissolved aluminum was constant, indicating that total recoverable is a more appropriate measurement than dissolved, at least when particulate aluminum is primarily aluminum hydroxide particles. In surface waters, however, the total recoverable procedure might measure aluminum associated with clay particles,

which might be less toxic than aluminum associated with aluminum hydroxide. (3) EPA is aware of field data indicating that many high quality waters in the U.S. contain more than 87 g aluminum/L, when either total recoverable or dissolved is measured.

15 The highest four-day average within the 30-day period should not exceed 2.5 times the chronic criterion.

17 With compliance to be reported as required under 18 AAC 80.305(b)(4)

18 To calculate the dissolved criterion, the total recoverable criterion was multiplied by the conversion factor (339.8)(1.0) = 339.8 ~ 340

19 This recommended water quality criterion was derived from data for arsenic (III), but is applied here to total arsenic, which might imply that arsenic (III) and arsenic (V) are equally toxic to aquatic life and that their toxicities are additive. In the arsenic criteria document (EPA 440-5-84-033, January 1985), Species Mean Acute Values are given for both arsenic (III) and arsenic (V) for five species and the ratios of the SMAVs for each species range from 0.6 to 1.7. Chronic values are available for both arsenic (III) and arsenic (V) for one species; for the fathead minnow, the chronic value for arsenic (V) is 0.29 times the chronic value for arsenic (III). No data are known to be available concerning whether the toxicities of the forms of arsenic to aquatic organisms are additive.

20 This recommended criterion is based on a 304(a) aquatic life criterion that was issued in the 1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water, (EPA-820-B-96-001, September 1996). This value was derived using the GLI Guidelines (60FR 15393-15399, March 23, 1995; 40CFR132 Appendix A); the difference between the 1985 Guidelines and the GLI Guidelines are explained on page iv of the 1995 Updates. None of the decisions concerning the derivation of this criterion were affected by any considerations that are specific to the Great Lakes.

21 To calculate the dissolved criterion, the total recoverable criterion was multiplied by the conversion factor (147.9)(1.0) = 147.9 ~ 150

25 For waters with a hardness of less than 25 mg/l as CaCO3, criteria should be calculated using the actual ambient hardness of the surface water. The maximum hardness value shall not exceed 400 mg/l even if the actual ambient hardness is greater than 400 mg/l as calcium carbonate.

30 This criterion may not be adequately protective when the chloride is associated with potassium, calcium, or magnesium. Also, because freshwater animals have a narrow range of acute susceptibilities to chloride, excursions above this criterion might affect a substantial number of species.

31 This value is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, PB85-227049, January 1985) and was issued in one of the following criteria documents: Aluminum (EPA 440/5-86-008); Chloride (EPA 440/5-88-001); Chloropyrifos (EPA 440/5-86-005).

38 When the concentration of dissolved organic carbon is elevated, copper is substantially less toxic and use of site specific criteria might be appropriate.

41 This water quality criterion is based on a 304(a) aquatic life criterion that was derived using the 1985 Guidelines (Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses, PB85-227049, January 1985) and was issued in one of the following criteria documents: Arsenic (EPA 440/5-84-033), Cadmium (EPA-822-R-01-001), Chromium (EPA 440/5-84-029), Copper (EPA 440/5-84-031), Cyanide (EPA 440/5-84-028), Lead (EPA 440/5-84-027), Nickel (EPA 440/5-86-004), Pentachlorophenol (EPA 440/5-86-009), Toxaphene, (EPA 440/5-86-006), Zinc (EPA 440/5-87- 003).

45 Including radium-226 but excluding activity from radon and uranium.

47 EPA is actively working on this criterion and so this recommended water quality criterion may change substantially in the near future.

50 This human health criterion is the same as originally published in the Red Book which predates the 1980 methodology and did not use the fish ingestion BCF approach.

51 To calculate the dissolved criterion, the total recoverable criterion was multiplied by the conversion factor (1.694)(0.85) = 1.4399 ~ 1.4

52 The recommended criteria were derived from data for inorganic mercury (II), but are applied here to total mercury. If a substantial portion of the mercury in the water column is methylmercury, the criteria will probably be under protective. In addition, even though inorganic mercury is converted to methylmercury and methylmercury bioaccumulates to a great extent, these criteria do not account for uptake via the food chain because sufficient data were not available when the criteria were derived.

53 To calculate the dissolved criterion, the total recoverable criterion was multiplied by the conversion factor (0.9081)x(0.85) = 0.771 ~ 0.77. The concentration of 0.9081 µg/l might not adequately protect rainbow trout, coho salmon and bluegill.

57 None, but monitoring requirements under this chapter apply.

63 The CMC = 1/[(f1/CMC1) + (f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 g/l and 12.82 g/l, respectively.

64 This value for selenium was announced (61FR58444-58449, November 14, 1996) as a proposed GLI 303(c) aquatic life criterion. EPA is currently working on this criterion and so this value might change substantially in the near future.

65 This recommended water quality criterion for selenium is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor (0.996-CMC or 0.922-CCC) that was used in the GLI to convert this to a value that is expressed in terms of dissolved metal.

74 Freshwater and saltwater criteria for metals are expressed in terms of the dissolved metal in the water column. The recommended water quality criteria value was calculated by using the previous 304(a) aquatic life criteria expressed in terms of total recoverable metal, and multiplying it by a conversion factor (CF). The term "Conversion Factor" (CF) represents the recommended conversion factor for converting a metal criterion expressed as the total recoverable fraction in the water column to a criterion expressed as the dissolved fraction in the water column. (Conversion Factors for saltwater CCCs are not currently available. Conversion factors derived for saltwater CMCs have been used for both saltwater CMCs and CCCs).

Table A. PARAMETERS FOR CALCULATING FRESHWATER DISSOLVED METALS CRITERIA THAT ARE HARDNESS-DEPENDENT [74]

					Freshwater Conversion Factors (CF)	
Metal	mA	bA	mC	bC	Acute (CMC)	Chronic (CCC)
Arsenic	—	—	—	—	1.000	1.000
Cadmium	1.0166	-3.924	0.7409	-4.719	1.136672-[(ln hardness)(0.041838)]	1.101672-[(ln hardness)(0.041838)]
Chromium III	0.819	3.7256	0.819	0.6848	0.316	0.86
Chromium VI	—	—	—	—	0.982	0.962
Copper	0.9422	-1.700	0.8545	-1.702	0.96	0.96
Lead	1.273	-1.460	1.273	-4.705	1.46203-[(ln hardness)(0.145712)]	1.46203-[(ln hardness)(0.145712)]
Mercury	—	—	—	—	0.85	0.85
Nickel	0.846	2.255	0.846	0.0584	0.998	0.997
Silver	1.72	-6.59	—	—	0.85	—
Zinc	0.8473	0.884	0.8473	0.884	0.978	0.986

Hardness-dependent criteria may be calculated from the following for freshwater metals:

Acute (dissolved) = exp {mA [ln(hardness)]+ bA } (CF)

Chronic (dissolved) = exp{mC [ln(hardness)] + bC } (CF)

Source: Appendix A. from *Alaska Water Quality Criteria Manual.* See Note E.

75 1999 Update of Ambient Water Quality Criteria for Ammonia, EPA 822-R-99-014

Table B. ACUTE FRESHWATER AMMONIA CRITERIA [11, 75]

pH	Total Ammonia Nitrogen in mg-N/L	
	Acute Criteria with Salmonids Present	**Acute Criteria with Salmonids Absent**
	$\text{Acute} = 0.275 / 1 + 10^{7.204 - \text{pH}} + 39.0 / 1 + 10^{\text{pH} - 7.204}$	$\text{Acute} = 0.411 / 1 + 10^{7.204 - \text{pH}} + 58.4 / 1 + 10^{\text{pH} - 7.204}$
6.5	32.6	48.8
6.6	31.3	46.8
6.7	29.8	44.6
6.8	28.1	42.0
6.9	26.2	39.1
7.0	24.1	36.1
7.1	22.0	32.8
7.2	19.7	29.5
7.3	17.5	26.2
7.4	15.4	23.0
7.5	13.3	19.9
7.6	11.4	17.0
7.7	9.65	14.4
7.8	8.11	12.1
7.9	6.77	10.1
8.0	5.62	8.40
8.1	4.64	6.95
8.2	3.83	5.72
8.3	3.15	4.71
8.4	2.59	3.88
8.5	2.14	3.20
8.6	1.77	2.65
8.7	1.47	2.20
8.8	1.23	1.84
8.9	1.04	1.56
9.0	0.885	1.32

Source: Appendix C. from *Alaska Water Quality Criteria Manual.* See Note E.

76 At 15° C and above, the criterion for when the early life stages of fish are absent is the same as the criterion for when the early life stages of fish are present.

Table C. CHRONIC FRESHWATER AMMONIA CRITERIA [15, 75]

Total Ammonia in mg-N/L

Chronic Criteria with Early Life Stages of Fish Present

$$\text{Chronic} = \left(0.0577 / 1 + 10^{7.688 - \text{pH}} + 2.487 / 1 + 10^{\text{pH} - 7.688}\right) \bullet \text{MIN}\left(2.85, 1.45 \cdot 10^{0.028(25-T)}\right)$$

pH	Temperature									
	0°C	**14°C**	**16°C**	**18°C**	**20°C**	**22°C**	**24°C**	**26°C**	**28°C**	**30°C**
6.5	6.67	6.67	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.30	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	2.10	2.10	1.91	1.68	1.47	1.29	1.14	1.00	0.879	0.773
8.2	1.79	1.79	1.63	1.43	1.26	1.11	0.973	0.855	0.752	0.661
8.3	1.52	1.52	1.39	1.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	1.29	1.29	1.17	1.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	1.09	1.09	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.920	0.836	0.735	0.646	0.568	0.499	0.439	0.386	0.339
8.7	0.778	0.778	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.661	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.565	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.486	0.486	0.422	0.389	0.342	0.300	0.264	0.232	0.204	0.179

Source: Appendix D. from *Alaska Water Quality Criteria Manual.* See Note E.

Table D. CHRONIC FRESHWATER AMMONIA CRITERIA [15, 75, 76]

Total Ammonia in mg-N/L

Chronic Criteria with Early Life Stages of Fish Absent

$$\text{Chronic} = \left(0.057\ 7 / 1 + 10^{\,7.688 - \text{pH}} + 2.487 / 1 + 10^{\,\text{pH} - 7.688}\right) \bullet 1.45 \cdot 10^{\,0.028 - (25 - \text{MAX}(T,7))}$$

pH	Temperature									
	0-7°C	**8°C**	**9°C**	**10°C**	**11°C**	**12°C**	**13°C**	**14°C**	**15°C**	**16°C**
6.5	10.8	10.1	9.51	8.92	8.36	7.84	7.35	6.89	6.46	6.06
6.6	10.7	9.99	9.37	8.79	8.24	7.72	7.24	6.79	6.36	5.97
6.7	10.5	9.81	9.20	8.62	8.08	7.58	7.11	6.66	6.25	5.86
6.8	10.2	9.58	8.98	8.42	7.90	7.40	6.94	6.51	6.10	5.72
6.9	9.93	9.31	8.73	8.19	7.68	7.20	6.75	6.33	5.93	5.56
7.0	9.60	9.00	8.43	7.91	7.41	6.95	6.52	6.11	5.73	5.37
7.1	9.20	8.63	8.09	7.58	7.11	6.67	6.25	5.86	5.49	5.15
7.2	8.75	8.20	7.69	7.21	6.76	6.34	5.94	5.57	5.22	4.90
7.3	8.24	7.73	7.25	6.79	6.37	5.97	5.60	5.25	4.92	4.61
7.4	7.69	7.21	6.76	6.33	5.94	5.57	5.22	4.89	4.59	4.30
7.5	7.09	6.64	6.23	5.84	5.48	5.13	4.81	4.51	4.23	3.97
7.6	6.46	6.05	5.67	5.32	4.99	4.68	4.38	4.11	3.85	3.61
7.7	5.81	5.45	5.11	4.79	4.49	4.21	3.95	3.70	3.47	3.25
7.8	5.17	4.84	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89
7.9	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89	2.71	2.54
8.0	3.95	3.70	3.47	3.26	3.05	2.86	2.68	2.52	2.36	2.21
8.1	3.41	3.19	2.99	2.81	2.63	2.47	2.31	2.17	2.03	1.91
8.2	2.91	2.73	2.56	2.40	2.25	2.11	1.98	1.85	1.74	1.63
8.3	2.47	2.32	2.18	2.04	1.91	1.79	1.68	1.58	1.48	1.39
8.4	2.09	1.96	1.84	1.73	1.62	1.52	1.42	1.33	1.25	1.17
8.5	1.77	1.66	1.55	1.46	1.37	1.28	1.20	1.13	1.06	0.990
8.6	1.49	1.40	1.31	1.23	1.15	1.08	1.01	0.951	0.892	0.836
8.7	1.26	1.18	1.11	1.04	0.976	0.915	0.858	0.805	0.754	0.707
8.8	1.07	1.01	0.944	0.885	0.829	0.778	0.729	0.684	0.641	0.601
8.9	0.917	0.860	0.806	0.756	0.709	0.664	0.623	0.584	0.548	0.513
9.0	0.790	0.740	0.694	0.651	0.610	0.572	0.536	0.503	0.471	0.442

Source: Appendix E. from Alaska Water Quality Criteria Manual. See Note E.

PART B – ATTACHMENT 1 - APPENDIX B

ANALYTICAL DATA VALIDATION CHECKLIST

Identify Program/sampling event
ex. Monthly Sampling Baseline Water Quality —June 2013

Introduction, provide the following:

- number of samples, media, sample collection date(s) for data addressed by memo
- indicate type of analyses and method reference number and laboratory performing analyses, *ex. samples were analyzed for metals (arsenic, cadmium, selenium) by EPA Method 1638 by Brooks Rand located in Seattle, Washington*
- reference the QAPP or work plan data collected under
- Indicate the method references,
  ex. The analyses were performed in general accordance with methods .specified in Standard Methods for the Examination of Water and Wastewater, 21s` Edition, 2005, etc...
- Indicate the type of reports provided by the laboratory *[ex. summary reports, full data package]*
- Indicate the laboratory work order groups included in the memo
- Provide a table showing field sample ID, Lab ID, requested analyses for each sample, indicate field duplicate/parent sample relationships:

Sample ID	Lab ID	Requested Analyses

- Indicate purpose and layout of memo, references for review criteria and qualification,
  ex. The following comments refer to [call out laboratory] performance in meeting the quality control specifications described in the analytical methods and the QAPP. Data were qualified based on the method and project criteria and guidance provided in the EPA documents USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, June 2008 and USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, January 2010.
- Define data qualifiers that may be assigned

Sample Receipt

Indicate that samples were/were not received with issues in regard to sample labeling, cooler temperatures, holding time, proper relinquish/receipt, etc. Describe any issues and impact to data quality, direction provided to the laboratory, any qualifiers assigned to data.

For each analysis group (organics, metals, inorganic conventionals, microbiology), evaluate based on QA/QC components required by the method and the QAPP

Organic Analyses

Samples were analyzed for [callout organic analyses]. Discuss each item below as needed. If all criteria in a category are acceptable, indicate Acceptable. If issues identified, describe them, sample results affected and qualifier assigned, or if not qualified, indicate not qualified and reason.

1. Holding Times —
2. GC/MS Instrument Performance Checks-
3. Initial and Continuing Calibrations —
4. Blanks — *[include method trip, filter, rinsate, field blanks as provided in data set]*

Location Path in Electronic System

Memorandum Header

5. Surrogates —
6. Internal Standards —
7. Laboratory Control Samples/Laboratory Control Sample Duplicates (LCS/LCSD) —
8. Matrix Spike/Matrix Spike Duplicates (MS/MSD) — *[identify samples used for MS/MSD]*
9. Field Duplicates —
10. Reporting Limits — *[indicate if RLs were achieved if not indicate impact to data use]*
11. Type of Review — *[indicate summary or if complete raw data review conducted]*

Metals Analyses

Samples were analyzed for [callout metals analyses]. Discuss each item below as needed. If all criteria in a category is acceptable, indicate Acceptable. If issues identified, describe them, sample results affected and qualifier assigned, or if not qualified, indicate not qualified and reason.

1. Holding Times —
2. ICP-MS Instrument Performance Checks —
3. Initial and Continuing Calibrations —
4. Blanks — *[include method filter, reinstate, field blanks as provided in data set]*
5. Internal Standards -
6. Laboratory Control Samples (LCS) (LCSD if applicable) -
7. Matrix Spike (MS) (MSD if applicable) — *[identify samples used for MS and MSD]*
8. Laboratory Duplicate — *[identify samples used for lab duplicates]*
9. Field Duplicate —
10. ICP or ICPMS Interference Check Sample —
11. Reporting Limits — *[indicate if RLs were achieved if not indicate impact to data use]*
12. Type of Review — *[indicate summary or if complete raw data review conducted]*

Conventional, Microbiology, Other Analysis

Categorize other data as appropriate and effective for the project; include checks as appropriate for the method. Samples were analyzed for [callout analyses]. Discuss each item below as appropriate for the methods. If all criteria in a category are acceptable, indicate Acceptable. If issues identified, describe them, sample results affected and qualifier assigned, or if not qualified, indicate not qualified and reason.

1. Holding Times-
2. Initial and Continuing Calibrations —
3. Blanks — *[include method filter, rinsate, field blanks as provided in data set]*
4. Standard Reference Materials (SR_M) and/or Laboratory Control Samples (LCS) (LCSD if applicable) —
5. Matrix Spike (MSD if applicable) — *[identify samples used forMS and MSD]*
6. Laboratory Duplicate — *[identify samples used for lab duplicates]*
7. Field Duplicate —
8. Reporting Limits — *[indicate if RLs were achieved if not indicate impact to data use]*
9. Type of Review — *[indicate summary or if complete raw data review conducted]*

Overall Assessment of Data

Provide a statement indicating the completeness percentage of data reported that is covered by memo, indicate if any rejected, and indicate if other data, even if qualified, are or are not usable without limitations for further project assessment.

Add a Table showing qualifiers assigned

Should include lab ID, Field ID, analyte, reported value (result, lab qualifier, units), assigned data review qualifier

PART B – ATTACHMENT 1 - APPENDIX C

FIELD AND DATA CALIBRATION FORMS

FORM 1

MONTHLY SUSITNA RIVER BASELINE WQ MONITORING

MONTHLY Susitna River Baseline WQ Monitoring

PRM: _____ Site Name_____ Date _____MonthDay_____ QA/QC Review
Circle Event Type: Monthly / Monthly + Single Event Initials_____
GPS Coordinates (WGS84) _____N_____W River Width (Ft) _____
Data Sonde No. _____ GPS No. _____ Camera No. _____ Log Book No._____

Field Crew Initials_____

FIELD MEASUREMENTS

Sample Pt #1 – 25% from LB Distance (yards) from LB: _____ Color App. (T)____(B)_____
Sample ID: WQ-SW-B -____PRM__ - L Water Depth (Ft.): _____ Color True (T)____(B)_____

Depth (Ft.) [at sample location]	Location [T=top; B=bottom; D=dupe]	Temp (°C)	DO (mg/L)	pH	Conductivity (µS/cm)	Redox Potential (mV)	Turbidity (NTUs) (T)	Turbidity (NTUs) (B)

Notes:_____
Sample Pt #2 – 50% from LB Distance (yards) from LB:_____ Turbidity (NTUs) (T)_____ Color App. (T)____(B)_____
Sample ID: WQ-SW-B -____PRM__ - M Water Depth (Ft.): _____ Turbidity (NTUs) (B)_____ Color True (T)____(B)_____

Depth (Ft.) [at sample location]	Location [T=top; B=bottom; D=dupe]	Temp (°C)	DO (mg/L)	pH	Conductivity (µS/cm)	Redox Potential (mV)	Turbidity (NTUs) (T)	Turbidity (NTUs) (B)

Notes:_____
Sample Pt #3 – 75% from LB Distance (yards) from LB:_____ Turbidity (NTUs) (T)_____ Color App. (T)____(B)_____
Sample ID: WQ-SW-B -____PRM__ - R Water Depth (Ft.): _____ Turbidity (NTUs) (B)_____ Color True (T)____(B)_____

Depth (Ft.) [at sample location]	Location [T=top; B=bottom; D=dupe]	Temp (°C)	DO (mg/L)	pH	Conductivity (µS/cm)	Redox Potential (mV)	Turbidity (NTUs) (T)	Turbidity (NTUs) (B)

Notes:_____

GRAB SAMPLES

	Sample Pt #1 25% from LB (Left)	Sample Pt #2 50% from LB (Middle)	Sample Pt #3 75% from LB (Right)
***Depth**	**1.5 Ft. from surface**	**1.5 Ft. from surface**	**1.5 Ft. from surface**
****Sample ID**			
Sample Time			
No. Samples Collected			
***Depth**			
****Sample ID**			
Sample Time			
No. Samples Collected			

Blank, DUP, or MS/MSD Collected: _____

Location:_____

Time:_____

NOTES:

* If water depth at sample point is > than 5 ft (1.5 m) then collect a grab sample at 1.5 Ft. below surface and 1.5 Ft. above bottom. If water depth is < than 5ft (1.5 m) just collect a grab sample at 1.5 Ft. below surface.

** Sample ID format: WQSWBPRM-R/M/L-T/B; *PRM = project river mile; R=right, M=middle, L=left (looking downstream); T=top; B=bottom*

EVENT PARAMETERS

Parameter	Monthly	Single-event
Hardness	x	
Nitrate+Nitrite	x	
Ammonia as N	x	
Total Kjeldahl nitrogen (TKN)	x	
Total phosphorus (TP)	x	
Soluble reactive phosphorus (SRP)	x	
Chlorophyll a	x	
Alkalinity	x	
Turbidity	x	
conductivity	x	
Total dissolved solids (TDS)	x	
Total suspended solids (TSS	x	
Total organic carbon (TOC)		x
Dissolved organic carbon (DOC)	x	
Total Metals (As, Ba, Be, Cd, Co, Cu, Fe, Pb, Mn, Mg, Dissolved Hg, Total Hg, Mb, Ni, Tl, V, Zn)	x	
Total Metals (Al, Cr, Se)		x
Dissolved Metals (As, Ba, Be, Cd, Co, Cu, Fe, Pb, Mn, Mg, Dissolved Hg, Total Hg, Mb, Ni, Tl, V, Zn)	x	
Dissolved Metals (Al, Se)		x
Fecal coliform		x
PAHs[1]		x
BETX[2]		x
Radionuclides		x

*** Samples may be split between preserved and unpreserved; contact Field Operations PM for assistance**

**** Preserved by SGS prior to shipping to subcontract laboratory.**

[1] PAHs -= Polynuclear Aromatic Hydrocarbons

[2] BETX = Benzene, ethylbenzene, toluene, xylenes

OBSERVATIONS (site conditions, weather, etc.)

_____

_____

_____

_____

_____

PHOTOGRAPHS

Photo Number	Direction	Notes

FORM 2

SUSITNA RIVER TEMPERATURE MONITORING STATION

Susitna River Temperature Monitoring Station

Date (YYYYMMDD): _____ QA/QC Initials: _____

Site Name/Project River Mile: _____

Arrival Time (HH:MM): _____ **Departure Time (HH:MM):** _____

River Temp (°C) (NIST Thermometer): _____

River Depth: _____

GPS (NNN.NNNNNN WGS84):Lat._____ **Long:** _____

Bank Location Facing Downstream (R/L):_____

Arrangement Type (Yes/No): Buoy String (BS):_____ **Pipe (P):**_____ **Overwinter (OW):**_____

Anchor Point (Tree etc.):_____ **(Photo):** _____

Thermistor Number	Thermistor Depth	Download (Y/N)	Arrangement Type	Equipment Status

WEATHER & SITE OBSERVATIONS

_____

_____

PHOTOGRAPHS (Camera, Photo Nos. and Description)

_____

_____

_____

_____

FORM 3

SUSITNA RIVER FOCUS AREA: SURFACE WATER TRANSECT SAMPLES

Susitna River Focus Area: Surface Water Transect Samples

Focus Area Name_____ **Date**_____ **Sample Time**_____

Sonde No._____ **Camera No.** _____ **GPS No.** _____ **Log Book No.** _____

Sampler Initials: _____ **QA/QC Initials:** _____

DOWNSTREAM TRANSECT

River Width (yards)_____ **Braided Channel Y/N**

Hydrolab measurements collected at grab sample depth (1.5 ft) **Sample Pts numbered from Left Bank

Sample Pt (#1 -#6 from LB)	Water Depth (ft)	Sample Depth (ft)	Temp (°C)	pH	DO (mg/L)	Cond. (µS/cm)	ORP (mV)	Turbidity (NTUs)

DOWNSTREAM TRANSECT – GRAB SAMPLES

Grab samples should be collected at 1.5 ft depth. If total water depth is shallower than 1.5 ft; make note of sample depth.

Sample Pt:	**Sample Pt:**	**Sample Pt:**
Depth (ft):	**Depth (ft):**	**Depth (ft):**
Sample ID: WQSWF_____D_____	**Sample ID: WQSWF_____D_____**	**Sample ID: WQSWF_____D_____**
Sample Time:	**Sample Time:**	**Sample Time:**
No. Samples Collected:	**No. of Samples Collected:**	**No of Samples Collected:**

Sample Pt:	**Sample Pt:**	**Sample Pt:**
Depth (ft):	**Depth (ft):**	**Depth (ft):**
Sample ID: WQSWF_____D_____	**Sample ID: WQSWF_____D_____**	**Sample ID: WQSWF_____D_____**
Sample Time:	**Sample Time:**	**Sample Time:**
No. Samples Collected:	**No. of Samples Collected:**	**No of Samples Collected:**

Blank, DUP, or MS/MSD Collected:_____

Location:_____

Time:_____

WEATHER & SITE OBSERVATIONS, PHOTOGRAPHS

_____

_____

Photo Number	Description

MIDDLE TRANSECT

River Width (yards) _____ Braided Channel Y/N

Hydrolab measurements collected at grab sample depth (1.5 ft) **Sample Pts numbered from Left Bank

Sample Pt (#1 -#6 from LB)	Water Depth (ft)	Sample Depth (ft)	Temp (°C)	pH	DO (mg/L)	Cond. (µS/cm)	ORP (mV)	Turbidity (NTUs)

MIDDLE TRANSECT – GRAB SAMPLES

Grab samples should be collected at 1.5 ft depth. If total water depth is shallower than 1.5 ft; make note of sample depth.

Sample Pt:	**Sample Pt:**	**Sample Pt:**
Depth (ft):	**Depth (ft):**	**Depth (ft):**
Sample ID: WQSWF_____M_____	**Sample ID: WQSWF_____M_____**	**Sample ID: WQSWF_____M_____**
Sample Time:	**Sample Time:**	**Sample Time:**
No. Samples Collected:	**No. of Samples Collected:**	**No of Samples Collected:**

Sample Pt:	**Sample Pt:**	**Sample Pt:**
Depth (ft):	**Depth (ft):**	**Depth (ft):**
Sample ID: WQSWF_____M_____	**Sample ID: WQSWF_____M_____**	**Sample ID: WQSWF_____M_____**
Sample Time:	**Sample Time:**	**Sample Time:**
No. Samples Collected:	**No. of Samples Collected:**	**No of Samples Collected:**

Blank, DUP, or MS/MSD Collected:_____

Location:_____

Time:_____

WEATHER & SITE OBSERVATIONS, PHOTOGRAPHS

_____

_____

_____

Photo Number	Description

UPSTREAM TRANSECT

River Width (yards)_____ Braided Channel Y/N

Hydrolab measurements collected at grab sample depth (1.5 ft) **Sample Pts numbered from Left Bank

Sample Pt (#1 -#6 from LB)	Water Depth (ft)	Sample Depth (ft)	Temp (°C)	pH	DO (mg/L)	Cond. (µS/cm)	ORP (mV)	Turbidity (NTUs)

UPSTREAM TRANSECT – GRAB SAMPLES

Grab samples should be collected at 1.5 ft depth. If total water depth is shallower than 1.5 ft; make note of sample depth.

Sample Pt:	**Sample Pt:**	**Sample Pt:**
Depth (ft):	**Depth (ft):**	**Depth (ft):**
Sample ID: WQSWF_____U_____	**Sample ID: WQSWF_____U_____**	**Sample ID: WQSWF_____U_____**
Sample Time:	**Sample Time:**	**Sample Time:**
No. Samples Collected:	**No. of Samples Collected:**	**No of Samples Collected:**

Sample Pt:	**Sample Pt:**	**Sample Pt:**
Depth (ft):	**Depth (ft):**	**Depth (ft):**
Sample ID: WQSWF_____U_____	**Sample ID: WQSWF_____U_____**	**Sample ID: WQSWF_____U_____**
Sample Time:	**Sample Time:**	**Sample Time:**
No. Samples Collected:	**No. of Samples Collected:**	**No of Samples Collected:**

WEATHER & SITE OBSERVATIONS, PHOTOGRAPHS

_____

_____

_____

Photo Number	Description

FORM 4

SUSITNA RIVER FOCUS AREA: SURFACE WATER PT. SAMPLES & PARAMETER MEASUREMENTS

Susitna River Focus Area: Surface Water Pt. Samples & Parameter Measurements

Site Name_____ **Date**_____ **Sample Time**_____

Sonde No._____ **Camera No.** _____ **GPS No.** _____ **Log Book No.** _____

Sampler Initials: _____ _____**QA/QC Initials:** _____

SW POINT SAMPLES-GRAB SAMPLES

Sample Pt:	
Water Depth (ft):	**Sample Depth (ft):**
Sample ID:	
Sample Time:	
GPS:	
In-stream Habitat:	

In-stream Habitat Types:

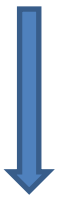
Riffle (RI)

Run (R)

Pool (P)

Glide (GL)

Stream Gradient



Blank, DUP, or MS/MSD Collected: _____

Location: _____

Time: _____

LONGITUDINAL PARAMETER MEASUREMENTS

Point ID	In-stream Habitat Type	Temp (°C)	pH	DO (mg/L)	Cond. (µS/cm)	ORP (mV)	Turbidity (NTUs)
40 U/S							
30 U/S							
20 U/S							
10 U/S							
Pt. Sample							
10 D/S							
20 D/S							
30 D/S							
40 D/S							
50 D/S							
Additional Parameter Measurements for Key Features (i.e. Slough 21 Upland Channel)							

WEATHER & SITE OBSERVATIONS

_____
_____
_____

LONGITUDINAL WATER QUALITY PROFILE OBSERVTIONS (note any channel obstructions or conditions that would be cause for longitudinal differences in WQ)

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

PHOTOGRAPHS

PHOTO ID	DESCRIPTION (Water Quality Influences, Obstruction, Seep, Trib, Confluence)

FA 115 SLOUGH 6A DEPTH PROFILE

Depth (ft)	Temp (°C)	pH	DO (mg/L)	Cond. (µS/cm)	ORP (mV)	Turbidity (NTUs)

FORM 5

PORE WATER SAMPLING RECORD

	PORE WATER SAMPLING RECORD	Date	Field Book #
		Sampler Name(s):	

AEA Susitna-Watana Project Location:	Project No.	Page ___ of ___
Location:	Location Cross-Reference:	Site ID:

Time	Purge Rate (gal/min)	Water Level Depth (ft)	Cumulative Volume Removed (gal)	pH	Cond (µS/cm)	Temp. F or C	Turbidity (NTU)	DO (Mg/L)	Comments

SAMPLE PARAMETERS

Time	Water Depth Below mP (ft)	Cond (µS/cm)	pH	Turbidity (NTU)	Temperature (ºC)	Ferrous Iron	Eh	DO (mg/L)

SAMPLE COLLECTION

Analyte	Container	Quantity	Preservative

Sample ID:			QA/QC Samples:
Sample Date/Time:			
Was a duplicate sample collected?	Yes	No	Sample control number:
Was an ambient blank sample collected?	Yes	No	Sample control number:
Was an equipment blank sample collected?	Yes	No	Sample control number:
Samplers Signature:			Date:

FORM 6

SUSITNA RIVER SEDIMENT AND POREWATER SAMPLING

Susitna River Sediment and Porewater Sampling

Focus Area Name_____ Date_____ Sample Time_____

Sonde No._____ Camera No. _____ GPS No. _____ Log Book No. _____

Sample Initials: _____ QA/QC Initials: _____

Hydrolab measurements collected in water column above sediment sampling location. Take Hydrolab measurements prior to collecting sediment sample

Sample Pt	GPS Coordinates	Water Depth (ft)	Temp (°C)	pH	DO (mg/L)	Cond. (µS/cm)	ORP (mV)	Turbidity (NTUs)
1								
2								
3								

SEDIMENT GRAB SAMPLES

Sample Pt:	**Sample Pt:**	**Sample Pt:**
Sample ID: WQSWS_____	**Sample ID: WQSWS_____**	**Sample ID: WQSWS_____**
Sample Time:	**Sample Time:**	**Sample Time:**
No. Samples Collected:	**No. of Samples Collected:**	**No. of Samples Collected:**
Sampling Device:	**Sampling Device:**	**Sampling Device:**
Sample Type: Grab Composite	**Sample Type: Grab Composite**	**Sample Type: Grab Composite**

POREWATER SAMPLES –(all dissolved)

Sample Pt:	**Sample Pt:**	**Sample Pt:**
Sample ID: WQSWP_____	**Sample ID: WQSWP_____**	**Sample ID: WQSWP_____**
Sample Time:	**Sample Time:**	**Sample Time:**
No. Samples Collected:	**No. of Samples Collected:**	**No. of Samples Collected:**
Sampling Device:	**Sampling Device:**	**Sampling Device:**
Sample Depth (in.):	**Sample Depth (in.):**	**Sample Depth (in.):**

WEATHER & SITE OBSERVATIONS, PHOTOGRAPHS

_____

_____

_____

Photo Number	Description

FORM 7

METALS AND MERCURY FISH TISSUE SAMPLING

AEA SuWa Water Quality Studies

Metals and Mercury Fish Tissue Sampling

Pg ___ of ___

Event & Site information

NOTE: FDA indicates that values used should be those obtained by the FDA team.

Form D4 Side A

Site ID (FDA):	Hab Type Note:	Date:	'Fish Survey Crew:	Fish Survey Consultant:
Site Arrival Time:	'Site Departure Time:	Weather:		
Focus Area (if applic):	'Stream Name (FDA):	Stream Code (FDA):	PRM (if known; FDA):	
DS Coords (FDA; WGS84): N	W	DS Coord Description (FDA):		
GPS Unit:	GPS Date:	GPS Wpt:		
US Coords (FDA; WGS84): N	W	US Coord Description (FDA):		
GPS Unit:	GPS Date:	GPS Wpt:		
Sample Collection Comments:				
Submitted by (name & consultant):	Submitted to (name & consultant):	Submittal Date:	'Submittal Time:	

Sample Collection

Target species are identified on Side A. Target life stage for all species is adult (ADT).

NOTE: Fish recorded on this form should be counted but not measured or weighed on form C or form C-DMT

Species	*Life Stg*	*Capt Meth*	*Proc Loc'n (Field or TLK)*	*Proc Date*	*Proc Time*	*Samp Tech*	*Cons/ Org*	*Leng (mm)*	*Weig (g)*	*Samp Type(s) & ID(s) (e.g., FL, EXAMPLE ID NEEDED; WB, EXAMPLE ID NEEDED; LV, EXAMPLE ID NEEDED)*	*SC Bk/#(s) (e.g., 2/4,5)*	*Sex*	*Camera ID*	*Comments (e.g., genetic sample type & bottle/vial ID, photo IDs)*

Target Species Codes(Length Method)

GRA (FL)	Arctic grayling	WHB (FL)	humpback whitefish	KNS (TL)	Ninespine stickleback	KSB (TL)	stickleback, undifferentiated
GBR (TL)	burbot	CLK (FL)	lake trout	TRB (FL)	rainbow trout	KTS (TL)	threespine stickleback
CDV (FL)	Dolly Varden	NOS (FL)	Longnose sucker	WRN (FI)	round whitefish	WHF (FL)	whitefish, undifferentiated

Sample Type Codes

FL	filet
WB	whole-body
LV	liver

Time Zone_____

QC1 Init Date_____

Data Entry Init Date_____

QC2 Init Date_____

Site Id (FDA)	Date:	Fish Survey Crew:	Fish Survey Consultant:

Sample Collection /Processing continued

Target species are identified on Side A. Target life stage for all species is adult (ADT)

NOTE. Fish recorded on this form should be counted , but not measured or weighed on Form C or Form C-DMT.

Species	*Life Stg*	*Capt Meth*	*Proc Loc'n (Field or TLK)*	*Proc Date*	*Proc Time*	*Samp Tech*	*Cons / Org*	*Leng (mm)*	*Weig (g)*	*Samp Type(s) & iD(5) (e.g., FL, EXAMPLE ID NEEDED; WB, EXAMPLE ID NEEDED; LV, EXAMPLE ID NEEDED)*	*SC Bk/#(s) (e.g., 2/4,5)*	*Sex*	*Camera ID*	*Comments (e.g., genetic sample type & bottle/vial ID, photo IDs)*

Time Zone_____

QC1 Init Date_____

Data Entry Init Date_____

QC2 Init Date_____

FORM 8

AEA WATER QUALITY
DEVELOPMENT, PURGE, & SAMPLE RECORD, FOCUS AREAS

URS	AEA WATER QUALITY DEVELOPMENT, PURGE, & SAMPLE RECORD, FOCUS AREAS	Date	Field Book #
		Sampler Names:	
QA/QC Initials:	Project Location: Susitna River Drainage	Project No. 26221129	
Location / Well ID:		Page __1_ of ___ (rev 05/15/13)	
GPS Coordinates:			

Sample Name (E=AEA; S=Susitna; G=Groundwater; FA=Focus Area and Number; WQ=Water Quality; #=Stainless well No. (#1 upstream well, #2 downstream well). Example: ESGFA144WQ1 (upstream most well)

EQUIPMENT USED Type of pump/equipment: ☐Grundfos ☐Peristaltic ☐QED ☐Air Bladder ☐ Bailer ☐ Other:

METHOD OF DEVELOPMENT/PURGING ☐ Bailing ☐ Pump – Well Volume ☐ Pump – Parameter Stabilization

WATER QUALITY PARAMETERS by (a) Data Sonde MX5; (b) YSI 556 & 2100P Turbidimeter (c) other (describe):
Calibrated? ☐ Yes ☐ No Equipment Decontaminated? ☐ Yes ☐ No Equipment Disposable? ☐ Yes ☐ No

CASING WELL VOLUME INFORMATION (circle)					***PHYSICAL GROUNDWATER OBSERVATIONS***	
Casing ID (inch)	1.38				Color:	Sheen: ☐ Yes ☐ No
Unit Casing Volume **(A)** (gal/ft)	0.077				Odor: ☐ Yes ☐ No Describe:	Residues: ☐ Yes ☐ No
					Notes:(i.e.,- residue type, foam, particulates, organic matter)	

Top of Groundwater (ft btoc – feet below top of casing):

PURGING INFORMATION **Note: If no obvious reference, measure off north side of casing and tick mark pipe.**
Measurement Reference Point: ☐ BTOC (at tick mark) ☐ BGS ☐ Bottom of "V" Notch on casing ☐ Other (describe)

Note: All piezometers are equipped with 1.5' of stainless screen, and schedule 40 stainless riser with a 1.38" inner diameter (ID).

Total Well Depth **(B)**_____feet

Measured Water Level Depth (not product) **[Start] (C)**_____ feet

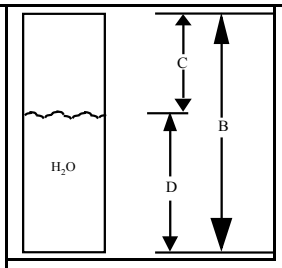
Length of Static Water Column **(D)**_____ - _____ = _____feet
(B) (C) (D)

Casing Water Volume = 0.077 x _____ =_____gallons
(A) (D)

Conversion from Gallons to Liters: # gal x 3.784 = Liters

Five Casing Water Volumes_____ (Liters) (gallons)

Maintain pump rate at less than 1 Liters / min following purging for parameter stabilization. If piezometer goes dry, proceed with sampling after 80% water level recovery is achieved.



Total Water Volume Removed _____ (Liters)

Measured Water Level Depth **[End] (C)**_____ feet

IMPORTANT! VERIFY UNITS AND CIRCLE APPROPRIATE VALUE FOR EACH WELL!

Time	Purge Rate (L/min)	Water Level Depth (feet)	Volume Purged (Liter)	Temp (°C)	pH	Specific Cond. (µS/cm)	DO (mg/L)	ORP (mV)	Turbidity (NTU)	OTHER
Stabilization Method Only: three consecutive readings, taken every three minutes, are within the following limits (shaded):				+/- 10%	+/- 0.2 units	+/- 3%	+/- 10%	+/- 20 mV	+/- 10% or less than 5 NTUs	

Samplers Signature:_____	Date:_____
WELL DEVELOPMENT, PURGE, & SAMPLE RECORD (Continued)	Page _2__ of ___

Location / Well ID: ESGFA_____WQ____

LABORATORY ANALYSES

Primary Samples *Note: No Chl-a for groundwater.*	Methylmercury (filtered)	Nitrate/Nitrite, TKN, TP (unfiltered)
	Total LL Mercury (unfiltered)	SRP (filtered)
	Total LL Metals (unfiltered)	Hardness (filtered)
	Dissolved LL Metals (filtered)	TOC (unfiltered)
	Turbidity (unfiltered)	DOC (filtered)
Blank, Duplicate, or MS/MSD	Location:	Time:
	Sample Name:	Blank, Duplicate, MS/MSD (*circle one*)

SAMPLE COLLECTION

Sample ID:	**Sample Date/Time:**

Observations/Notes:

QA/QC SAMPLES

Trip blank carried with samples?	Yes	No	Sample ID:	
Was a duplicate sample collected?	Yes	No	Sample ID:	
Was a field blank sample collected?	Yes	No	Sample ID:	

Scanned and Input to Database by:		Date:
Samplers Signature:		Date:

FORM 9

MERCURY ASSESSMENT SOIL/VEGETATION SAMPLE FORM

MERCURY ASSESSMENT SOIL/VEGETATION SAMPLE FORM
Susitna River Baseline Studies

Site Name: (LZX)_____ **Date**_____

Site ID: (LZX-X)_____ **Day of Week** _____

Sampler Names/Initials:_____ **FIELD BOOK #**_____

FIELD MESUREMENTS

Location Description and PRM: _____

GPS Coordinates (DD, DMS, NE):_____

GRAB SAMPLES

SOIL USCS_____**ORGANIC MAT THICKNESS (cm)**_____

SAMPLE ID: HgBioS-_____**DUPLICATE ID: HgBioS-**_____**MS/MSD (Y/N)**
(HgBioS-Site ID-PRM)

SAMPLE TIME _____**DUPLICATE TIME**_____

VEGETATION SAMPLE SPECIES_____

SAMPLE ID: HgBioV-_____**DUPLICATE ID: HgBioV-**_____**MS/MSD (Y/N)**

(HgBioV-Site ID-PRM)

SAMPLE TIME _____**DUPLICATE TIME**_____

GRAB SAMPLE PARAMETERS:

SOIL: Total Mercury (1631E), Methyl-mercury (1630M), Total Percent Solids (SM 2540G)
VEGETATION: Total Mercury (1631E), Methyl-mercury (1630M)

WEATHER & SITE OBSERVATIONS:

_____

_____

PHOTOGRAPHS:

_____

_____

PART B – ATTACHMENT 1 - APPENDIX D

FIELD ACTIVITIES STANDARD OPERATING PROCEDURES (SOP)

D-1

STANDARD OPERATING PROCEDURES FOR CONTINUOUS TEMPERATURE MONITORING

Standard Operating Procedures
for
Continuous Temperature Monitoring

1 Purpose

This document describes the general procedures, methods, and considerations to be used for calibrating and deploying the continuous temperature monitoring thermistor systems (TidbiT v2 temperature data loggers by Onset HOBO® thermistor systems).

2 Scope/Application

The procedures contained in this document are to be used by field personnel while calibrating and deploying thermistor systems. Any other procedures or methods used that are not described in this document must be documented in the field log book and subsequent reports, along with a description of the circumstances requiring their use. Mention of trade names or commercial products in this operating procedure does not constitute endorsement or recommendation for use.

3 Calibration

TidbiT v2 temperature data loggers require calibration prior to deployment. The TidbiTs must be connected to a computer using a launch shuttle (See TidbiT v2 Temperature Manual for more information on shuttle connection). HOBOware software is used to launch and calibrate each TidbiT. Calibration of the TidbiTs will be checked in the office for functionality (i.e. did they malfunction while being stored), battery level, and drift using a procedure detailed by the Washington State Department of Ecology. Once calibrated, begin logging by clicking the launch option. A blinking green light on the top of the thermistor indicates that the thermistor is collecting data.
(Note: Logging times can also be pre-programmed for delayed starts)

4 Equipment and Deployment

There are three types of thermistor deployment systems that will be used, which will be determined by site characteristics (e.g., slope of the bank, presence of strong anchoring materials, water level, and locations relative to icing and/or break-up).

- Anchor-buoy systems are best used on banks with little slope where large trees or rocks can be used for anchoring.
- Bank mounted systems are best used where bank slopes are steep and rocks for anchoring pipes are prevalent.
- Overwintering systems will be installed immediately prior to winter freeze.

4.1 General Equipment

For all types of thermistor deployment systems, field personnel will need:

- Safety gloves
- Cable clamps
- Zipties or stainless steel wire
- Galvanized steel cable
- Socket wrench

4.2 Anchor-Buoy System

4.2.1 System Preparation

In addition to the general equipment mentioned above, the anchor-buoy system requires an A-1-sizedbuoy and an anchor consisting of an approximate 57 pound (lb.) section of railroad rail with a hole drilled at one end. Loop the galvanized steel cable through the anchor and attach opposing ends with two cable clamps to create a closed "loop". Cut another piece of galvanized steel cable to affix/hang the thermistors. The length of this cable depends on the depth of the water at the deployment site. The cable should be long enough to achieve a uniformly distributed temperature profile that accounts for periods of elevated river stage. The cable is usually twice the length of the water depth to allow for fluctuations. Depending on depth, one to five thermistors will be wired to cable clamps and attached to the cable in order to obtain continuous temperature data from the top, middle, and bottom of the water column. One end of the cable is attached to the cable loop around the anchor, and the other end of the cable is attached to a buoy. Another cable is attached to the anchor loop. This cable is looped around a tree or other strong stationary bank object using two cable clamps.

4.2.2 Deployment

The anchor-buoy system will then be deployed using three field personnel. Two field personnel will position themselves on the side of the boat closest to the bank. One individual will be responsible for holding the anchor (wearing gloves) on the edge of the boat. The other individual will hold the buoy and ensure that no entanglement (boat or personnel) or tripping hazards exist. The third field worker will be positioned on the bank holding the cable on a reel looped around the tree. The boat operator will then slowly steer into the current until the desired deployment position is achieved while cable is "paid–out" from the bank. On a pre-determined count, the boat crew will drop the anchor and buoy in the water. The cable attached to the bank is then cut and attached to a tree with two cable clamps.

Figure 1 depicts an anchor-buoy thermistor system.

4.2.3 Downloads and Redeployment

Generally, the anchor-buoy system should be inspected once a month to verify system arrangement and perform data retrieval using a downloading shuttle. Instructions for shuttle use can be found in the data linked files TibdiT manual on the SharePoint site. Each thermistor will be downloaded by pulling the thermistor system to shore using the cable attached to the bank. A chainsaw winch may be needed if the thermistor string is too difficult to pull in by hand. Thermistors will be "docked" to the shuttle while remaining attached to the cable. When the blinking amber light on the shuttle is present, the thermistor is being downloaded. When the amber light stops flashing and the green light begins flashing, the download is complete. A red blinking light indicates thermistor malfunction or download error. If two subsequent attempts are unsuccessful, the thermistor should be replaced with a new unit. The thermistor string can then be redeployed using the techniques described in section 4.2.2.

4.3 Bank Mounted System

4.3.1 System Preparation and Deployment

A bank mounted system consists of a length of galvanized steel cable determined by site location water depth, with thermistors attached in the same manner as mentioned above in section 4.2.1. The cable will be placed in a 2 inch galvanized steel pipe with multiple holes along the length of the pipe for river water circulation at anticipated seasonal river stages. The pipe will be mounted on a rock attached to the bank using lag screws or anchor bolts, pipe clamps, and a rock drill. The cable with thermistors attached will be placed in the pipe and a cap will be placed on top of the pipe to protect the thermistors. Figure 2 depicts the bank mounted thermistor system.

4.3.2 Downloads and Redeployment

A pipe wrench will be needed to unscrew the top of the pipe to reach the thermistors. Thermistors will then be attached to the shuttle and downloaded. The thermistor string will be placed back in the pipe and the cap replaced once the download is finished.

4.4 Overwinter System

4.4.1 System Preparation and Downloads

The overwinter system is designed to replace the buoy system and house the thermistors in the water below the ice during the freezing and thawing periods. Thermistor deployment will be similar to the anchor-buoy system, with thermistors attached to the galvanized steel cable; however, a single thermistor will be housed in a PVC pipe 'bomb' and followed closely by net floats so that the system can remain neutrally buoyant, out of the sediment and beneath the ice. This system can be seen in Figure 3. At the beginning of ice break up, the thermistors will be downloaded using the HOBO shuttle device as mentioned above. Two pipe wrenches are required to open the PVC pipe 'bomb'.

4.5 Data Organization

Once back at the field office, shuttle systems will be attached to the computer using the HOBOware software. Temperature data will be uploaded to the computer system and can be converted to excel files for graphing and data organization.

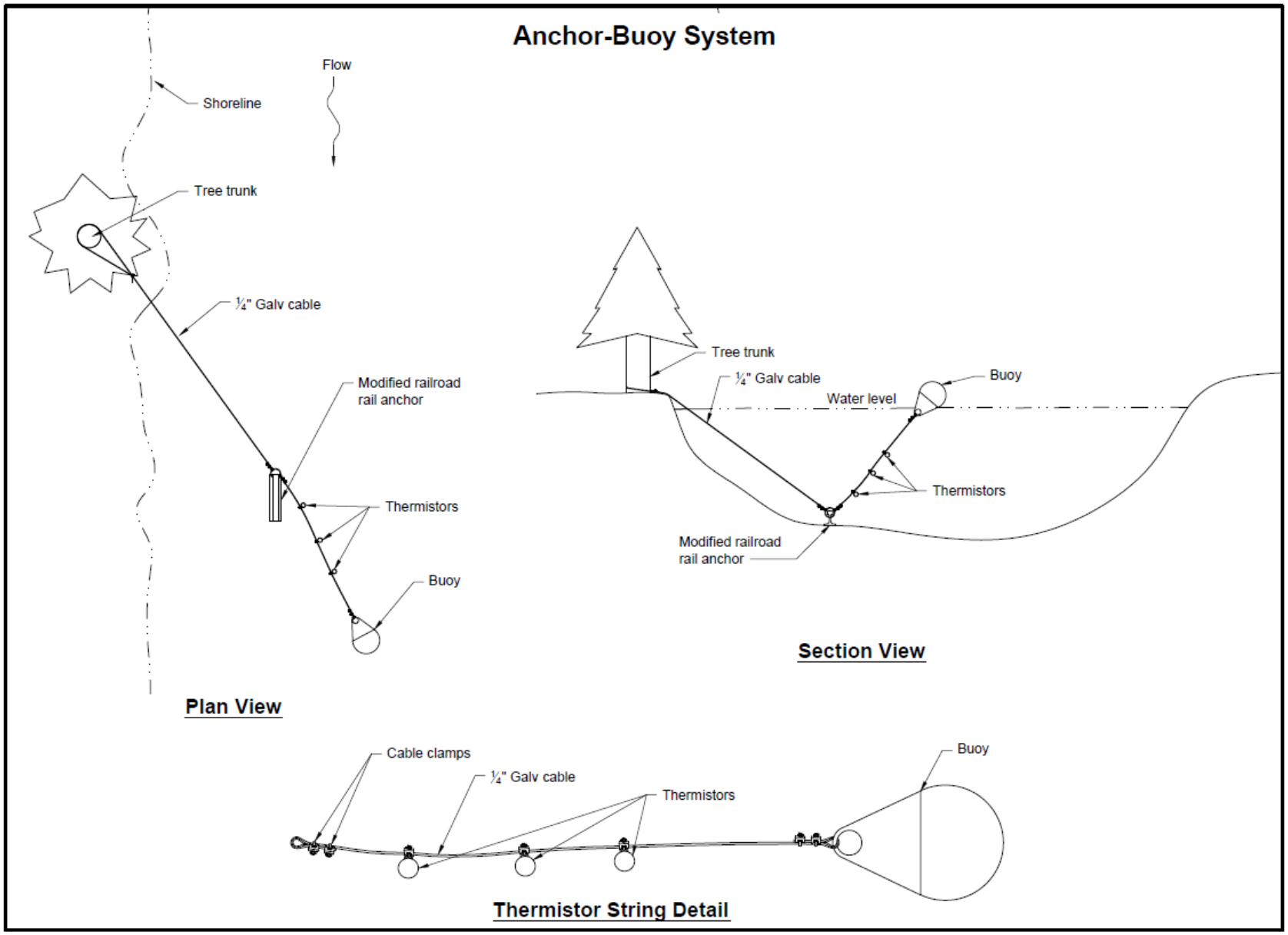


Figure 1. Anchor-Buoy Thermistor System

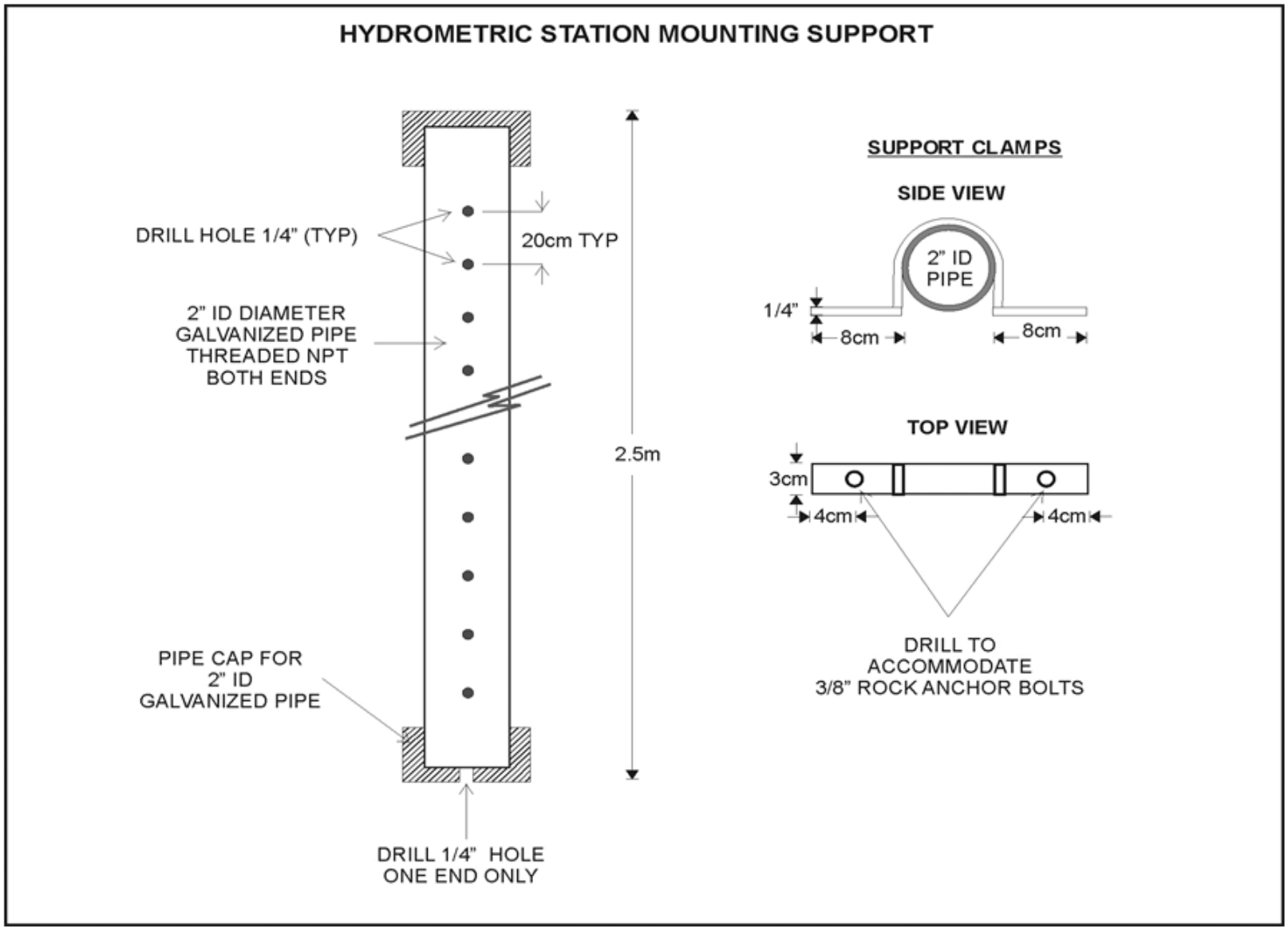


Figure 2. Bank-Mounted Thermistor System

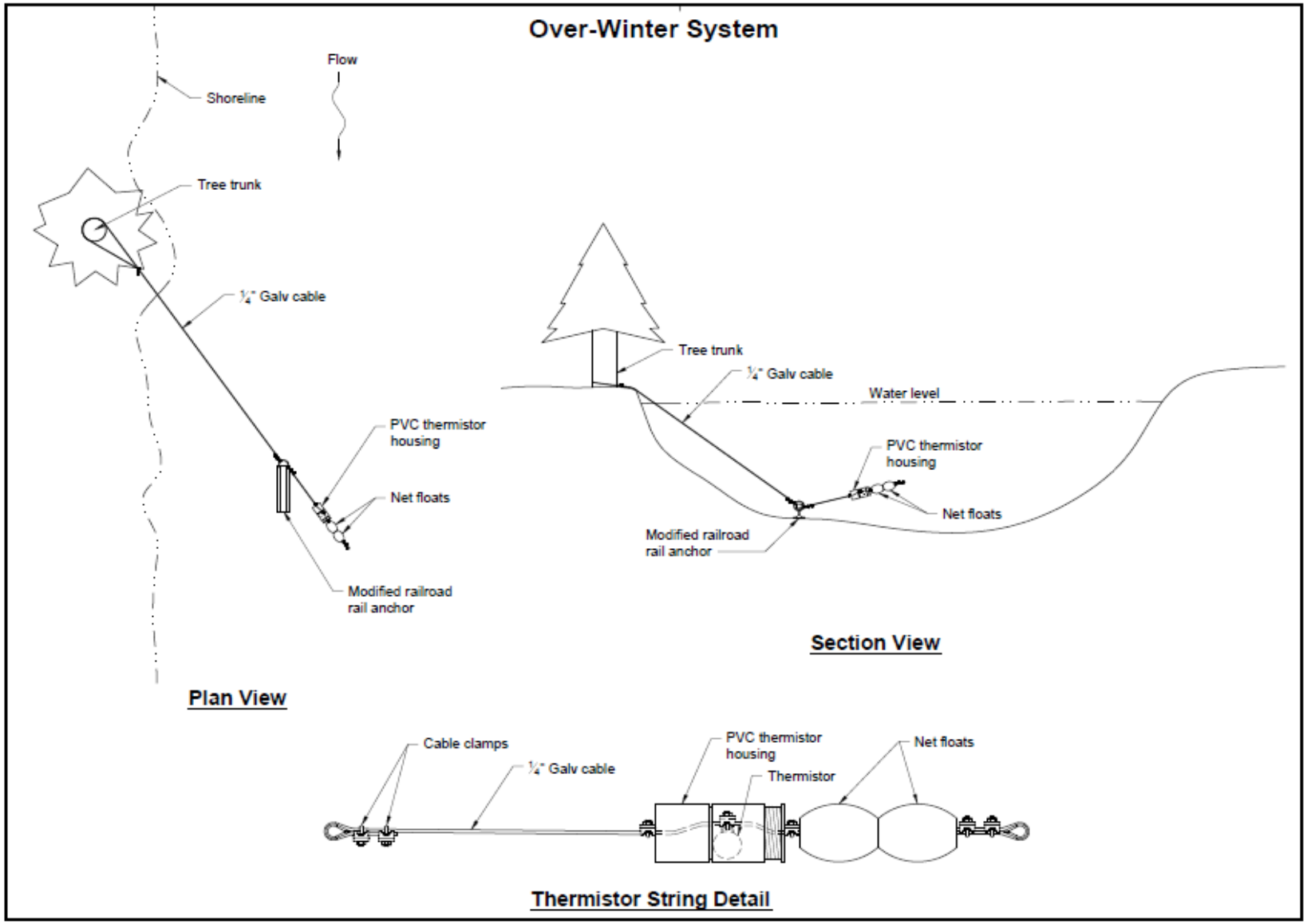


Figure 3. Over-Winter Thermistor System

D-2

TIDBIT RE-INSTALL PROCEDURES & RECOMMENDATIONS FOR 2013

TETRA TECH

MEMO

Cc:	Robert Plotnikoff; Paul Myerchin; Paul Dworian; John Wayman; Harry Gibbons
From:	Travis Miguez
Date:	June 7, 2013
Subject:	2013 Susitna River Temperature Study –TidBiT Re-Install Procedures & Recommendations for 2013 Data Management

To: Mark Vania

This brief memo describes the pre-mobilization maintenance to be perfomed on our TidbiT water temperature recorders.

1.0 PRE-DEPLOYMENT TIDBIT MAINTENANCE

Prior to re-deployment, all TidbiTs to be redeployed in 2013 need to be checked in the office for functionality (ie. did they malfunction while being stored), battery level and drift and then programmed for redeployment in 2013. Functionality and battery level can be checked in the office on a laptop using HOBOware by simply connecting the Tidbit to the shuttle which is connected to the laptop via USB. Drift will be accounted for using a Tidbit calibration procedure recommended by the Washington State Department of Ecology (Section 1.2).

1.1 FUNCTIONALITY AND BATTERY CHECK

Simply, if the TidbiT repeatedly fails to connect to the shuttle, it should be replaced and the S/N swap noted. Once launched, the battery power % will be displayed in HOBOware's launch logger. If the battery is low (2.7 V is the recommended mimimum battery level), the TidbiT should be replaced, designated as 'BAD' and disposed of according to local regulations, replaced in the network, and the S/N swap noted. The battery in the TidbiT v2 is a non-replaceable unit.

The battery life of the logger should be about five years at a logging interval of one minute or greater under operational temperatures between 0° and 25°C (32° and 77°F). In the Susitna River water temperature study, we we are using a 15-minute sampling interval, meaning that most of the TidbiT batteries should still be in the 90% to 100% range if stored above freezing over the winter.

For the purpose of the calibrations, launch a pre-set delayed start for each TidbiT with a **sampling interval of 2 minutes**. The HOBOware software sets the internal TidbiT clock using the laptop's clock. We want to ensure we always use **Alaska Standard Time (AST) as our time standard**. You may have to temporarly set your computer's clock one hour back during this stage. It is critical to always keep the AST standard in all of our studies as this is a requirement from AEA and it eliminates guess work in the case of missing data and/or mid-season re-deployment.

For the calibrations (and field deployments) all TidbiTs need to be logging at the same time at the same sampling interval. The description in the Launch Logger can be entered as 'S/N-Calibration', where S/N is the serial number. The description title is written into the .csv file name and we want to keep the calibration records separate from the deployment records (which are logged at a different time-interval). Temperature (recorded in

the AEA data standard of °C) and battery voltage should be selected as the standard required parameters for all deloyments.

We will also need to launch and calibrate TidbiTs to replace those that were left deployed over the winter, as well as spares in case one or more are lost in the river. The TidbiTs installed over winter should be maintained and re-calibrated once they are brought back from the field.

1.2 CALIBRATIONS

To standardize the TidBiT calibration procedure, we will use the following procedure detailed by the Washington State Department of Ecology:

- Set up a warm bath (approximately 20°C -70°F) and drop all TidbiTs into it. Allow sufficient time for TidbiTs to equilibrate. Use a scientific thermometer (a laboratory grade NIST thermometer) to record the water temperature at each two-minute interval over a thirty minute period. The accuracy of this calibration data may be requested by AEA and stakeholders at some point, hence the accuracy and resolution of the thermometer is important.
- Set up a cold bath (approximately 5°C -40°F) and repeat the procedure.

Following the calibrations, connect the shuttle to each TidbiT and download the calibration data. If the shuttle is connected to the laptop, it will allow for viewing of the calibration data of each TidbiT for QA/QC purposes. Ensure each TidbiT was reading within an acceptable range of the observed water temperatures (within ~0.5-1°C) during both calibration baths and that the difference is seen at both temperatures (ie. if a TidbiT is reading ~0.2°C high during the warm bath, it should also be reading ~0.2°C high during the cold bath). If the range is skewed or the readings are off by more than 1°C, replace the TidbiT and note the swap.

All of the replacement TidbiTs for those that failed calibration QA/QC need to be calibrated and checked as well.

1.3 PRE-SET LAUNCH FOR FIELD DEPLOYMENT

Set up each TidbiT for a delayed start **in AST at 15-minute intervals** (:00, :15, :30 and :45). It shouldn't matter what time the unit is pre-set to start at as long as it starts on one of those quarterly hour increments. All TidbiTs must be logging at the same time interval and at the same time. Make the description something similar to the format: 'S/N–LOCATION-MMM-YYYY" for file labeling. If the TidbiT is redeployed at a later time, the MMM can be changed to make file management easier.

For continuity purposes, **install the same data loggers** (or the replacement) **in the same positions on the cables as the 2012 study** and install at the same location where possible.

2.0 DATA MANAGEMENT

To ensure all data is captured during the 2013 season other than that which is lost due to malfunction or lost equipment, a couple of ideas:

☐attach a thin rope or lanyard through the hole on the USB plug on the shuttle and attach it to something so if it is dropped into the river accidently, the data may still be recoverable. ☐all files should be uploaded from the shuttle each evening after the field visit and accounted for. If a file is missing, it should be re-visited if possible or noted.

If you have any questions regarding these procedures, please contact Mark Vania, Travis Miguez or Robert Plotnikoff.

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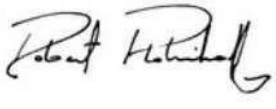


D-3

FIELD ACTIVITIES STANDARD OPERATING PROCEDURES FOR BASELINE WATER QUALITY, FOCUS AREA, AND GROUNDWATER SAMPLING

Field Activities Standard Operating Procedures

for

Baseline Water Quality, Focus Area, and Groundwater Sampling

1 Purpose

The collective goal of the water quality studies is to assess the effect of the proposed Project and its operations on water quality in the Susitna River Basin. The objective of the Field Activities Standard Operating Procedures (SOPs) is to establish sample collection protocols that are compatible with field conditions (boat operations and other); time constraints, and analytical methods forthe Baseline Water Quality, d Focus Area, and groundwater sample collection. The sampling procedures described herein are intended to supplement information provided in the *Quality Assurance Project Plan (QAPP) for Water Quality and Mercury Monitoring Program*.

2 In Situ Parameters and Instrument Calibration

In-situ field parameters will be collected at each predetermined surface water sample location using a Hydrolab® MS5 Data Sonde equipped with on-board sensors capable of measuring temperature, specific conductance, dissolved oxygen (DO), pH, redox potential (ORP), and turbidity. Color will also be characterized using a Hanna® Instruments HI 727 handheld colorimeter.

Prior to the collection of any field parameters, MS5 instrumentation will be calibrated at the start of each workday or as conditions dictate otherwise per the manufacturer's specifications. A copy of the Hydrolab MS5 User's Manual will be available at all times at the field site in Talkeetna, AK. Furthermore, the accuracy of each MS5 will be evaluated by comparison of sensor readings to known calibration standards at the end of each workday. All calibration and post standard comparison results will be recorded on an equipment calibration log (provided in Appendix C of the QAPP).

2.1 Baseline Monthly Sampling

2.1.1 Preparation

All equipment will need to be prepared prior to sampling field or laboratory parameters. The peristaltic pump should be attached to the battery using alligator clips. Other equipment needed includes zip ties, clippers, nitrile gloves, filters, field forms and field books, and sample bottles. All sample bottles should be labeled with date, time, and identification prior to sampling. Sample times should be recorded on the field form.

2.1.2 Sample Location

Prior to sampling each pre-determined location (as identified in the QAPP), the length of each transect (river width) will be measured using a handheld laser range finder to determine the appropriate sample station distances (25%, 50%, 75%) referenced from the left bank (LB). All LB and right bank (RB) determinations will be made facing in the downstream direction of surface water flow. The location of each transect end point will be recorded using a handheld GPS. All coordinates will be recorded in

decimal degrees (NNN.NNNNNN), WGS 84 datum. The depth at each transect sample station will be measured by lowering a USGS sounding reel and boom with a 50 to 75 lb weight until it reaches the river bottom. The depth indicator will be reset to 0 at the water's surface prior to lowering. The depth will be determined from the depth indicator attached to the sounding reel. The water column depth will also be measured by periodically by a portable transducer depth finder (i.e., - Hummingbird Model 407120 or other). For purposes of comparison, depth measurements will be periodically verified using both methods for accuracy, or if an appreciable weighted cable angle from plumb exists due to the downstream current.

2.1.3 In Situ Methods

The depth from which each suite of in-situ parameters are collected will coincide with depth of surface water sample collection. Since the length of MS5 onboard sensors span a distance of approximately 4 inches, the center of the sensor array (4-inches from the lowest extent of the MS5) will be placed at the target depth of surface water sampling for in-situ field parameter collection. This will be achieved by either using zip ties to attach the MS5 to the cable and boom, and then lowering the MS5 to the desired sampling depth, or by using the sample tubing after sample collection and attaching it to a MS5 flow through cell in order to stabilize readings more quickly. Once the MS5 is lowered to the target sample depth, parameters will be monitored for up to three minutes for thermal equilibration and parameter stabilization. When using the Hydrolab flow through cell, stabilization will be achieved when temperature sensor readings at 30 second interval are within 10% of each other. Stabilization of the following parameters must also be monitored:

- pH (+/- 0.3 pH units);
- Specific Conductance (+/- 3%);
- DO (+/- 10);
- ORP (+/- 20 mV)

Following stabilization, field parameters will be recorded on the appropriate field form. Turbulent flow may limit parameter stabilizations which may otherwise continuously change conditions at depth.

A flow through cell may be used for field parameter collection; however, this should only be used in circumstances where other methods are not available or inadequate. When using the flow through cell, the following should be implemented:

- Disassembly, removal, and rinsing of foreign debris from flow through cell water prior to use;
- Complete immersion of all sensors within the flow through cell;
- Flushing of 5 tubing and flow cell volumes (assuming prior decontamination has been performed), to thermally equilibrate the flow through cell;
- Evacuation of all air bubbles from incoming tubing; and
- Sufficient flow rate to minimize temperature variability from ambient conditions and pump

2.1.4 Grab Sample Methods

The sample collection procedures described below are analysis specific, and should be performed in the sequential order listed below. Before sampling, all equipment needed should be setup. The samples will be collected via high density polyethylene (HDPE) and silicon tubing mentioned below. Samples will

first be collected 1.5 ft from the surface and then 1.5 ft from the bottom (if water depth is greater than 4 ft). A list of parameters measured may be found in the QAPP.

2.1.4.1 Collection of Trace Level Analyses

Trace analyses are especially susceptible to cross contamination issues, requiring specific trace sample collection methods. Examples include: methylmercury, total mercury, and dissolved mercury by Method 1631. For these reasons, sample equipment and materials are **NOT** to be reused at any other sample location, and should avoid all contact with metallic surfaces and minimize ambient condition exposure. Specific QA/QC protocols for sampling and equipment are detailed in the QA/QC section of this SOP.

Total mercury (not filtered) and dissolved mercury (0.45 micron filter) will be collected using a peristaltic pump and disposable sample tubing. The filter for dissolved mercury analyses will be verified mercury free. All sample tubing will be stored in sealed containers to prevent ambient exposure, and equipment blanks will be collected to verify cross contamination interferences from sample equipment.

Silicon (flex) tubing for the peristaltic pump head will be individually removed and cut from the sealed container for every new site. All tubing will be discarded if any cross contamination issues or prolonged exposure are suspected. All tubing (silicon and HDPE) will be stored in a dedicated, sealed containers to minimize exposure to ambient conditions.

When preparing a length of HDPE tubing for sample collection, new powder free nitrile gloves will be donned prior to handling the HDPE roll of tubing. A new piece of HDPE tubing will be cut for each site. *Note: a site is considered each new location along the transect.* Suspend the tubing in air when cutting the appropriate length to avoid touching any metallic surfaces. **With the exception of ceramic knives, no cutting utensils will be used at any point in preparing disposable sampling materials for trace analyses. Dedicated ceramic cutting blades must be used to prepare lengths of sample tubing and opening filter containers (bags). Cutting utensils will be stored in a zip seal plastic bag when not in use.** Tubing containers (bags) will be immediately sealed once the appropriate length of tubing has been acquired.

The length of HPDE tubing will be affixed to the steel winch cable using plastic zip ties. The open end of the HDPE tubing will be aligned facing upstream and will be placed into a small PVC elbow fitting attached to the end of the cable and zip tied in place. The silicon tubing will be attached inside of the HDPE tubing and will be fed through the pump for contact with sampling water.

All laboratory containers for trace analyses (total mercury – 250 milliliter (ml) Teflon; dissolved mercury – 250 ml teflon) will be individually packaged and prepared (preserved), and stored in sealed double bags by the laboratory. After attaching the tubing to the davit/cable/winch system, flush the sample tubing (silicon and HDPE) with 3L of water from the sample location prior to attaching the filter. The total mercury bottle should be filled first, without a filter attached, and then a filter should be attached to sample dissolved mercury. After the in-line 0.45 micron filter is attached, flush an additional 1L of water through the filter prior to sample collection.

Under no circumstances should the innermost bag be opened unless a sample is being collected, nor should any foreign material enter the innermost bag (i.e., - labels, ink, debris, etc.). All packaged sampling equipment (tubing and filters) should not be opened until required for sampling.

Specific mercury sampling protocols (following Clean Hands, Dirty Hands Sampling Technique):

1) Upon arrival at the sampling site, one member of the two person sampling team is designated as "dirty hands"; the second member is designated as "clean hands". All operations involving contact with the sample bottle and transfer of the sample from the sample collection device to the sample bottle are handled by the individual designated as "clean hands". "Dirty hands" is responsible for preparation of the sampler (except the sample container itself), operation of the machinery, and for all other activities that do not involve direct contact with the sample.
2) The sample collection area (boat) should be positioned as such to minimize interference/cross contamination with ambient conditions. Contaminant source could include boat exhaust, metallic surfaces, clothing, breath, etc.).
3) Complete a bottle label.
4) Put on powder free nitrile gloves ("clean hands" and "dirty hands").
5) "Dirty hands" - Remove the low level mercury bottle from the cooler during sampling activities. Do not open the zipper-seal bags in which the blank is enclosed and ensure the blank gets returned to the cooler before leaving the site.
6) "Dirty hands" prepares the peristaltic pump and polyethylene tubing placement.
7) "Clean hands" installs the flex tubing in the peristaltic pump head and attaches the other to the HDPE tubing. At no point should the flex tubing (silicon) be allowed to touch any object.
8) Both "clean hands" and "dirty hands" change gloves.
9) "Dirty hands" - When ready to sample, remove a prepared sample bottle package from the cooler, and open the outermost bag.
10) "Clean hands" - Unseal inner zipper-seal bag. Do not remove the bottle from the double bagging, Place the bottle upright under the tubing or spigot that will dispense the water. Uncap the bottle and fill it slowly. To prevent loss of preservative do not overfill the bottle. Fill the bottle to the shoulder and cap it. Empty any excess water from the inner zipper-seal bag.
11) "Dirty hands" operates the pump while "clean hands" fills the sample containers.
12) Dirty hands" operates the pump while "clean hands" fills the sample containers.
13) "Clean hands" closes the inner zipper-seal bag.
14) "Dirty hands" - Affix the bottle label to the outside of the outer bag and seal outer bag.
15) Place the sample bottle in the cooler. Remember to put the TB back into the cooler when leaving the site. All low level Hg bottles and the TB should be in the same cooler. If the number of Hg bottles requires multiple coolers, one TB should be in each cooler.

Above protocol is repeated for dissolved mercury samples with Clean Hands again only touching the inner most bag and sampling bottle. Dirty Hands will attach the in-line filter to the sample tubing after putting on a new pair of nitrile gloves.

2.1.4.2 Collection of Other Analyses

Other Dissolved Metals

Once the trace mercury analyses have been collected, the same sampling apparatus (peristaltic pump and tubing) can be used to collect other dissolved metals analyses (Method 200.8/6020) using the same 0.45 micron filter dedicated to the sample location. Samples not requiring field filtration should be collected

from the pump tubing after the in-line filter has been removed. Sample collection procedures are as follows:

1) Samples will be collected directly from the pump discharge stream (silicon tubing), ensuring that the sampling device does not come in contact with the sample container.
2) Each sample will be placed in a labeled laboratory supplied containers equipped with the appropriate sample preservative (if any).
3) Each sample container will be filled to the container shoulder (or other) to minimize headspace; however, overfilling should be avoided to prevent loss of any sample container preservative. All containers for volatile analyses must not have any headspace.
4) All sample collection forms will be concurrently completed throughout the sample collection process documenting the sample name, method of collection, type of analyses, total number of containers, sampler's initials, and date and time. All samples containers collected from the same location will be marked with a "common" sample time that represents the start of sample collection.
5) All sample containers will be placed directly into a closed cooler chilled with gel-ice immediately following sample collection.
6) All filtered samples will be collected first, followed by unfiltered samples.

Chlorophyll-a

Chlorophyll-a samples will be collected in 1L amber glass containers and placed immediately in a cooler with frozen gel ice to maintain a temperature of 4°C, and minimize light exposure. At the end of each workday, all chlorophyll-a samples will be filtered at the field office to prepare the filter for shipment to the laboratory for analysis. Samples should be filtered within 24-hours. Equipment required to perform the filtration process includes the following:

- Glass fiber filters (GF-B) provided by the laboratory;
- Glass funnel and rack;
- 1L Erlenmeyer flask;
- 1,000 mL graduated cylinder;
- Dual hole rubber stopper with glass and flex hose connections;
- Vacuum pump;
- Aluminum foil and labels;
- Wash bottle; and
- Deionized water.

The procedure to prepare each filter (sample) for laboratory submittal is as follows:

1) Each sample will be filtered through a GF-B filter provided by the laboratory. The filter will be placed in a glass funnel that has been rinsed with de-ionized water to remove any previous sample filtrate.
2) Attach the funnel to one of the dual stopper ports (Erlenmeyer flask) via hose, and connect the other stopper port to the vacuum pump stream.
3) Don nitrile gloves.

4) Shake sample bottle to ensure sample is completely mixed. Transfer the contents of the amber container to the graduated cylinder that has been pre-rinsed with deionized water to track the total volume of water to be passed through the filter.
5) Filter a known amount of sample through the filter using the applied vacuum, while simultaneously recording the volume of water passing through the filter. If filter fouling occurs, discontinue the filtration, and record the total volume of water passed through the filter. Do not replace the filter and resume filtration of the remaining sample.
6) Using a wash bottle containing de-ionized water, minimally rinse the sides of the filter assembly and amber container to recover the remaining material that has not yet passed through the filter.
7) Remove the filter; fold the filter in half; wrap the filter in aluminum foil; label the sample; place the filter in the freezer until shipment. The laboratory has 21 days after filtration to process the samples; however, the samples should be shipped within 16-days to allow laboratory extraction and analysis. The label should be used to enclose the aluminum foil and should document the date and time of collection; filtration date; total water volume passed through the filter; sampler's initials, and requested analysis.
8) Samples can be shipped in weekly batches; however, the shipment should account for transit time, and business work week schedule for laboratory receipt of incoming samples. Samples should maintain a minimum temperature of 4°C throughout shipment. If necessary, dry ice should be supplemented to ensure sample preservation.

2.1.4.3 One Time Sampling Event

A one-time sampling event will be completed in September to analyze for additional parameters. These parameters include: residues (an in-situ observation of river conditions), total organic carbon (TOC), metals (aluminum, chromium, and selenium), radionuclides, fecal coliform, BETX (benzene, ethylbenzene, toluene, and xylenes) and EPA 610 PAHs (polynuclear aromatic hydrocarbons). Samples for these parameters are to be collected following the same procedures as other baseline parameters following the collection of the trace mercury samples (see above). Due to the volume of water needed to fill the sample container for radionuclides, this will be the last sample collected at each sampling location. Specific instructions for fecal coliform and BETX sampling are below.

<u>Fecal Coliform Samples</u>

The analysis for fecal coliform is sensitive to a variety of interferences that are worthy of special considerations, including:

- 8-hour hold time;
- Ensure that all laboratory sample container seals are intact prior to sample collection;
- Do not touch any body part or foreign surface after donning nitrile gloves for sample collection; and
- Do not breathe on or near the sample container when it is open or during the sample collection process.

<u>BETX Samples</u>

It is very important that BETX sample vials are fully filled (without headspace). In order to do this, the cap must be filled with water and placed on top of the water-filled sample vial to ensure that that all air is

out of the sample vial. The vial should be tipped upside down and tapped on the samplers palm to make sure there are no trapped bubbles.

2.2 Focus Area Sampling

Focus Areas will be monitored at sites identified in the QAPP. Focus areas will require three different types of sampling: transect, point, and groundwater sampling. The methods for these are outlined below. Instructions for groundwater sampling are included as a separate SOP within this Appendix. The same QA/QC procedures outlined for the baseline monthly program in 2.2 above, will be applied to focus area sampling as well.

2.2.1 Transect Sampling

Transect sampling for Focus Areas will follow the same procedures outlined in the Baseline Monthly Sampling section above including equipment preparation and sample collection; however Focus Areas will be sampled at a higher frequency during a shorter amount of time. Focus area transects will have 3-6 points along each transect, from LB to RB. Each Focus Area will include three transects, an upstream transect, middle, and downstream transect. Samples will only be collected 1.5 ft from the water surface at each transect point. The same sampling parameters for field and lab will be collected as the baseline samples, however methylmercury will also be collected in the Focus Areas. Methylmercury samples require field filtration and will be collected after the total mercury sample is collected using the "clean-hands", "dirty-hands" method mentioned above. Other parameters not collected in Focus Areas include: numerous metals (see Table 12 in the QAPP), and color. Also, there will be no one-time sampling event that includes other lab parameters (e.g., fecal coliform, BETX, PAHs, etc.). Samples along the transect that are too shallow to sample from a boat will be sampled from the ground using the same procedures as point sample collection.

2.2.2 Point Sampling

Each focus area has two to three point samples that must be collected in addition to transect sampling. The point samples are located in side channels or sloughs. Field crew members will hike to sampling points with sampling equipment, which includes a backpack with built in pump and battery, sample bottles, Hydrolab MS5, tubing that is zip tied to an extendable boat pole, filters, gloves, and field forms. The boat pole with attached tubing will be held in the water at the point sampling location about 1.5 ft below the surface. Sampling parameters are the same as the focus area transect sampling parameters, and will occur in the following order:

1. Mercury and methylmercury samples will be collected using the "clean hands" "dirty hands" method,
2. Samples requiring filtration,
3. All other samples.

Hydrolab field parameters will be collected at the sampling point, and at ten meter increments 40 m upstream of the sampling point, and 50 m downstream of the sampling point. All measurements will be recorded on field forms along with the corresponding habitat (riffle, run, pool, glide) to each field measurement point.

2.2.3 Post Sampling Procedures

Upon return to the field office, samples should be placed in the refrigerator, COCs completed, field forms and notes s scanned to the computer, and equipment (Hydrolab MS5) post calibrated.

2.3 Groundwater Monitoring

Stainless steel piezometers for sampling groundwater will occur at select Focus Areas (see Table 9c in the QAPP). Specific piezometer locations for these purposes will be coordinated with other studies (groundwater and riparian) to accommodate mutual study objectives.

2.3.1 In Situ Methods

The depth to water and calculated casing volume equivalent will be determined prior to purging each piezometer. At a minimum, each piezometer will be purged of five casing volume equivalents prior to sample collection using a peristaltic pump equipped with disposable polyethylene and silicon sample tubing. Field parameters will be monitored and recorded on prepared field forms during the purging process using a calibrated Hydrolab Data Sonde MX5 multiprobe instrument. Groundwater samples will be collected upon parameter stabilization which will be achieved when three consecutive readings taken at three minute intervals are within the following limits:

- Turbidity (10% for values greater than 1 NTU)
- Dissolved Oxygen (10%)
- Specific Conductance (3%)
- Temperature (10%)
- pH (+/- 0.2 pH units)
- ORP/Eh (+/- 20 millivolts)
- Color (na)

2.3.2 Grab Sample Methods

The sample collection procedures described below are analysis specific, and should be performed in the sequential order listed below. Before sampling, all equipment needed should be setup. The samples will be collected via high density polyethylene (HDPE) and silicon tubing mentioned below.

2.3.2.1 Collection of Trace Level Analyses and Other Analyses

Once parameter stabilization has been achieved, and the flow through cell apparatus is disconnected, a new set of tubing will be cut using the same procedures as the Baseline Monthly Sampling described above for parameters listed in Table 12 of the QAPP.

3 Quality Assurance/Quality Control (QA/QC)

Per the QAPP, QC samples collected in the field for laboratory analyses will include trip blanks, field blanks, field replicates, and equipment blanks. The frequency of QC sample collection is as follows:

- Field blanks (MS/MSD) – One set per 20 sites; (typically 1 per 20 samples per ADEC);
- Trip blanks – One per set of coolers per day;
- Field replicates (duplicates) – One set per 20 sites; (typically 1 per 10 samples per ADEC); and
- Equipment blanks – One set per 20 sites/samples (1 per 20 samples per ADEC if warranted)

3.1 Field Blanks (MS/MSD)

Field blank sample containers will be collected (filled) in the field at the selected sample station location. Furthermore, the sample will be collected at the same location from which the media (water) is transferred to the primary sample containers (boat stern or other), and should be representative of ambient conditions at the time of sample collection. Field blank sample containers will be filled with the appropriate laboratory prepared reagent water specific to the analyses requested. The two types of reagent water used for field blank preparation will be the following:

1) For trace metals (total mercury, dissolved mercury, and methylmercury) - laboratory reagent water supplied in a sealable 5-gallon plastic carboy
2) All other analyses - laboratory standard reagent water

3.2 Equipment Blanks for Disposable Equipment

Equipment blank samples will be collected prior to using disposable sampling equipment, and will also be collected in the field to capture additional handling of disposable sampling materials prior to sample collection. The purpose is to evaluate potential contaminant interferences prior to usage. Equipment blank testing will be performed for the following:

- 0.45 micron High Capacity Filters:
    - One filter per 100 count lot will be randomly selected for equipment blank testing prior to lot usage. The equipment blank will be tested for trace and other metals analyses consistent with the surface water (Baseline Water Quality); however, only dissolved mercury will be analyzed (no methylmercury) since this will also be indicative of methylmercury interferences. The filter will be provided to SGS laboratories in Anchorage, AK. Prior to sample collected, the filter will be flushed with 100 mL of laboratory prepared reagent water to simulate field conditions.
- HDPE and Silicon Tubing:
    - One equipment blank will be collected per 1,500 feet of HDPE tubing and 250 feet of silicon tubing. One 15-foot segment of HDPE tubing and one 2.5-foot segment of silicon tubing will be provided to SGS laboratories in Anchorage, AK. The equipment blank will be tested for trace and other metals analyses consistent with the surface water (monthly sampling program); however, only dissolved mercury will be analyzed for (no methylmercury) since this will also be indicative of methylmercury interferences.
    - The segments of tubing will be cut using a ceramic cutting tool, including the exposed (loose) end of tubing (one inch) to expose a fresh surface. Approximately1L of laboratory prepared reagent water will be flushed through the coupled tubing arrangement (silicon and HDPE), prior to collection of the sample. No in-line filter will be included in the sampling arrangement.

Samples will be submitted on a rush turnaround (24 to 72 hours) to evaluate suitability of materials prior to usage. Any analyte detections above those specified in the QAPP will warrant refusal of materials for sample usage, additional decontamination (materials preparation) procedures, selection of alternative materials, or other recommendations by the project chemist.

Similar to the field blanks, the type of laboratory prepared reagent water used to fill each sample container is analyses specific. The time at which the equipment blank sample is collected will also depend on the type of sampling equipment being used. The following protocols will be adhered to when collecting equipment blank:

- Trace Metals Analyses: Reagent water for trace metals analyses will be used to collect equipment blanks for total mercury, dissolved mercury, and methylmercury. Since all trace metal sampling equipment is disposable and laboratory prepared (free of contaminants), the equipment blank sample will be collected prior to sample collection (introduction of any foreign material - river water). Reagent water will be transferred to a laboratory approved container (free of contaminants), from which water will be pumped using the same tubing configuration, peristaltic pump, and sampling protocols described for trace metal analysis sample collection.
- Other Analyses: Standard laboratory reagent water will be used to collect equipment blank samples for all other analyses requiring equipment blanks. At a minimum, the equipment blank will be collected following the standard equipment decontamination protocol of flushing with de-ionized water (centrifugal pump). This will typically coincide with completion of all sample stations along a transect. Samples will be collected using the same equipment used to collect each surface water sample (tubing, pump, etc.).

3.3 Duplicates

All duplicate samples will be marked with the same time as the original sample, and will use the same equipment and tubing and will follow the same procedures as original sample collection.

3.4 Post Sampling Procedures

Upon return to the field office, samples should be placed in the refrigerator, COCs completed, chlorophyll a samples filtered, field forms and notes scanned to the computer, and equipment (e.g., Hydrolab MS5) post calibrated.

D-4

STANDARD OPERATING PROCEDURES FOR FISH COLLECTION AND OTOLITH EXTRACTION FOR METHYLMERCURY ANALYSIS

Standard Operating Procedures
For
Fish Collection and Otolith Extraction for Methylmercury Analysis

1 Fish Collection

1.1 Purpose of Fish Collection

This document provides general procedures, methods, and considerations to be used and observed while collecting fish samples for as part of the methylmercury study task.

1.2 Scope/Application

The procedures contained in this document are to be used by field personnel when collecting fish samples by the AEA fish study team and delivered to the Talkeetna field office. Any other procedure or methods of collection used that are not described in this document must be documented in the field log book and subsequent investigation report, along with circumstances requiring its use. Mention of trade names or commercial products in this operating procedure does not constitute endorsement or recommendation for use.

Target fish species will be collected from the proposed inundation zone are identified in the QAPP.

Methylmercury concentrations in fish vary predominately by species, age, water body size, and location. There is a well-known positive correlation between fish size (length and weight) and mercury concentration in muscle tissue. Larger, older fish tend to have higher mercury concentrations. These fish will be the primary targets for sampling. Body size targeted for collection will represent the adult phase of each species life cycle.

If possible, seven adult individuals from each species will be collected. Collection times for fish samples will occur in late August and early September 2013. Filet samples will be analyzed for methyl and total mercury. Liver samples will also be collected from burbot and analyzed for mercury, methylmercury, arsenic, cadmium, and selenium.

1.3 Equipment

Clean nylon nets and polyethylene gloves will be used during fish tissue collection. Species identification, measurement of total length (mm), and weight (g) will be recorded on the field forms, along with sex and sexual maturity. Fish will be placed in Teflon® sheets and into zipper-closure bags and placed immediately on ice. It is recommended that the fish be kept on a stringer in the water until just before departing the field.

Each fish sample should be labeled with the company collecting the fish, species, collection date, and sample number. The sample number should have the sample location, species, and sample date. For example, the third grayling caught in the mainstem at RM 185.5 on July 24, 2013 would have sample number RM185.5-Gray-72413-3. The information will be written on the outside of the ziplock bag with a sharpie.

It is important to call the URS Talkeetna field office (Mark Vania) at 907-277-8808 and let them know several days in advance that fish are going to be delivered. This will allow the lab and sample team to be prepared for delivery of the fish. The cooler with the fish will be delivered to the URS Talkeetna field office, across the street from the Swiss Alaska Hotel. The person dropping off the cooler should have the field collection forms with them.

URS will check all the data, extract the otolith, and freeze the remaining fish. The whole fish will then be sent to the analytical laboratory under standard COC provisions. There they will clean the fish, extract the samples, and analyze.

2 Otolith Extraction

2.1 Purpose of Otolith Extraction

This document provides general procedures, methods, and considerations to be used and observed while extracting fish otoliths fish for as part of the methylmercury study task.

2.2 Scope/Application

The procedures contained in this document are to be used by field personnel when removing otoliths from fish collected by the AEA fish study team and delivered to the Talkeetna field office. Any other procedure or methods of collection used that are not described in this document must be documented in the field log book and subsequent investigation report, along with circumstances requiring its use. Mention of trade names or commercial products in this operating procedure does not constitute endorsement or recommendation for use.

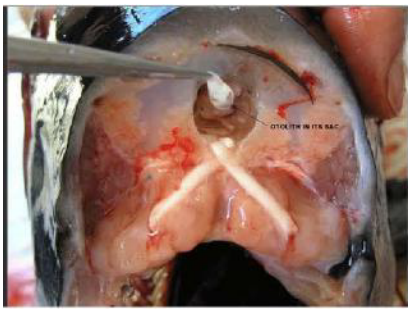
2.3 Equipment

Gather all necessary equipment before sampling:

- A very sharp knife (a heavy butcher knife is preferred over a thick fillet knife)
- Gloves (fillet, cotton, rubber, etc.)
- 96-well trays (with lids, double thick spacers, and rubber bands)
- Labels for samples and trays Orange and yellow beads
- Forceps
- Paper towels
- Wash bottle for water

The "chop" method is the quickest and easiest method of extracting otoliths from whole fish. It is accomplished with a cut down through the top of the head at approximately mid-brain. It is not necessary to cut all the way through, as the front of the head will swing down out of the way.

The cut will expose a cross-section of the brain. If the brain is not solid, but a liquefied "goo," be careful that the otoliths don't flow out of the cavity, hidden in the white soup.



At the bottom of the brain cavity you will probably see either an otolith or a sacculus on both the left and right sides. (In this image, most of the brain has been removed and one otolith is shown.) If your cut is a little forward, you can simply insert the slightly opened tips of your forceps and grasp the sac containing the otolith, or the otolith itself. You will be able to feel the forceps hitting the otolith.

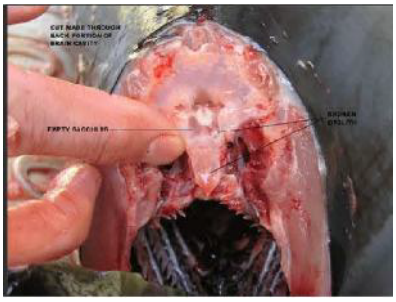


Image courtesy of Alan Murray, SSRAA

If your cut is too far into the brain cavity, you may force an otolith out of its sacculus or even cut/break the otolith in half. Either way, a careful search with forceps will be needed to locate the otoliths.

Remove the left otolith and place it on the back of your hand while you retrieve the right one. Gently tweeze any tissue off the otoliths and wipe away any blood by dragging the otoliths across a textured surface (such as a cotton glove or athletic wrist guard). Handle the otoliths carefully as they break easily.

The "scalp" method is probably the quickest method of removing otoliths from headed fish. Place the head on a cutting board with the snout pointed up and gill plates flared out for stability.

Image courtesy of Alan Murray, SSRAA

Firmly grip the snout and lower jaw with one hand and cut down across the top of the head, a little above the eyes, all the way to the cutting board. The result is a cut that slices off the top of the head, approximately through the mid to upper half of the brain.

Rotate the head onto its upright position (lower jaw down) and with closed forceps, gently probe under the rear, lower half of the brain. Roll this part of the brain up and out of the cavity toward the snout. Be careful not to dislodge the otoliths. Looking down into the brain cavity, the two otoliths should be visible. You can also grasp the otoliths without removing the brain; a quick method once you learn where to search for them.

If the otoliths are not visible, check to see if they came out with the brain. Also check to see if your cut may have been too deep, pulling the otoliths out with the knife. If the brain is not solid you will have to search through the "soup" with the forceps. Remember, be patient! Practice and experience will quickly teach you how to make the proper cut and how to find the otoliths.

Once you've located the otoliths, place them into a labeled plastic bag for shipment to the lab for cleaning and processing.

D-5

STANDARD OPERATING PROCEDURES FOR FUR SAMPLING METHODS

Standard Operating Procedures
for
Fur Sampling Methods

1 Purpose

This document describes the general procedures, methods, and considerations to be used and observed while collecting fur samples for as part of the methylmercury study task.

2 Scope/Application

The procedures contained in this document are to be used by ABR (or other) field personnel when collecting fur samples. Any other procedures or methods of collection used that are not described in this document must be documented in the field log book and subsequent investigation report, along with a description of the circumstances requiring their use. Mention of trade names or commercial products in this operating procedure does not constitute endorsement or recommendation for use.

River otter and mink, both of which occur in the study area in low numbers, can accumulate the highest concentrations of mercury in their body tissues. Predicting how methylmercury in the aquatic food chain will affect mammal populations is difficult. The concentration of methylmercury in mammal tissue depends on diet, range, and longevity of the animal.

Fur samples from river otters and mink can be collected using one of two methods:

- Nonlethal hair snags placed along trails used by these animals.
- Lethal trapping to collect animals.

Preferably, samples from at least 7 adult individuals from each species will be collected. Samples will be analyzed for total mercury. Sampling will focus on the proposed reservoir inundation zone. However, given the low population of these animals in this area, it is likely that the sampling area will need to be broadened to procure sufficient samples. Tributaries of the Susitna River near the proposed dam site, including Fog, Deadman, Watana, Tsusena, Kosina, Jay, and Goose creeks, and the Oshetna River, are likely areas for expanded sampling.

3 Equipment

Hair snags will be placed along trails or other activity areas (latrine sites, dens) used by river otters and mink, as revealed by winter tracking during aerial surveys.

The type of hair snag used will depend on the species being sampled. Collection of river otter hair will be attempted using modified cable snares (DePue and Ben-David 2007) and collection of mink hair will be attempted using tube traps (Pauli et al. 2008). Hair-snag stations will be set on travel routes and trails

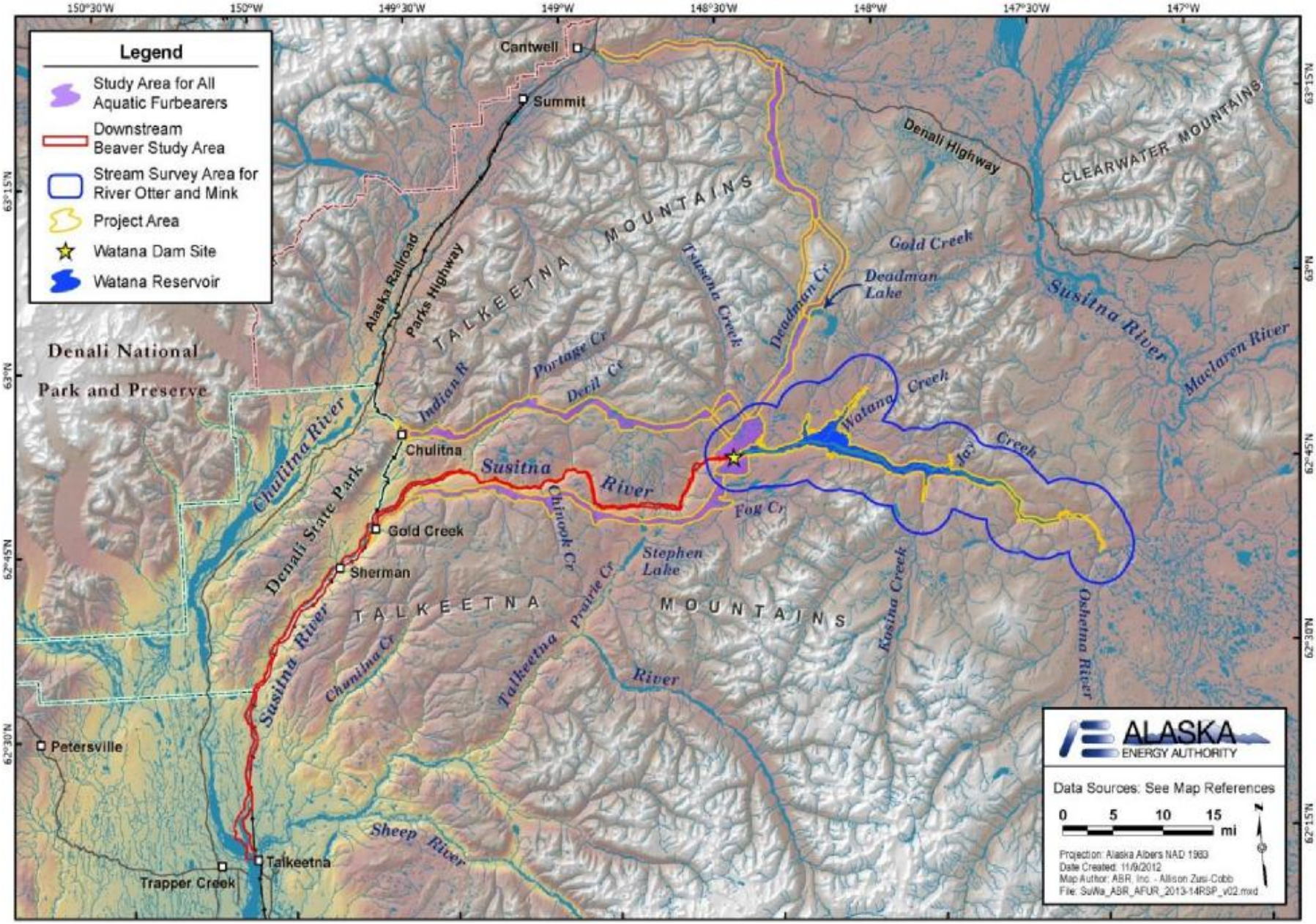
identified during aerial surveys in winter. If possible, hair specimens will be collected from at least two locations to minimize the possible effect of spatial variation in hair mercury content.

If hair snagging fails to produce useable samples, then lethal trapping will be employed. Because the level of historical trapping activity in the study area is quite low, a trapper probably would need to be hired to specifically target river otters and mink in the study area (Figure D8-1). For example, the annual harvests of river otters over 8 years (2003–2010, from ADF&G records) were low (Prichard et al. 2013; see Figure D8-2 below for analytical zones):

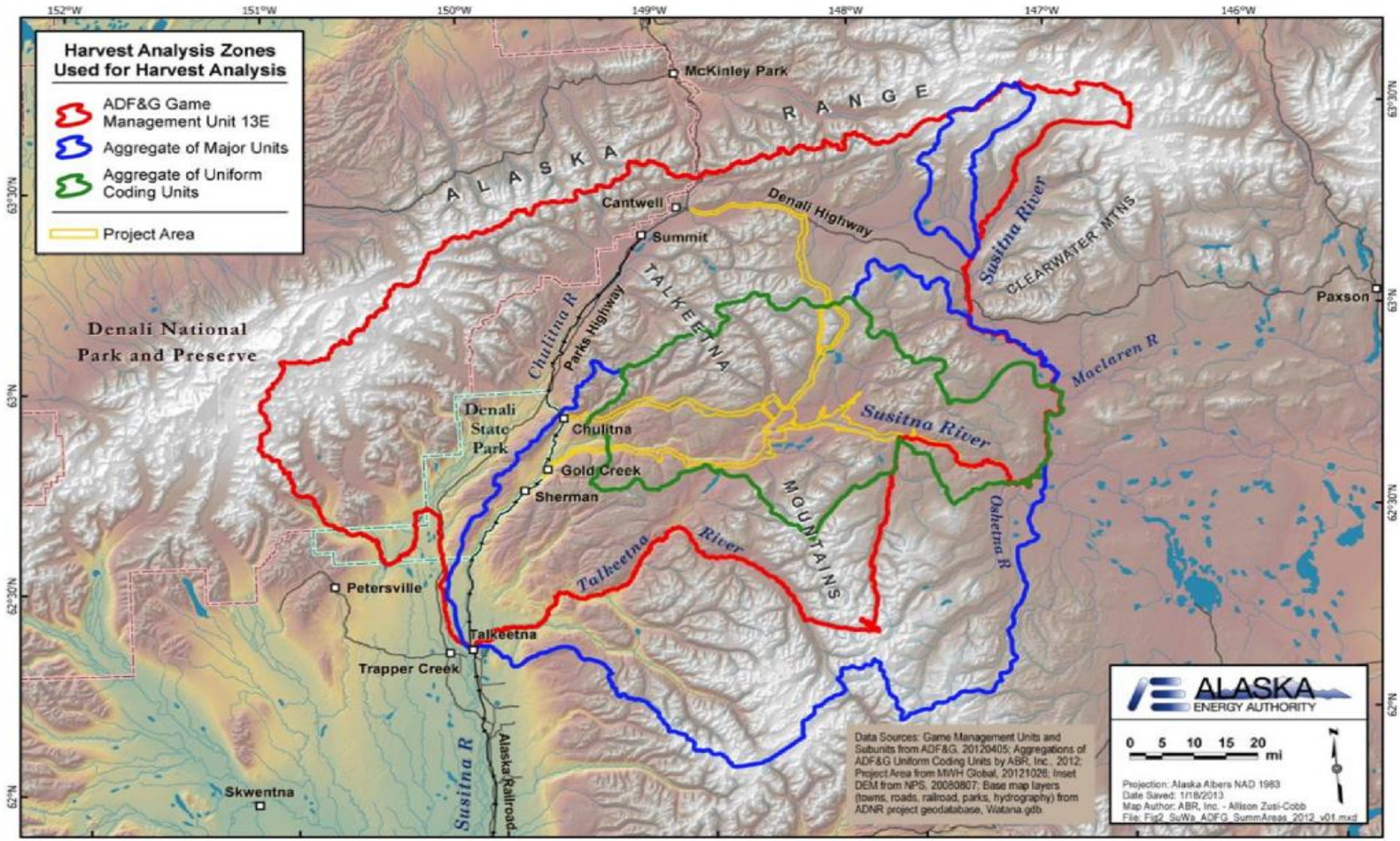
- 1–19 (mean 7.0) in Game Management Unit 13E (18,965 km^2)
- 0–9 (mean 4.3) in aggregated major units (14,643 km^2)
- 0–1 (mean 0.1) in 13 aggregated UCUs (4,477 km^2), encompassing most of the Project area

Tracks or sightings of small numbers of river otters and a single mink were recorded during winter track surveys for terrestrial furbearers in winter 2013, and other sightings were recorded incidentally during surveys for raptors and waterbirds in spring and summer 2013.

Study area for aquatic furbearers (RSP Section 10.11)



Geographical zones used for wildlife harvest analysis (Prichard et al. 2013)



Trapping methods that may be employed are not specified here; any legal and humane method may be used. The entire carcass will be purchased at or above fair market value and the skin collected will not be preserved or tanned. If samples cannot be obtained in the stream survey area for river otters and mink, then the study may be expanded to encompass a wider area.

Up to 10 grams of hair can be used, however, the analyses can be performed on fur samples as small as 15 milligrams. Polyethylene gloves will be used during fur collection. Species identity and sample weight (g or mg) will be recorded on the field forms. Hair samples will be placed in Teflon® sheets and into plastic zipper-closure (ziplock) bags.

Each hair sample will be labeled with the name of the collector and company affiliation, species, collection date, sample number, and specific location (GPS coordinates). The sample number will incorporate will the sample location, species, and date. For example, the second otter collected along the river at the Oshetna River on July 24, 2013 would have sample number Oshetna-otter-72313-2. The information will be written on the outside of the ziplock bag with a sharpie. A portion of each sample will be reserved for DNA analysis at the University of Alaska Fairbanks to confirm species identity.

The collecting team will call the URS Talkeetna field office (Mark Vania, 907-277-8808) to notify them several days in advance that hair samples are going to be delivered. This will allow the lab and sample team to be prepared.

URS will check all the data and will ship the samples to the analytical laboratory (Brooks Rand in Seattle) under standard COC provisions. The lab will clean the hair, prepare the samples, and analyze them.

4 Literature Cited

DePue, J. E., and M. Ben-David. 2007. Hair sampling techniques for river otters. *Journal of Wildlife Management* 71: 671–674.

Pauli, J. N., M. B. Hamilton, E. B. Crain, and S. W. Buskirk. 2008. A single-sampling hair trap for mesocarnivores. *Journal of Wildlife Management* 72: 1650–1652.

Prichard, A. K., N. A. Schwab, and B. E. Lawhead. 2013. Past and current big game and furbearer harvest analysis. Susitna–Watana Hydroelectric Project (FERC No. 14241), 2012 Technical Memorandum, prepared for Alaska Energy Authority, Anchorage, by ABR, Inc.—Environmental Research & Services, Fairbanks. 51 pp.

D-6

STANDARD OPERATING PROCEDURES FOR FEATHER SAMPLING METHODS

Standard Operating Procedures
for
Feather Sampling Methods

1 Purpose

This document describes the general procedures, methods, and considerations to be used and observed while collecting feather samples for as part of the methylmercury study task.

2 Scope/Application

The procedures described in this document are to be used by field personnel when collecting feather samples. Any other procedure or methods of collection used that are not described in this document must be documented in the field log book and subsequent investigation report, along with circumstances requiring their use. Mention of trade names or commercial products in this operating procedure does not constitute endorsement or recommendation for use.

Waterbirds such as loons, grebes, arctic terns and belted kingfishers consume varying amounts of small fish. Those fish may contain methylmercury, which may accumulate in piscivorous animals. Previous studies have shown that mercury levels in waterbirds are highly variable. This variability results from the propensity of waterbirds to migrate among drainages and from the variability of mercury concentrations between drainages and food sources.

Because of their dietary preferences, the common and Pacific loons, arctic tern, and belted kingfisher are likely to be more conservative indicator species than red-necked and horned grebes and other aquatic bird species that could be exposed to mercury.

For raptors, ospreys typically consume a diet exclusively of fish, whereas bald eagles feed on fish, birds and other animals including carrion. These birds have a long life span (15 to 30 years in the wild), so they are likely to have the opportunity to accumulate significant amounts of mercury throughout their lifespans. Predicting site-specific mercury exposure in raptors from residues in feathers or other tissues is difficult because they tend to feed over broad ranges seasonally (bald eagles and ospreys are migratory) and because bald eagles tend to favor salmon, when available. Mercury concentrations in salmon are generally lower than in other species of fish, but are typically only available seasonally in freshwater environments. This means that mercury concentrations in raptors may vary seasonally as well.

Molted feathers will be collected from nests of raptors (principally bald eagles, given that ospreys are rare in the study area), loons, grebes, arctic terns, and belted kingfishers found during wildlife surveys in 2013 and 2014. Feathers from raptors and waterbirds will only be collected after the nests have been vacated for the season. In 2014, kingfisher feathers may be collected from nesting burrows during the planned survey of colonially nesting swallows. When possible, wing (preferably secondaries) and tail feathers will be collected.

Samples will be analyzed for total mercury. Samples will be collected in the proposed reservoir inundation zone; in practice, however, it probably will be necessary to collect some feathers from other locations nearby.

3 Equipment

Feather samples will be collected from nests after the nesting season ends, or if nests are abandoned or fail prematurely. As much as 10 grams of feather may be collected, although the analyses can be performed on feather samples as small as 15 milligrams. Polyethylene gloves will be used during feather collection.

Species identity, nest location (GPS coordinates and nest number, if applicable), and sample weight (in grams) will be recorded on the field forms. Feather samples will be placed first in Teflon® sheets and then into plastic zipper-closure (Ziploc) bags.

Each feather sample will be labeled with the collector's name and company affiliation, species, location, collection date, and sample number. The sample number will include the sample location, species, and sample date. For example, the second eagle feather collected along the river at RM 185.5 on July 24, 2013 would have sample number RM185.5-eagle-72413-2. If the samples are collected some distance from the river, then can be identified using GPS coordinates or nest numbers. The information will be written on the outside of the ziplock bag with a sharpie.

It is important to call the URS Talkeetna field office (Mark Vania) at 907-277-8808 and let them know several days in advance that feathers are going to be delivered. This will allow the lab and sample team to be prepared. The samples will be shipped directly to Brooks Rand Labs (Lydia Greaves) at 3958 6th Ave NW, Seattle WA 98107, USA. The lab can be contacted at 206-753-6127 or lydia@brooksrand.com. The samples will be shipped under standard COC provisions outlined elsewhere in this QAPP.

The lab will clean the feathers, prepare the sample, and analyze them.

PART B – ATTACHMENT 1 - APPENDIX E

EXAMPLE CHAIN OF CUSTODY (COC)

E-1

SGS NORTH AMERICA INC. COC FORM

SGS North America Inc.
CHAIN OF CUSTODY RECORD

Locations Nationwide

Alaska	Maryland
New Jersey	New York
North Carolina	Indiana
West Virgina	Kentucky

www.us.sgs.com

Instructions: Sections 1 - 5 must be filled out.
Omissions may delay the onset of analysis.

Page ____ of ____

Section 1

CLIENT:	**URS**		
CONTACT:	**Mark Vania**	**PHONE NO:**	**Office: 433-6708** **Field#: 733-1053**
PROJECT NAME:	**AEA Susitna Monthly Waters**	**PROJECT/ PWSID/ PERMIT#:**	
REPORTS TO:	**Mark Vania**	**E-MAIL:**	mark.vania@urs.com
INVOICE TO:	**Mark Vania**	**QUOTE #:** / **P.O. #:**	10579 / 26221129.02000

Section 2

RESERVED for lab use	SAMPLE IDENTIFICATION	DATE mm/dd/yy	TIME HH:MM	MATRIX/ MATRIX CODE	# CONTAINERS	Type C = COMP G = GRAB MI = Multi Incre-mental Soils	Section 3 Preservative: HCl	HNO3	HNO3	HCl	none	none	none	H2SO4	HCl	FREEZE	REMARKS/ LOC ID
							Low Level Hg (1631)	Low Level Metals (200.8-LL)	Diss LL Metals w/ Hardness (200.8-LL)	Diss LL Hg (1631)	Turbidity (2130B) Alkalinity (2320B) TDS (SM2540C) pH (SM4500H-B) Conductivity (SM2510B)	TSS	Soluble Reactive Phosphorus (SM4500P-E)	NO2+NO3 (SM4500NO3-F) Ammonia (SM4500NH3-G) TKN (SM4500N-D) Total Phos (SM4500P-B,E)	DOC (SM5310B)	Chlorophyl a (SM10200H)	

Section 5

Relinquished By: (1)	**Date**	**Time**	**Received By:**
Relinquished By: (2)	**Date**	**Time**	**Received By:**
Relinquished By: (3)	**Date**	**Time**	**Received By:**
Relinquished By: (4)	**Date**	**Time**	**Received For Laboratory By:**

Section 4

DOD Project? Yes No

Cooler ID: _____

Data Deliverable Requirements:

Requested Turnaround Time and/or Special Instructions:

Temp Blank °C: _____

or Ambient [ ]

(See attached Sample Receipt Form)

Chain of Custody Seal: (Circle)

INTACT BROKEN ABSENT

(See attached Sample Receipt Form)

[ ] **200 W. Potter Drive Anchorage, AK 99518 Tel: (907) 562-2343 Fax: (907) 561-5301**
[ ] **5500 Business Drive Wilmington, NC 28405 Tel: (910) 350-1903 Fax: (910) 350-1557**

E-2

AQUATIC RESEARCH INCORPORATED COC FORM

Aquatic Research Incorporated

3927 Aurora Ave. N / Seattle, WA 98103 / (206) 632-2715

CHAIN-OF-CUSTODY RECORD

SHEET _____ OF _____

CLIENT: _____

PROJECT ID: _____

SAMPLING DATE: _____

CASE FILE NO.: _____

SAMPLERS: _____

DATA RECORDED BY: _____

SAMPLE INFORMATION

PARAMETERS

SAMPLE ID	DATE/TIME COLLECTED																				BOTT #	NOTES

	Relinquished By	Date/Time	Received By	Date/Time
Printed Name				
Signature				
Affiliation				

	Relinquished By	Date/Time	Received By	Date/Time
Printed Name				
Signature				
Affiliation				

Miscellaneous Notes (Hazardous Materials, Quick turn-around time, etc.): _____

IEH - Aquatic Research

3927 Aurora Ave. N / Seattle, WA 98103 / (206) 632-2715

CHAIN-OF-CUSTODY RECORD

SHEET _____ OF _____

CLIENT: _____ PROJECT ID: _____

SAMPLING DATE: _____ CASE FILE NO.: _____

SAMPLERS: _____ DATA RECORDED BY: _____

SAMPLE INFORMATION

PARAMETERS

SAMPLE ID	DATE/TIME COLLECTED	USP Heavy Metals																				BOTT #	NOTES

	Relinquished By	Date/Time	Received By	Date/Time
Printed Name				
Signature				
Affiliation				

	Relinquished By	Date/Time	Received By	Date/Time
Printed Name				
Signature				
Affiliation				

Miscellaneous Notes (Hazardous Materials, Quick turn-around time, etc.): _____

E-3

BROOKS RAND LABS COC FORM

BROOKS RAND LABS
MEANINGFUL METALS DATA

3958 6th Avenue NW
Seattle, WA 98107
Phone: 206-632-6206
Fax: 206-632-6017

samples@brooksrand.com
www.brooksrand.com

Chain of Custody Record

Page_____of_____

White: LAB COPY
Yellow: CUSTOMER COPY

Client:	Address:	COC receipt confirmation? Y / N If so, by: email / fax (circle one)
Contact:		
Client project ID:		Email:
PO #:	Phone #:	Fax #:

Requested TAT in business days:
- ☐ 20 (standard)
- ☐ 15
- ☐ 10
- ☐ 5
- ☐ Other ____

Surcharges apply for expedited turn around times.

	Sample ID	Collection		Miscellaneous				Field Preservation			Analyses required								Comments
		Date	Time	Sampler (initials)	Matrix type	# of containers	Field filtered? (Y/N)	Unpreserved / ice only	HCl / HNO_3 (circle one)	Other (specify)	Total Hg, EPA 1631	Methyl Hg, EPA 1630	ICP-MS Metals (specify)	As / Se species (specify)	% Solids	Filtration	Other (specify)	Other (specify)	
1																			
2																			
3																			
4																			
5																			
6																			
7																			
8																			
9																			
10																			

Relinquished by:	Date:	Time:	Relinquished by:	Date:	Time:
Received by:	Date:	Time:	Received at BRL by:	Date:	Time:
Shipping carrier:	# of coolers:		BRL work order ID:	BRL project ID:	

PART B – ATTACHMENT 1 - APPENDIX F

FIELD DATA COLLECTION, PROCESSING, AND DELIVERY STANDARDS

(NOTE: Current data delivery standards may be revised periodically and based on Project needs. Several common fields will remain among revised versions of the data standards template so that earlier monitoring results using initial versions can be linked with more current monitoring results using a later version of the Data Delivery Standards.)

(significant changes since last version are in green)

AEA Susitna Project – Water Resources Programs

Field Data Collection, Processing, and Delivery Standards

version Oct 9, 2013 DRAFT

For questions and comments concerning this document,
contact the Susitna Project Data Resource Manager:
Dana Stewart, DES.IT,LLC
(datadana3@yahoo.com)

(significant changes since last version are in green)

AEA Susitna Project – Water Resources Programs
Field Data Collection, Processing, and Delivery Standards

Contents

Acronyms in This Document

ADNR	Alaska Dept. of Natural Resources
AEA	Alaska Energy Authority
MS	Microsoft
QC	Quality control
UAF GINA	Univ. of Alaska, Fairbanks – Geographic Information Network of Alaska

(significant changes since last version are in green)

A. Data Collection, Backup, and Delivery

In general, the process for preparing and submitting field data includes the following steps:

1. Create field forms and mobile device entry screens. Review with Dana Stewart and Judy Simon at least 2 weeks before field trip.
2. Project data resource manager creates data templates and dictionary from the field forms and delivers them to the consultant's data coordinator. The templates define the format for final data submittals by consultants to AEA for the project database. (Applies only to water quality and fish.)
3. In the field, record data on field forms or in mobile devices and do QC1. Data might also be entered to electronic format, which is QC2.
4. Backup field forms, field books, and mobile devices (ArcPad, Trimble, cameras, GPS, thermistors, etc.) nightly.
5. Submit these raw deliverables to AEA at least monthly, via AEA SharePoint. AEA considers these to be interim deliverables. Very large files can be submitted to AEA IT on external drives or DVDs.
6. Enter data to electronic format (QC2) and process the raw data as needed for the study: assign site IDs if not done in the field, flag unusable records, perform data reduction, etc.
7. A final review is done by a senior scientist (QC3).
8. Format data for submittal to the AEA project database, using data templates if provided.
9. Submit final QC3 data files to AEA SharePoint or via hard drive, as done for raw data. (Refer to the GIS User Guide for delivery of GIS data.)
10. For data being delivered for storage in the project database, data must be accompanied by a data dictionary.
11. For database submittals only, the project data resource manager will perform QC4 review and coordinate revisions with the consultant's Data Coordinator.
12. Data and dictionary are incorporated into the Susitna project relational database. No more revisions can be made in the data by consultants, as the data is considered Final for the study year.
13. If data revisions are needed later, such as for QC5, they'll be coordinated by the project data resource manager. The appropriate QC columns will be updated, which will serve as adequate documentation.

QC Protocol – Briefly

- There will be 5 levels of data QC, named QC1 to QC5, each of which is tracked either within tabular datasets (as for Excel and database tables), or within file path names (as for raw field data files). This allows for quick determination of the QC status of all data.
- Details for the QC Protocol are found in Appendix A: Data QC Protocol.
- The QC levels, briefly, are as follows:

QC1 – Field Review: Review of field forms before leaving the field, or the QC level of raw data collected via field equipment such as thermistors, cameras, GPS units, etc.

QC2 – Data Entry: Data from paper or electronic field forms are entered into an electronic format, reviewed, and verified.

QC3 – Senior Review: Final review by senior professional scientist before submitting field data to AEA, or the QC level of raw data cleaned up for delivery to AEA.

QC4 – Database Validation: Tabular data files are verified to meet project database standards.

QC5 – Technical Review: Data revision or qualification by senior professionals when analyzing data for reports.

File Paths / Names

- All delivered files should be named to clearly identify the source and type of data within. If helpful, these file names may include folder names to group files together by field event and data type, such as for photo collections.
- The maximum filename length is 250 characters, including folder names and the file extension.
- All delivered files must be accompanied by a **Letter of Transmittal** which will include the information below, expanding on codes / shorthand as needed to clearly identify the deliverable. The template for the Letter of Transmittal is provided in the Appendices.
- Include the following information within file path / names, in the order below:

Descriptor	Format / Example
project name	SuWa
submitting comp./agency	HDR, LGL, ADFG, R2, etc.
program name	FA-IFS, FAQ
study subject	ChanMorph, AqHabitat, FishRadioTelem, ButterflyCollection, etc.
beginning study date	YYYYMMDD
study area/location	MidRiver , DevilCanyon, RM180.4
deliverable type	Photo, FieldBk, FieldFrm, HoboDump, GPSDump, etc.
field form name	(if applicable) Title of the field form included
QC level	QC1, QC2, or QC3
equipment name	(if applicable) GPS name, thermistor serial number, camera name, etc.
Data Coordinator staff	initials
date submitted	YYYYMMDD (or date of photo)
sequential file name	(if applicable) photo numbers, etc. Original camera photo names are ok, IF unique within the folder. A catalog with more descriptive info is expected for photos.
file type	.xls, .mdb, .pdf, .jpg, etc.

Examples:
SuWa Golder FAQ SalmonLifeHist 201307 MidRiver Database QC3 DF 20130830.mdb

(significant changes since last version are in green)

SuWa LGL FAQ FishRadioTelem 20120601 MidRiver\GPS dumps QC1\GPS12 MB 20120610.txt
SuWa R2 IFS Riparian\20120731 RM98\Photos QC1 JZ 20120831 \IMGP2041.jpg

Field Data Collection Guidelines

- Field forms and field books should be backed up after each day's field work, either by scanning to PDF and storing on a laptop or external drive (hard drive, thumb drive, or DVD), OR making a photocopy, OR taking pictures with digital camera and storing the images on a laptop or external drive.
- If equipment isn't available for backup, then a new field book should be used each day, or new loose leaf field book pages in a binder. Do not take used field books into the field if they haven't been backed up.
- Each field book should have the following information on the front cover: Study, consultant, date range.
- Each field book page should have a header of waypoint name, streamcode (if known), date, crew (if first page for the day), and page #.
- Each field form page should have a header of study name, waypoint name, streamcode (if known), date, and page # of #. The crew should be recorded on the first form of each site/date.
- Once the river miles and site identifiers have been identified for the project, these may be recorded in addition to or instead of waypoints.
- Photo descriptions can be included in field notes, and then entered into the photo catalog later, so that anyone looking at a photo knows what they are looking at.

Raw Data Delivery

- Raw data should be delivered on the first day of each month for all field events occurring in the previous 30 days. Special considerations for delivery schedules and requirements can be worked out for each study if needed.
- The table below lists general raw data deliverable requirements:

Data Source	QC Level	Delivery Schedule	Delivery Format
Field book scans	QC1	First day of each month.	.PDF
Field form scans	QC1	First day of each month.	.PDF
GPS dumps	QC1 – raw dump, no data cleanup	First day of each month.	.TXT, .CSV, or .XLS
Lab reports	QC1 – as received from lab	First day of each month.	.PDF and .XLS
Mobile data collector (ArcPad, etc.)	QC1 – raw dump, no cleanup	First day of each month.	.TXT or .CSV
Photos	QC1 – raw dump from camera, before cleanup	First day of each month.	.JPG
Telemetry dumps	QC1 – raw dump, no cleanup	First day of each month.	.TXT or .CSV

Thermistor dumps	QC1 – raw dump, no cleanup	First day of each month.	.TXT or .CSV

- Photos should be accompanied by photo catalogs to enable users to find applicable photos as needed in the future.
- Raw video files may be submitted to Alaska DNR for storage at UAF GINA.
- Data submittals can be posted to the AEA SharePoint site, Library "SUWADATA", folder "2013 Field Data Deliverables", in the appropriate folder for the study. Upon posting, a **Letter of Transmittal** (Appendix B) should be emailed to the data managers listed on the Letter template to notify them of the delivery, so they may maintain a catalog of all deliveries for AEA.
- Upload times to AEA SharePoint have been tested; expect a 10 MB file to upload in less than 2 minutes, and a 30 MB file to upload in 4 minutes. If an upload exceeds 100 MB, please notify AEA IT Dept. (Sara Nogg) before posting to plan transmission and storage space.
- Once raw data have been archived, external hard drives may be returned upon request.

Final Data Delivery

- Data collected in the field will be processed and submitted to AEA, constituting final data delivery. Delivery schedules and final data format for each study will be agreed on by AEA, the consultant Data Coordinator, and the project data resource manager. Tabular data may be MS Excel or Access relational format, or a GIS database.
- Processed data should follow the Susitna QC protocol (refer to "Appendix A: Data QC Protocol"). All raw data intended for the Susitna project relational database must be processed: equipment dumps are not intended for database imports.
- Photos selected for final delivery should be delivered with a catalog providing further details on specific location, date, etc. The catalog can be an MS Excel or MS Access table.
- Final video submittals should be sent to Sara Nogg at AEA and (contact?) at ADNR. They will ultimately be stored at UAF GINA for user and AEA access.
- The table below lists final data deliverable requirements:

Data Source	QC Level	Delivery Schedule	Delivery Format
DIDSON data	QC1	Study due date	
Field tabular data	QC3 – loaded from field forms and equipment dumps, processed, cleaned up, senior review	Study due date	.XLS or .MDB
Lab tabular data	QC3 – loaded from lab format, standardized, senior review	Study due date	.XLS or .MDB
Modeling data	QC3 – data used to feed into a modeling application	Study due date	.XLS or .MDB
Photos	QC3 – renamed if desired, bad photos removed	Study due date	.JPG
Photo Catalog	QC3	Study due date	.XLS or .MDB

Videography	QC3 – processed and compressed	Study due date	contact UAF GINA manager Dayne Broderson & ADNR

- All deliverables should be accompanied by a transmittal letter (Appendix B).
- Once data files are delivered to AEA, they should be archived at the consultant's office for at least 2 years.

(significant changes since last version are in green)

B. Data Attributes and Databases

Data Attributes

Standards are being established for the Susitna project for some data attributes, whether stored on field forms, MS Excel sheets, database tables, etc. These standards should be considered as much as is practical.

Attribute Naming Standards

These naming standards were previously listed in the SharePoint document "SuWa - Field Data Standards - Attributes DES20120511". That document has been retired and the applicable content moved here.

1. Tables and attributes may be given descriptive names up to 30 characters long and start with a letter.
2. Most attributes also need a 10-character abbreviated name to make datasets compatible with GIS shapefiles. Capitalize the first letter of each abbreviation for readability.
3. Measurement units should be included in the field name as a suffix.
4. Order values may be included in field names, to put attributes or records in a certain order. e.g. FloatTime1, FloatTime2. Some of these may be normalized to 1:M tables.
5. Attributes that contain "Lookup Codes" should be suffixed with "Cd" to help users understand that the values are short codes, and refer to a Lookup table.
6. (more detailed guidelines for naming are found below for specific subjects)

A list of data domains is provided as an appendix to this document. Contact the project data resource manager to get the most up-to-date list and to make revisions or additions.

Attribute Naming - Names Not Allowed

Too Generic

These field names are not allowed as standalone and need clarification within the name, usually with a subject prefix or initials. Some of these are also reserved words in database software, so mustn't be used alone.

Too Generic	Better Example
Class	AqHabClass
Code	FishSpecCd
Comment	FishCtCom
Date	RTTrackDat
Desc, Description, Note	TurbidDesc
End	TransectED
File	GPSFile
ID	RTTrackID
Name	SiteName

Parameter	LabParam, Analyte
Sample	SampleID
Start	TransectST
Temp	WaterTempC
Time	FloatTime1
Type	RosgenType
Unit	AqHabUnit
UOM	AnalyteUM

Database Reserved Words

Some words have special meaning within database engine software; some of these "reserved words" should be avoided as full names for attributes. For example, DATE and COUNT are database function names, so are disallowed as attribute names unless they are qualified with descriptors, such as SurvDate or FishCount.

AEA currently uses MS Access 2010 and Alaska Department of Natural Resources uses Oracle, so reserved words for these platforms should be considered in attribute naming. Some reserved words are found in the generic names list, but others to avoid include:
Current, Float, Group, Index, Key, Label, Limit, Memo, Nested, Note, Range, Recover, Report, Reset, Resource, Return, Set, Size, Table, Text, User, Value, Year, Zone.
Complete lists of reserved words can be found on Microsoft and Oracle websites, but those listed above seemed the most likely to be encountered in the Susitna project.

Attribute Data Values

Case

- Values may be upper or lower case or a mixture, for readability and reporting.
- Case should be applied consistently within a field.
- Some data systems can accommodate case sensitivity while others can't, so values should be assumed to be equivalent for upper and lower case. For example, a units code of M or m represents meters.
- Coded values should be upper case; this helps identify them as codes from lookup tables.

Comment, Note

- Field names for comments and notes should be named to reflect the entity, as it helps clarify data entry from field forms where multiple comments are recorded. Example: site comment and method comment may be recorded on the same field form, so these fields should be named differently.
- If a comment field is being used for a single attribute, then it should be named accordingly. Eg: Fish Count Comment (FshCntComm).

(significant changes since last version are in green)

Coordinates

- All coordinates must be WGS84 and in units decimal degrees NNN.NNNNN (5 – 6 decimals).
- Degree decimal minutes dumped from GPS are not allowed in final data. Consultants will convert coordinates before delivery.
- Coordinates should be Text data type, to help preserve appropriate decimal precision.

Dates and Times

- All dates are Text data type, format YYYYMMDD. (The DateTime type is problematic in GIS, so is not used.)
- Times should be stored in separate attributes from dates.
- Times are Text data type, 24-hour time
    - Time of Day format = HH:MM or HH:MM:SS, specified in the data dictionary.
    - Duration Time format = HH:MM or MM:SS, specified in the data dictionary
- If a time is for duration, try to reflect that in the attribute name with "Dur".
- Consider using a units field for durations, which can read as HH:MM or MM:SS.
- Field names should reflect the entity, so they are easily distinguished from other dates and times in reports and query output. For example: fish wheel dates might be FWLogDate and FWCatchDat.
- A time zone qualifier must be included in any tables that have time-of-day attributes. Use codes:
    - **AKST** = Alaska Standard Time
    - **AKDT** = Alaska Daylight Time.
- IFS study GWS instruments are set to time zone AKST all the time, this should be indicated in their time zone field. This is important for GIS.

Derived and Calculated Fields

- Data tables may contain calculated and derived fields. The formula must be provided in the data dictionary and list any other fieldnames used in the calculation.
- Calculated fields must be named to show their status, using a "Calc" as a name suffix, such as AvgWidCalc.
- At this point, the MS Access 2010 data type of Calculated is not used for the Susitna project.

Downstream / Upstream Orientation

- Whereas some disciplines may normally orientate as "looking upstream", the Susitna project has chosen a downstream orientation for all applications with deliverables to AEA.
- Any attributes that are specific to a left bank (LB) or right bank (RB) feature should be orientated as "looking downstream".

(significant changes since last version are in green)

Location / Site Identifiers

- A linear route layer has been developed for the Susitna River mainstem for the current project. River miles along this route are name "PRM" (project river mile). Some studies and historic data may include "HRM" (historic river mile), calculated in the 1980s studies. When HRM is present, the historic source should be noted in the data dictionary and possibly a field in a site table. A cross-reference table of PRM and HRM may be created by the GIS team.
- As of this document version, streamcodes and project river miles have been generated only for the Susitna River mainstem main channel and certain river features. Off channel and tributary sites are making use of lat/long for location identifiers, but naming conventions for them are being considered.
- Location names must be meaningful, and at least include a project river mile (PRM) if available, verified on the current linear reference. (A site name domain is being generated for some fish studies.)
- No cryptic site codes. Codes used in the field must be converted to site names in the GIS site domain before submittal.
- The following verbiage from the project implementation plans explains the use of River Miles in the project and applies to data as well:

  The Project River Mile (PRM) system for the Susitna River was developed to provide a consistent and accurate method of referencing features along the Susitna River. During the 1980s, researchers often referenced features by river mile without identifying the source map or reference system. If a feature is described by river mile (RM) or historic river mile (HRM), then the exact location of that feature has not been verified. The use of PRMs provides a common reference system and ensures that the location of the feature can be verified. The PRM was constructed by digitizing the wetted width centerline of the main channel from 2011 Matanuska-Susitna Borough digital orthophotos. Project River Mile 0.0 was established as mean low water of the Susitna River confluence at Cook Inlet. A centerline corresponding to the channel thalweg was digitized upstream to the river source at Susitna Glacier using data collected as part of the 2012 flow routing transect measurements. The resultant line is an ArcGIS route feature class in which linear referencing tools may be applied. The use of RM or HRM will continue when citing a 1980s study or where the location of the feature has not been verified. Features identified by PRM are associated with an ArcGIS data layer and process, and signifies that the location has been verified and reproduced.

Measurements: Numeric, Estimates, and Descriptive

- Attributes of a numeric nature should be NUMBER data type and cannot contain characters.
- Number fields are typically measurements such as count, width, velocity, etc. However, some measurement results require alphanumeric values, which can be accommodated in various ways.

- If estimated measurements must be stored, they go into the numeric field, with a TEXT flag to describe the nature of the estimate, such as EstFlag.

  Example:

  Count values that are not allowed: "~10", ">20", "many", "5-10"

  Use the following instead:

FishCount	CntEstFlag	
10		this means exactly 10
10	~	this means about 10
20	>	this means >20

- If counts of "5-10" and "many" need to be allowed for some reason, we can employ a count description (CountDesc) field,TEXT datatype.
- Other descriptive measurements, such as some Turbidity, use a TEXT field named with "Desc", such as TurbidDesc. The domain for a field like this should be defined and enforced to allow for reporting.
- Queries and reports may need to include EstFlags and Desc fields, if they exist. Users need to know how to deal with measurements like this, so they should be documented in the dictionary.
- Use caution that the default value for numeric fields isn't set to zero (0). This will be checked during QC4 verification.

Measurements Units (UM)

- The Susitna project prefers that Units be included in field names where practical. However, some attributes may need units stored in a separate units of measurement (UM) field.
- Some attributes use varying units based on discipline, or the units can't be denoted within a 10-character field name. These will need a separate UM field. Examples may include:

  WetWid and WetWidUM
  RelatCond and RelCondUM
  SpecCond and SpecCondUM

- Some parameters will have standard measurement units for the project. These can be identified when reviewing field forms, but at least include:

water temperature:	degrees C
fish distribution:	metric units
Instream Flow (IFS):	English units
Habitat Suitability Criteria (HSC):	English units

- Unit values should never include special characters, as the Unicode character set could be misinterpreted during data imports and exports. For example, the Unicode symbol for micron "µ" should be represented with an ASCII "u".

Person / Staff Names

- Use first initial and last name (FLastname), such as DStewart.

- Avoid using a person's initials in the final data, to avoid an additional lookup and confusion of acronyms.
- Exception: Authors in the Bibliographic Database are Last, First M.

Special characters and symbols

- ASCII special characters are allowed within values. These are common in:
  long text fields like Comments
  streamcodes with periods (SU 1.120.10)
  multiple values separated by commas or semicolon (WeatherDes = wind, light rain)
- Values should never contain Unicode symbols, only ASCII characters.

Waypoint names

- Waypoints may typically be assigned sequential numbers within a GPS unit. More descriptive names may also be used.
- Waypoints don't need to be renamed in the project database, as they should always be accompanied by the GPS unit ID and GPS date which will create a unique waypoint list.

Relational Databases

If MS Access databases will be delivered as part of the final data deliveries, the following guidelines should be used.

Database Object Names

The Leszynski (Hungarian) naming convention is commonly used by MS Access developers and is adopted for the Susitna project, with some minor customization. Note that this convention isn't enforced by MS Access; it is implemented by the database administrator for easier maintenance and programming in Visual Basic for Access (VBA), where reference to an object name may not indicate its data type.

	Attributes (no prefix)
tbl	Table: data
tlu	Table: lookup, valid value, code
tmp	Table: temporary, can be deleted without adverse effect
qry	Query, view
(The next ones aren't typically delivered with a database by consultants.)	
frm	Form
rpt	Report
mcr	Macro
mod	Module

Other naming rules:

- Table names are restricted to a 30-character maximum, as required to meet GIS standards for this project.
- Attribute names are restricted to a 10-character maximum to accommodate GIS shapefile users. In 2013, longer field names were implemented, with each field assigned a synonym name of only 10 characters to use if needed for shapefiles.
- Table and attribute names can't start with a number, per project GIS standards.
- Attribute names must start with a capital letter.
- Contain only letters and numbers.
- Underscores may be allowed if necessary, but no spaces.
  In 2013, field names in the data templates contained spaces to make them readable. The spaces have since been removed, or replaced with underscores.
- When exporting a dataset to use as a shapefile, the long field names need to be replaced with 10-character field names to be compatible with shapefile systems.
- Symbol fonts are never allowed in names.
- Name using Pascal case (camel case with the first letter capitalized). This is a mix of upper and lower case, where each new element of the name is capital, and is encouraged for readability.

The naming convention may be re-addressed if the database is later moved to another platform with case sensitivity issues between Oracle, MS Access, and SQL Server.

Attribute Data Types

The following field data types will be utilized in the Susitna database and are permitted in deliverables:

Boolean (True/False, Yes/No)
Hyperlink
Number
Text (make sure zero-length string properties are disabled in MS Access)

Data types that aren't permitted at this time in deliverables:

Attachment (OLE, BLOB)
AutoNumber (change to Text or LongInt for delivery)
Calculated (MS Access 2010 data type)
DateTime (dates and times must be Text)
Memo
Multi-valued (MS Access accdb format)

A naming convention for attributes to show the data type won't be implemented for the Susitna project, as we need to accommodate the shapefile attribute name limit of 10 characters. For example, we won't use prefix "int" for integer type attributes.

Unique Record Identifiers (Primary Keys)

- A logical / natural primary key must be identified for each dataset, whether MS Access table or MS Excel data sheet.
- If a synthetic / surrogate key is also desired, or in some situations required, then the key name must be descriptive; the name "ID" alone (a default name created by MS Access) is not allowed. Refer to the Susitna project Data Naming Conventions for descriptors.
- Surrogate keys may be text, numeric, or MS Access AutoNumber data types. Text keys should be upper case for portability to another platform.
- If the key contains information, it should be noted in the data dictionary so users can interpret it correctly. For example, SurveyID is year + study method + sequential number (2012RTTAG2).

C. Data Dictionary

The Program Lead team is tasked with compiling a comprehensive data dictionary document for all water resources studies. Ideally, a data dictionary utility with reporting capabilities will be employed, although this has not been decided yet. This may provide a more detailed and descriptive document than the GIS metadata, which is needed to meet GIS project standards.

For the Susitna project, we make a distinction between the terms "metadata" (refers to the GIS) and "data dictionary" (refers to the relational database). The metadata has standards that the GIS team and ADNR establish and enforce for the GIS. The relational database will be documented differently from the GIS, and its template doesn't resemble GIS metadata.

- (This item is in progress and will be updated.)
- When field data is submitted to the Program Lead team for level QC4, it should be accompanied by a data dictionary. This will provide a detailed, descriptive document to compliment the GIS metadata project standards.
- The dictionary will be reviewed for table naming and descriptions, identification of keys, field names, data types, and descriptions.
- Descriptions should not typically be terse, but rather detailed with an eye to being useful to scientists years later and without access to current scientists for explanation. Special handling of anomalies within tables or fields should also be described.
- The format for data descriptions can be MS Excel or MS Word until further notice. Storing field descriptions within MS Access table designs won't fulfill the dictionary requirements.

(significant changes since last version are in green)

Appendix A: Data QC Protocol

Introduction

The F&A Program Lead team is tasked with implementing a standardized QA/QC protocol, intended for use in all environmental field studies in 2012, including fish and aquatic, water quality, river ice, IFS, and others. This document will be presented to the leader and appointed Data Coordinator of each of these study teams.

Members of the Program Lead team can be contacted with questions and comments:

Dana Stewart – Data Resource Management
Judy Simon – Program Coordination
Joetta Zablotney – GIS-related QC

QC Levels

There will be 5 levels of data QC, named QC1 to QC5, each of which is tracked within the data. This allows for quick determination of the QC status of every data record. The first three levels are to be completed by the study team, the fourth level by the Program Lead team, and the final level by senior professionals during analysis and reporting.

QC1 – Field Review: QC review performed by the person collecting field data, whether recorded on paper field forms or directly into electronic data collection tools, and then by the field team leader. This is also the QC level of raw data collected via field equipment such as thermistors, cameras, GPS units, etc.

The goals of QC1 are to identify errors and omissions and correct them under similar field conditions prior to leaving the field, and to backup files in the field.

Review is done on 100% of data and includes completeness, legibility, codes, and logic on all information recorded. This is typically completed in the field daily. Once completed, QC1 notations are made directly on the field form in an entry named "QC1", containing the date and responsible staff and formatted as "YYYYMMDD FLastname" (example: "20120631 JDoe").

QC2 – Data Entry: Data from paper forms are entered into an electronic format, then data entry is verified by a second party against the field forms.

The goal of QC2 is to verify correct, complete, and consistent data entry.

Verification is done on 100% of data entered and includes extrapolation of shorthand codes that might be used in the field into longhand or standard codes during data entry. Data entry errors are corrected at this time, then QC is recorded in a column named "QC2", containing the date and responsible staff and formatted as "YYYYMMDD FLastname" (example: "20120631 JDoe").

QC3 – Senior Review: Data are reviewed by a senior professional scientist on the consultant team, checking for logic, soundness, and adding qualifiers to results if warranted.

Calculated results can also be added at this time (formulas must be documented in the data dictionary). Photo locations should be verified. This is the final review before submitting field data to the Program Lead, and is recorded in the "QC3" column in the same format as QC2. This is also the QC level of raw files that have been "cleaned up" or otherwise processed for delivery to AEA, such as photos.

QC4 – Database Validation: Electronic data files are submitted to and verified by the Program Lead's data resources manager. The deadline for this delivery is negotiated with the team Data Coordinator in consideration of the study due date.

Data are verified for completeness, project standards (codes, field name conventions, date formats, units, etc.), calculated and derived fields, QC fields, etc. The data files are incorporated into the project database schema, splitting into normalized tables as necessary and all primary and foreign keys checked. An error report is generated for the study consultant, who is expected to make corrections and resubmit data. The process is repeated until verification is clean and records are marked in column "QC4" (such as "20121001 DStewart").

QC5 – Technical Review: Data revision and qualification may be applied by senior professionals when analyzing data for reports, trends, and FERC applications. Data calculations may be stored with the data. Some data items may get corrected or qualified within the database, while others are only addressed in report text. QC5 may be iterative, as data are analyzed in multiple years.

If a data item is revised directly, it's recorded in 2 columns, QC5 (date and staff) and QC5Edit (what is revised and why). This will serve as adequate documentation of the revisions, so maintenance of additional documentation isn't usually necessary. QC5 revisions will be physically made by the Data Resource Manager, directed by the senior professional.

Data Collection Devices (e.g. ArcPad, Trimble)

Field forms should be reviewed and approved by the Program Lead team before use in the field. If mobile data devices (ArcPad and Trimble) are used to record field data directly, they must be accompanied by backup paper field forms in case of equipment failure, and both the paper forms and device entry screens should be approved by the Program Lead team.

Both paper and electronic field forms should be backed up nightly in the field by scanning and downloading to a storage unit or photocopy to paper.

Data Revisions

Once the processed field data (QC3) have been submitted by a consultant to AEA via R2, and it has been validated as ready for incorporation into the Susitna project database (QC4), the data are considered to reside with AEA, and subsequent revisions will only be made by the Program Lead team on their behalf. If a study team discovers that data require revisions, their Data Coordinator

can send a formal, written request (i.e. email) to the Data Resource Manager. Revisions will be made and the appropriate QC columns updated, which will serve as adequate documentation.

Appendix B: Letter of Transmittal

(next page)

(significant changes since last version are in green)

SUSITNA-WATANA
HYDROELECTRIC PROJECT

LETTER OF TRANSMITTAL

To: ☐ Dana Stewart, DESIT
☐ Judy Simon, R2
☐ Sara Nogg, AEA
☐
☐
☐

Date:
Project:
Subject:

Transmitted via ☐ AEA SharePoint ☐ DVD ☐ Thumb drive ☐ External hard drive
☐ Other_____

are the following files: **Please specify file names and folder/file paths and include a brief description

As: ☐ Raw / QC1 ☐ Final/ QC3 ☐ Other _____

Remarks:

Please notify us if the enclosures are not received.

Submitted by:

Name:

Company

cc:

(significant changes since last version are in green)

Appendix: Data Domains

(next page)