Susitna-Watana Hydroelectric Project (FERC No. 14241)

Mercury Assessment and Potential for Bioaccumulation Study (Study 5.7)

Errata to Evaluation of Continued Mercury Monitoring Beyond 2014 Technical Memorandum (September 30, 2014)

Prepared for

Alaska Energy Authority

SUSITNA-WATANA HYDRO

Clean, reliable energy for the next 100 years.

Prepared by

Tetra Tech

November 2014

ERRATA TO EVALUATION OF CONTINUED MERCURY MONITORING BEYOND 2014 TECHNICAL MEMORANDUM (ORIGINALLY FILED SEPTEMBER 30, 2014)

TM Reference	Errata Description
Study 5.7 Technical Memorandum, Mercury Assessment and Potential for Bioaccumulation, Evaluation of Continued Mercury Monitoring Beyond 2014; page 11, Figure 5.5-1	Replaced Figure 5.5-1 with a revised version. Changes in the figure include: 1) addition of notation at bottom of the Water Column Dissolved Hg/Water Column Total Hg box reporting average concentrations of mercury "(Provisional Data; Under Review)", and 2) "Dry Otter and Mink Fur Hg" box revised to reflect splitting of Hg results into "Dry Mink Fur Hg" and "Dry Otter Fur Hg". Average concentration of Hg as dry weight in mink fur is 6,258 ng/g. These samples were not collected within the study area of the proposed reservoir.
Study 5.7 Technical Memorandum, Mercury Assessment and Potential for Bioaccumulation, Evaluation of Continued Mercury Monitoring Beyond 2014; page 14, Table 6.1-1	Replaced Figure 6.1-1 with a revised version. Maximum and Minimum concentrations of mercury (Hg) in Dry Mink Fur samples revised; maximum concentration was incorrectly reported as 29,950 ng/g, but that was actually a "post-spike" sample concentration intended to evaluate potential interference elements in the matrix. The correct maximum concentration for this sample is 7,670 ng/g dry weight and minimum concentration is 4,180 ng/g. The "Dry Otter/Mink Fur Hg" tissue results are split into separate categories: "Dry Mink Fur Hg" and "Dry Otter Fur Hg". In addition, Otter Fur collected from within the study area is reported as "Wet Wt. Otter Fur Hg". The Table 6.6-1 now includes additional summary statistics for each of the media analyzed for Hg: 1) mean concentration, 2) Standard Deviation , and 3) number of observations. Additional footnotes (4 & 5) are added at the bottom of the Table 6.1-1. Data for Piscivorous Mammals is provisional until final quality assurance review is completed.
Initial Study Report Meeting Presentation (ISR 5.7), Study 5.7 Mercury Assessment and Potential for Bioaccumulation	• Slide 6, 1st bullet, 4th sub-bullet, beginning of first sentence: changed "60 fish tissue samples" to "67 fish tissue samples". • Slide 7, Second bullet, end of second sentence: "total of 13 results" changed to " total of 14 results". • Slide 8, Table replaced with revisions based on those made in Table 6.1-1 from "Study 5.7 Technical Memorandum, Mercury Assessment and Potential for Bioaccumulation, Evaluation of Continued Mercury Monitoring Beyond 2014"; page 14, Table 6.1-1. • Slide 9, Figure replaced with revisions based on those made in Figure 5.5-1 from "Study 5.7 Technical Memorandum, Mercury Assessment and Potential for Bioaccumulation, Evaluation of Continued Mercury Monitoring Beyond 2014"; page 11, Figure 5.5-1.

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LIST OF ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

Abbreviation	Definition
ADEC	Alaska Department of Environmental Conservation
AEA	Alaska Energy Authority
AWQS	Alaska Water Quality Standards
FA(s)	Focus Area(s)
FERC	Federal Energy Regulatory Commission
ILP	Integrated Licensing Process
MeHg	Methylmercury
NOAA	National Oceanic and Atmospheric Administration
NTU	Nephelometric turbidity unit
PRM	Project River Mile
Project	Susitna-Watana Hydroelectric Project
RSP	Revised Study Plan
SQuiRT(s)	Screening Quick Reference Table(s)
TEL	Threshold Effects Level
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey

1. INTRODUCTION

The Alaska Energy Authority (AEA) is preparing a License Application that will be submitted to the Federal Energy Regulatory Commission (FERC) for the Susitna-Watana Hydroelectric Project (Project) using the Integrated Licensing Process (ILP). The Project is located on the Susitna River, an approximately 320-mile-long river in Southcentral Alaska. The Project's dam site would be located at Project River Mile (PRM) 187.1.

Mercury contamination is widely known to present human health concerns. In the environment, processes such as reducing and low oxygen conditions can lead to increased rates of mercury methylation (Figure 1-1). Based on several studies, mercury that is found in newly formed reservoirs originates predominantly from inundation of organic soils (Figure 1-2). The linkage between sediment sources, mobilization into the water column (dissolved form), and the potential for bioaccumulation in fish tissue and piscivores therefore presents a human health concern with respect to mercury contamination. Methylmercury (MeHg) bioaccumulates, and the highest concentrations are typically in the muscle tissue of adult predatory fish. Targeting adult fish is a good way of monitoring methylmercury migration to the larger environment. Potential for bioaccumulation in aquatic life is determined when chronic thresholds for toxics exposure in a medium are identified. Potential for mortality is determined when acute criteria for toxics in a medium are exceeded.

A Mercury and Potential for Bioaccumulation Study (Study 5.7) was initiated in 2013 to answer key questions (Revised Study Plan [RSP] Section 5.7.1; AEA 2012) and determine: 1) whether conditions within the reservoir will cause mercury methylation from inundated conditions, 2) the concentrations of methylmercury that might occur, and 3) whether a mechanism exists to transfer that methylmercury to wildlife, resulting in detrimental impacts.

Data on the mercury concentration in sediment, sediment porewater, soil, vegetation, water, fish, and piscivorous mammals have been collected within the past two years (2013/2014) within the Susitna River basin. These data were further evaluated for adequacy in representation of current conditions in and around the Susitna River. The need for continued monitoring of mercury data beyond 2014 is being evaluated to determine whether the existing data collection efforts are sufficient to satisfy objectives for characterizing baseline mercury conditions in the Susitna River and tributaries (RSP Section 5.7.1).

2. STUDY OBJECTIVES

Based on several studies, the mercury that is found in newly formed reservoirs originates predominantly from inundation of organic soils. Receptors are and will be present in the inundation area (macroinvertebrates, fish, birds, etc.). Mercury methylation in reservoirs is a fairly well understood process, and numerous models exist to predict the occurrence and magnitude of the phenomena.

Given these known factors, key questions that need to be answered by this study include the following:

1) Whether conditions within the reservoir will cause mercury methylation from this source.

2) The concentrations of methylmercury that might occur.

3) Whether a mechanism exists (fish and small invertebrates living in the methylation zone) to transfer that methylmercury to wildlife, resulting in detrimental impacts.

Study 5.7 assesses the status of mercury concentrations in several media and mercury cycling between the aquatic and terrestrial environment. Based on these questions, specific objectives of Study 5.7 study are as follows:

- Summarize available and historic water quality information for the Susitna River basin, including data collection from the 1980s Alaska Power Authority (APA) Susitna Hydroelectric Project.
- Characterize the baseline mercury concentrations of the Susitna River and tributaries. This will include collection and analyses of vegetation, soil, water, sediment pore water, sediment, piscivorous birds and mammals, and fish tissue samples for mercury.
- 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 develop maps of 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.
- 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.

3. STUDY AREA

As established in Study Plan Section 5.7.3, the study area begins at project river mile (PRM) 19.9 and extends upstream from the proposed reservoir to PRM 235.2. An overview map and detailed sample locations are provided in the Initial Study Report (ISR) (AEA 2014).

4. ELEMENTS REQUIRED TO COMPLETE THE STUDY

AEA initiated the Mercury Assessment of Potential for Bioaccumulation Study in 2013. To meet study goals, AEA completed numerous study components which are summarized in ISR Study 5.7 Section 5. The following sections describe study components planned for 2014.

4.1 Planned Monitoring Components in 2014

AEA summarized its plans for completing the Mercury Assessment and Potential for Bioaccumulation Study in ISR Study 5.7, Part C, Section 7 as follows:

- Geologic studies for the inundation zone.
- Collection of sediment samples at the six remaining sites located on CIRWG lands (RSP Section 5.7.4.2.4).
- Limited winter water quality sampling in January and March of 2014 (RSP Section 5.7.4.2.3).
- Summer monthly water sampling from June to September 2014 (see ISR Section 5.5 for details).
- Completion of the Predictive Risk Analyses (RSP Section 5.7.4.6) and mercury modeling (RSP Sections 5.7.4.7 and 5.7.4.8).

5. STUDY COMPONENTS COMPLETED IN 2014

The 2014 efforts focused on the collection of water and sediment mercury and methylmercury to aid in the creation of a pathways analysis model used to determine the need for further mercury sampling in other media. Specific study components completed in 2014 are summarized below.

5.1 Geologic Studies for the Inundation Zone

The ISR Study 4.5, Part C Section 7.2 states the following elements and 2015 schedule for geologic mapping of the area to be inundated by the reservoir:

Geologic Mapping – summer mapping to be scheduled prior to leaf-out and after leaves have fallen (May and September) for geologic mapping associated with regional geology development, mineral resources and claims, reservoir rim stability, and a continuation of geologic mapping as needed for lineaments and geologic features (potential fracture and shear zones) and evaluation of rock displacement or rupture in the dam site area.

Results from this geologic characterization of the inundated land will be used to determine potential for mobilization of mercury in the reservoir. This study is on-going and is not yet completed.

5.2 Collection of Sediment and Porewater Samples

Sediment and porewater samples were collected at the six remaining sites located on CIRWG lands (RSP Section 5.7.4.2.4) in 2014: Susitna River just below and above the proposed dam site, and the mouths of Fog, Tsusena, Deadman, and Watana Creeks (Section 5.5.4.6 of the RSP; Section 4.5 of the ISR).

5.3 Limited Winter Water Quality Sampling

Winter samples were collected from five baseline monitoring sites in January 2014 and March 2014 (Table 5.3-1). Field parameters were collected on-site during each visit and laboratory parameters generated following analysis of samples. Laboratory data from 2014 winter sampling has been completed and is now undergoing a quality assurance review. The procedure for a quality assurance review includes development of a Data Validation/Verification Report (DVR) for ten percent of all samples collected for this winter monitoring program. The DVR is a data review requirement of ADEC to ensure compliance with use of high quality data used to make regulatory decisions.

Three groundwater wells previously established in Focus Areas FA-104 (Whiskers Slough), FA-128 (Slough 8A), and FA-138 (Gold Creek) were sampled in February 2014, March 2014, and April 2014 (Table 5.3-2). Both field and laboratory parameter results were generated on three separate sampling dates. Raw data is currently being reviewed to assure it meets acceptance limits per the Quality Assurance Project Plan for Water Quality and Mercury Assessment for the Susitna-Watana Hydroelectric Project Susitna River, Southcentral Alaska (QAPP).

5.4 Summer Monthly Sampling

Total mercury samples were collected from baseline water quality and seven Focus Area (FA) transects identified in ISR Study 5.7 Sections 4.3 and 4.4, respectively, from June to September 2014. Total mercury samples were collected from one location on a transect at each of the baseline water quality sites. Total mercury samples were also collected from each transect within seven Focus Areas (Table 5.4-1). If a transect within a Focus Area crossed braided channels then one total mercury sample was collected from the mainstem and another from the braided channel area. A single fur sample was collected outside the inundation area and was the only sample gathered during the 2014 field studies.

6. APPROACH FOR STUDY COMPLETION

6.1 Pathway and Threshold Analyses

An illustrative pathway model was constructed that reports concentrations of total, dissolved, and methylmercury measured in various receptors in the Susitna River drainage (Figure 5.5-1) and describes a preliminary evaluation of potential transfer between media (e.g., sediment– sediment porewater, porewater–surface water, surface water–fish tissue). A final analysis of potential for mercury bioaccumulation will combine evaluation of criteria or threshold exceedance and if these concentrations promote transfer between connected components of the pathway (Figure 1-2) model. An additional diagram as seen in Figure 1-2 will be constructed for the new reservoir and include wetlands, bogs, and terrestrial vegetation that will be submerged by inundation.

6.1.1 Data Applied to Pathways Analysis

Data used to construct the pathway model were primarily based on data collected in 2013 that have undergone QA/QC review. Presence of mercury in each of the media sampled and analyzed is identified and used to determine if a concentration gradient is present (e.g., potential for transfer from sediment to porewater, porewater to surface water, and sediment to biota). Evaluation for adequacy of data used in pathways analysis was based on factors like completeness in sampling all media, determination for adequacy of number of samples collected in each media, and spatial representation of the sampled media.

Fourteen sediment and sediment porewater samples were analyzed for total mercury in 2013 and used in the preliminary pathways assessment. Fish sample collection occurred in August through October 2013. Liver samples were also collected from burbot and analyzed for total mercury and MeHg. A single fur sample collected from mink and otter outside the Project area was collected in March 2014 and analyzed for total mercury. A total of 50 soil and vegetation samples from five sites in each of ten locations within the reservoir inundation zone were collected during August 2013. Vegetation and soil samples were analyzed for total mercury and MeHg. Each soil and vegetation sample was analyzed for concentrations of mercury in wet samples and dry weight results were calculated. In all cases dry weight sample concentrations (calculated values) exceeded wet weight sample concentrations. Dry weight sample concentration results were used in the current mercury conceptual pathway assessment.

6.1.2 Application of the Pathway Model

The initial approach used to assess mercury data from various media was to compare data with existing and appropriate water quality criteria, sediment thresholds, and fish tissue screening levels. Surface water results were compared to Alaska Water Quality Standards (18 ACC 70.020(b)) for protection of beneficial uses in fresh water and to criteria for protection of human health. Sediment and fish tissue results were compared to the Screening Quick Reference Tables (SQuiRTs) used by the National Oceanic and Atmospheric Administration (NOAA) to determine if the threshold effects level (TEL) to aquatic life have been exceeded. Table 6.1-1 summarizes the concentrations of mercury compared to criteria or thresholds, including human health as well as criteria for protection of aquatic life.

Based on discussion provided in Section 5.7.2 of the RSP, naturally occurring deposits of mercury may occur as parent geology for this element; for example, diorite and granodiorite have been identified in the proposed inundation zone. Given the limited presence of small-scale mining in the Project area other sources of mercury could be associated with atmospheric deposition. Lakes at Glacier Bay, Alaska, have shown that current rates of atmospheric mercury deposition are almost double the concentration currently than observed during pre-industrial times (Engstrom and Swain 1997). The presence of mercury in organic rich soils from decades of post-industrial deposition could be the only source of this element in the inundation zone. Vegetation samples collected from the area provide some indication of intensity of aerial deposition based on comparison with concentrations of mercury with known sources of this element.

6.2 Comparison to Existing Criteria and Thresholds

Preliminary examination of 2013 mercury results included a review from each of the media sampled in both the aquatic and terrestrial environment. Comparison of results with criteria or effects thresholds was one of the evaluation tools used to review results of mercury concentrations in each of the media. Table 6.1-1 presents the maximum and minimum concentrations from observations in each of the sampled media during 2013 and compares the maximum concentrations with available criteria or thresholds. Comparison to maximum concentrations is the most conservative approach for determining potential risk of effects from high mercury concentrations. When the maximum mercury concentration exceeded the criterion, further examination for how many results exceeded and if most results were near the minimum concentration as reflected by the average concentration.

Of the 375 samples collected as part of the water quality baseline monitoring study in 2013 were analyzed for total and dissolved mercury. The Focus Areas had a higher density of sampling locations, so that prediction of change using the EFDC water quality model could be made with a higher degree of resolution under Project operations during wet, dry, and average years. Grab samples collected from the Focus Areas were analyzed for total mercury and methylmercury generating 300 results. Focus Area water quality mercury sampling results have been compared with state criteria and thresholds for protection of beneficial uses to evaluate how Project operations will affect potential fish spawning and rearing habitat.

Based on 2013 sampling results, the average concentration of dissolved mercury in the water column was 1.06 ng/L (Figure 5.5-1). This average is below the most stringent criterion, of 12 ng/L that is protective of aquatic life. Two dissolved mercury samples collected in June 2013 (from PRM 59.9) and July 2013 (PRM 33.6) exceeded the Human Health criterion of 50 ng/L at 58.7 and 56.4 ng/L, respectively (Table 6.1-1). The remainder of results were well below the Human Health criterion. Comparison of total mercury concentrations were not compared to the criterion for protection of aquatic life as results from 2013 did not pass acceptance limits. These results will be compared against criteria once examination of the 2014 data set is made and adjustments to 2013 results using a correction factor. Similarly, one mercury result (220 ng/g) from 14 sediment samples exceeded the recommended SQuiRT Threshold of 174 ng/g. Concentrations were much lower in the remainder; the overall average mercury concentration in the sediment samples was 23.01 ng/g.

Background information for mercury in fish tissue was acquired from recent fish tissue analysis by ADEC with results ranging from 29.07ng/g (total mercury in Sockeye salmon) – 380.0 ng/g (total mercury in lake trout) in the Susitna Drainage (ADEC 2012). The average concentration among several species of fish sampled in 2013 from the Susitna drainage was within the range described by ADEC. Data collected in 2013 was similar to results collected by the 2012 ADEC effort.

7. STEPS TO COMPLETE THE STUDY

7.1 Data Verification/Validation

Revised Study Plan (RSP) Section 5.7.4.2.3 (AEA 2012) stated that AEA would recommend the need for continuing surface water sampling for mercury in 2014 based on 2013 results. Total mercury sample results collected in 2013; however, did not meet QA/QC requirement acceptance limits specified in the QAPP. The review of 2014 sample results will be completed by December 2014 to determine if total mercury estimates in surface water, sediment, and pore water satisfies acceptance limits and can be used for further data analysis and interpretation. Because ingestion rates of mercury in piscivores is directly correlated with fish, a determination for potential for bioaccumulation must initially be completed for aquatic receptors. Identifying a potential source of mercury from fish (see Section 5.7.4.2 of the RSP) in the Project area must occur before any conclusions can be made regarding transfer from aquatic to terrestrial receptors. This will be completed when pathways analysis begins following review of the 2014 data results.

8. RECOMMENDATIONS

Based on results from 2013 sampling, the total mercury concentrations for 2013 from water column samples are considered high estimates as results did not meet acceptance limits for laboratory performance. A correction factor will be developed for the 2013 results following QA/QC review of 2014 data. The concentrations of total mercury in sediments from four sites that were collected in 2013 are well below SQuiRT TEL and the concentration of total mercury in sediment porewater (Total Hg) is several times lower than the water column concentration.

The final pathway analysis has not yet been completed and is the next major component of this study that will determine potential sources for bioaccumulation. Existing fish data collection and tissue results will be used to identify these potential sources from several media where contact or ingestion of mercury is possible. Pathways analysis will be used to determine if reservoir and riverine habitat have the potential for generating methylmercury by using predicted elements from the Environmental Fluid Dynamic Code (EFDC) model that are known to facilitate the genesis of methylmercury (Figure 1-1). Post-reservoir conditions will establish potential sources and location of predicted methylmercury concentrations and the subsequent potential for bioaccumulation.

Based upon its preliminary review of the mercury results measured in each of the media, AEA is not proposing any additional sampling for mercury in 2015. Most of the observations characterizing mercury in each of the media were below existing thresholds or criteria. Monitoring would be expanded (as stated in Section 5.5.4.4 of the RSP) if metals in surface water, fish tissue, or sediment exceeded criteria or thresholds. Most of the mercury results in select media did not exceed available criteria/thresholds, therefore, suggesting no additional sampling is necessary.

9. REFERENCES

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AEA (Alaska Energy Authority). 2014. Mercury Assessment and Potential for Bioaccumulation Study, Study Plan Section 5.7. Initial Study Report. June 2014. http://www.susitna-watanahydro.org/wp-content/uploads/2014/05/05.7_MERC_ISR_PartA.pdf

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10. FIGURES

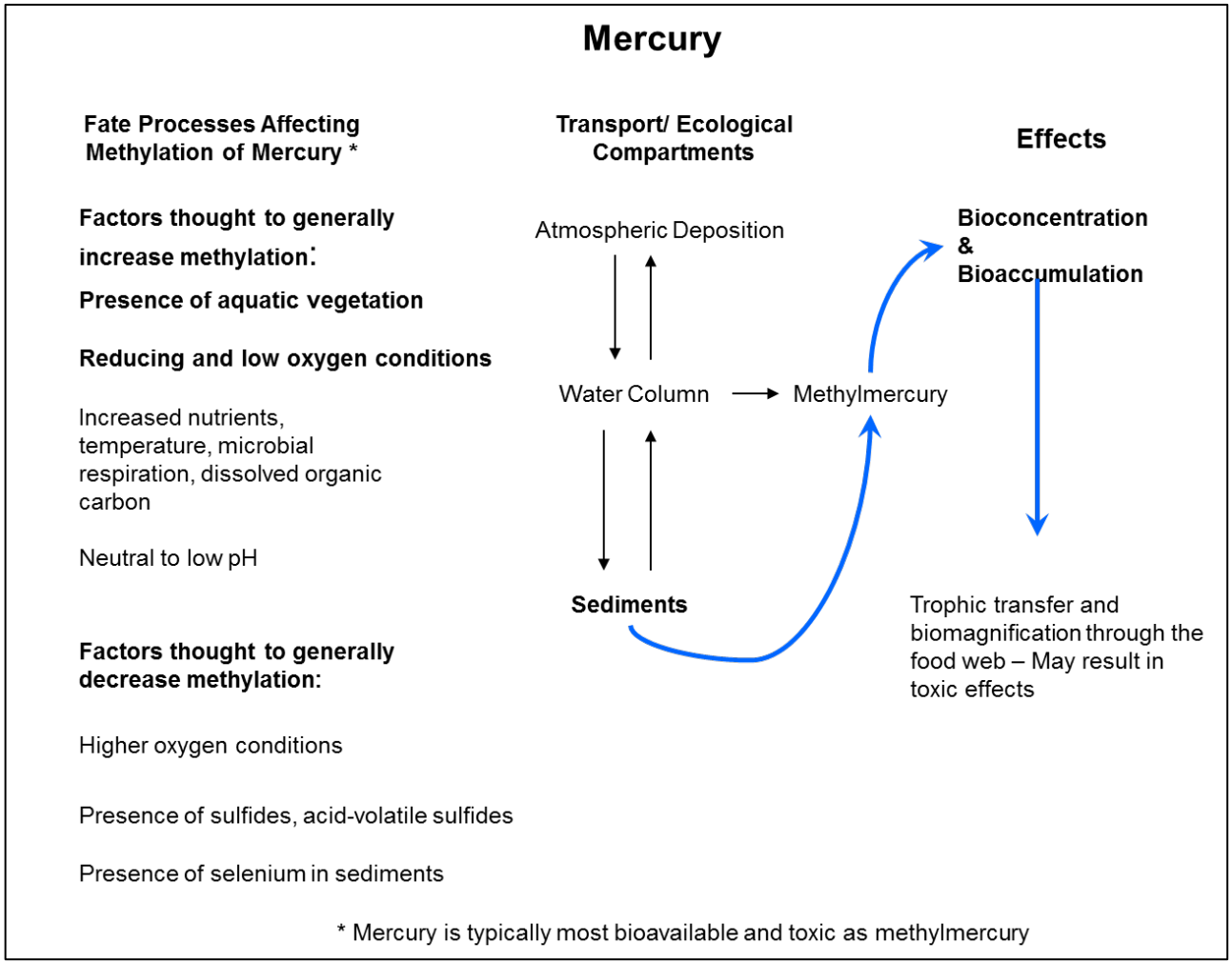


Figure 1-1. Factors in the Environment that Effect Mercury Bioconcentration and Bioaccumulation.

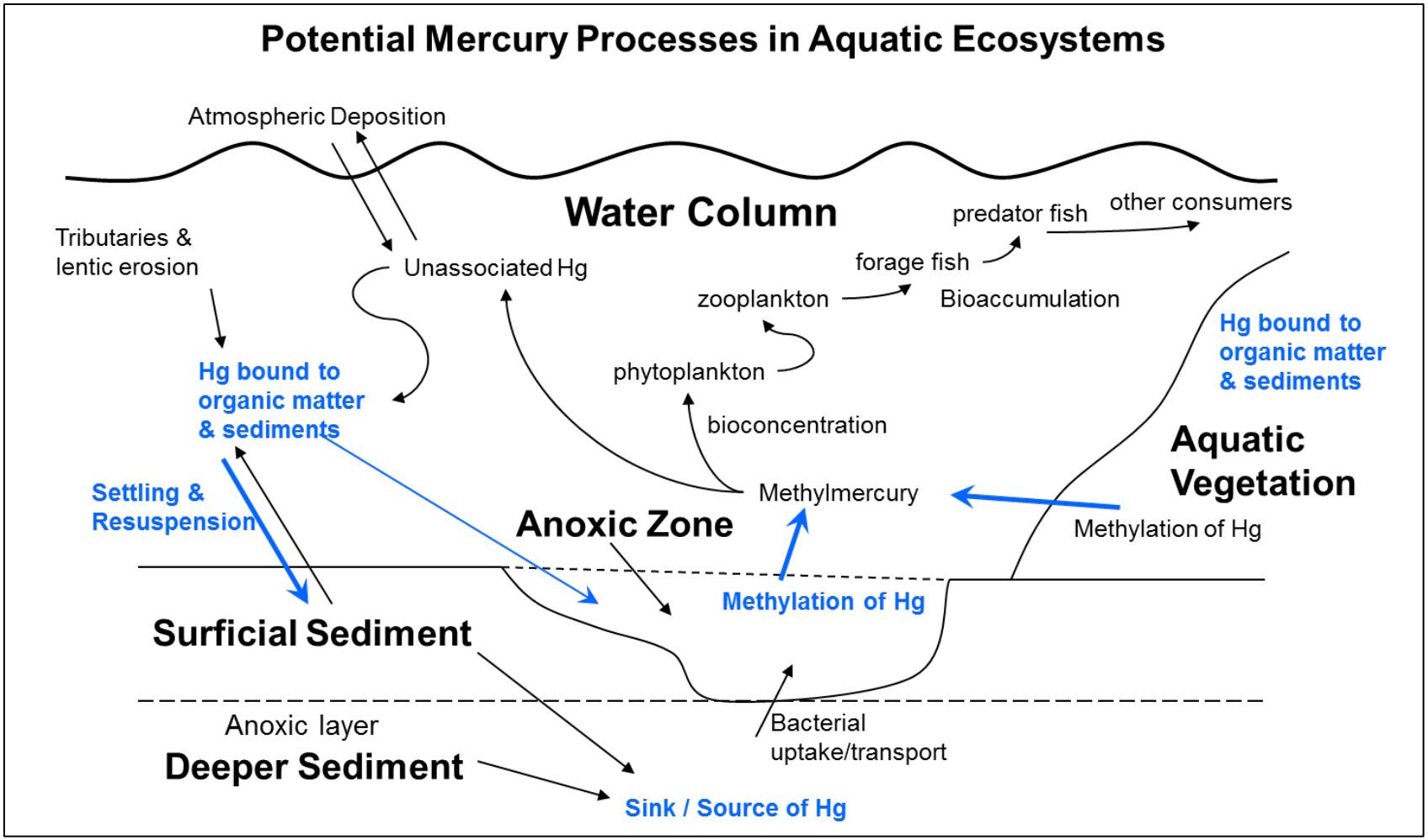


Figure 1-2. Potential Mercury in a Mature Reservoir.

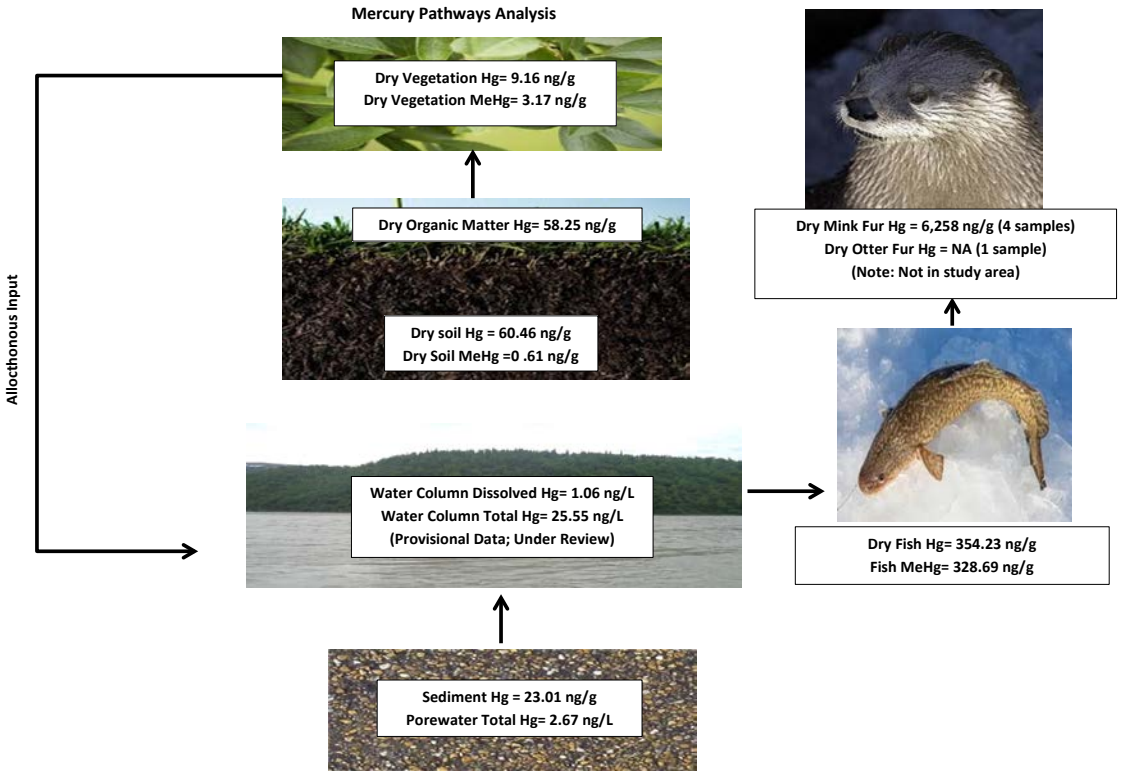


Figure 5.5-1. Average 2013 Mercury Concentrations and Pathways for Transfer of Mercury in the Susitna Basin.

11. TABLES

Table 5.3-1. 2014 Winter Sampling at Baseline Water Quality Monitoring Sites and Parameters.

Winter Baseline Water Quality Monitoring			
Sampling Date	Susitna River PRM	Lab Parameters	Field Parameters
1/28/2014	29.9, 87.8	TP, SRP, Ammonia, NO_3+NO_2, TKN, MeHg, Alkalinity, Hardness, TDS, TSS, TOC, DOC, Turbidity, Chlorophyll Dissolved and Total Al, As, Fe, Ba, Be, Cd, Cr, Co, Cu, Pb, Mo, Ni, Se, Tl, V, Zn, Mn, Ca, Mg, Hg	Color, Temperature, DO, pH, Specific conductance, ORP, Turbidity
1/29/2014	185, 225		
1/30/2014	140		
3/10/2014	29.9, 87.8		
3/11/2014	185, 225		
3/12/2014	140		

Table 5.3-2. 2014 Winter Sampling at Groundwater Well Monitoring Sites in Select Focus Areas.

Winter Focus Area Groundwater Well Monitoring			
Sampling Date	Focus Area	Lab Parameters	Field Parameters
2/6/2014	FA-104 (Whiskers Slough)	TP, SRP, Ammonia, NO_3+NO_2, TKN, MeHg, TOC, DOC, Turbidity, Dissolved and Total Al, Fe, Hg	Temperature, pH, Specific conductance, ORP, DO
2/12/2014	FA-138 (Gold Creek)		
2/17/2014	FA-128 (Slough 8A)		
3/6/2014	FA-104 (Whiskers Slough)		
3/12/2014	FA-138 (Gold Creek)		
3/16/2014	FA-128 (Slough 8A)		
4/2/2014	FA-104 (Whiskers Slough)		
4/9/2014	FA-138 (Gold Creek)		
4/13/2014	FA-128 (Slough 8A)		

Table 5.4-1. Focus Areas at which water quality sampling occurred.

Focus Area ID (Common Name)
FA-144 (Slough 21)
FA-141 (Indian River)
FA-138 (Gold Creek)
FA-128 (Slough 8A)
FA-115 (Slough 6A)
FA-113 (Oxbow 1)
FA-104 (Whiskers Slough)

Table 6.1-1. Concentrations of Mercury Compared to Criteria or Thresholds.

Sample Matrix	Maximum (ng/g dry or ng/L wet)	Minimum (ng/g dry or ng/L wet)	Mean (ng/g dry or ng/ L wet)	Standard Deviation	No. of Observations	Criteria or Threshold
Hg in Dry Vegetation	16.1	6.71	9.16	1.9	50	
MeHg in Dry Vegetation	5.15	2.54	3.17	0.53	50	
Hg in Dry Organic Matter	129	26.8	58.25	20.04	55	
Hg in Dry Soil	119	27.1	60.46	21.07	55	
MeHg in Dry Soil	4.34	0.096	0.61	0.89	55	
[1]Dissolved Hg in Water Column	58.7	0.5	1.06	4.21	375	Acute = 2,040 ng/L
Total Recoverable Hg in Water Column	See note [2]	See note [2]	See note [2]	See note [2]	See note [2]	Aquatic Life: Chronic = 12 ng/L Acute = 2,400 ng/L Human Health = 50 ng/L
Hg in Sediment	220	1.82	23.01	54.76	14	(SQuiRT) 174 ng/g
Hg in Sediment Porewater	12.5	0.5	2.67	3.98	14	
Dry Fish Tissue Hg (no liver included)	2,920	26.9	354.23	428.47	67	[3]29.07 ng/g – 380 ng/g
Dry Fish MeHg (no liver included)	2,860	25.2	328.69	307.79	67	
[4]Dry Mink Fur Hg	7,670	4,180	6,258	1,278	4	
[4]Dry Otter Fur Hg	6,330	2,070	NA	NA	2	
[5]Wet Wt. Otter Fur Hg	417	NA	NA	NA	1	

[1] Dissolved acute criterion is 85% of total recoverable mercury.

[2] Based on results from 2013 sampling, the total mercury concentrations for 2013 from water column samples are considered high estimates as results did not meet acceptance limits for laboratory performance. A correction factor will be developed for the 2013 results following QA/QC review of 2014 data

[3] Indicates range of total mercury reported from ADEC (2012) Susitna Basin study from several species with minimum concentration in Sockeye Salmon and maximum concentration in lake trout. (not an AWQS).

[4] Fur samples were collected outside the study area (near the Sustina River between Indian River and Portage Creek) in 2014 and results are considered provisional until the full quality assurance review is completed by mid-December 2014. Range of concentrations of Hg in Mink combine results from fur and fur & pelt results.

[5] River otter fur collected in the study area in 2014 and results are considered provisional until the full quality assurance review is completed by mid-December 2014. A single sample consisting of 4 hairs provided a single result.

Initial Study Report Meeting

Study 5.7 Mercury Assessment and Potential for Bioaccumulation

October 16, 2014

(revised per errata November 14, 2014)

Prepared by
Tetra Tech, Inc.

Study 5.7 Objectives

- Summarize **available and historic mercury information** for the Susitna River basin, including data collection from the 1980s Alaska Power Authority (APA) Susitna Hydroelectric Project
- **Characterize the baseline mercury concentrations** of the Susitna River and tributaries. This will include collection and analyses of vegetation, soil, water, sediment pore water, sediment, piscivorous birds and mammals, and fish tissue samples for mercury
- 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 develop maps of where mercury methylation may occur
- Use the **water quality model to predict** where in the reservoir **conditions** (pH, dissolved oxygen [DO], turnover) are likely **to be conducive to MeHg formation**
- Use **modeling to estimate MeHg** concentrations in fish.
- **Assess potential pathways for MeHg** to migrate to the surrounding environment
- **Coordinate study results with other study areas**, including fish, instream flow, and other piscivorous bird and mammal studies

Study 5.7 Components

- Vegetation (ISR Part A, Section 4.2.1; pg 3)
- Soil (ISR Part A, Section 4.2.2; pg 3)
- Water (ISR Part A, Section 4.2.3; pg 4)
- Sediment and Sediment Porewater (ISR Part A, Section 4.2.4; pg 7)
- Piscivorous Birds and Mammals (ISR Part A, Section 4.2.5; pg 8)
- Fish Tissue (ISR Part A, Section 4.2.6; pg 9)

Study 5.7 Variances

- Table 5.7-5 in Study Plan Section 5.7.4.2.3 summarizes the proposed water sampling locations for mercury analysis in water. PRM 225.5 (Susitna near Cantwell) could not be sampled due to limited access by helicopter. The sample site was relocated to PRM 235.2 (Susitna River adjacent to Oshetna Creek). See subsection 4.2.3.4 in this ISR.

- RSP Section 5.5.4.4.2 indicated that water samples would be collected at three locations along each transect for mainstem samples. Water samples were collected from just one position in the river due to limited access by wading at PRM 235.2 (Susitna River adjacent to Oshetna Creek) and 187.2 (Susitna at Watana Dam site). See subsection 4.2.3.4 in this ISR.

- Study Plan Attachment 5-1 indicated that an Ekman dredge or modified Van Veen grab sampler would be deployed from a boat; however, this approach was impractical and other approaches (wading) were employed (as identified in the QAPP). See subsection 4.2.4.1 in this ISR.

- EPA Method 1631 recommends digestion of mineral soil with aqua regia and oxidized with bromine monochloride (BrCl) to extract mercury from samples for analyses. The soil samples collected in 2013 contained a significant fraction of peat and organic material mixed with soil. For these types of organic soils, EPA recommends digestion with HNO_3/H_2SO_4 digestion before using BrCl. Given the soil was a mix of organic and inorganic components, each sample was split and analyzed them using both digestion methods, giving two analytical results for each sample.

Study 5.7 Variances

- RSP Section 5.7.4.6.1 indicated seven to ten of each target species of fish would be collected; however, additional fish were collected for some species (Arctic grayling and round whitefish). The Study Plan also indicated that only adult fish would be collected; however, some juvenile specimens were incidentally collected. While most were released, if a juvenile fish was captured accidentally and died, it was analyzed.

- The Study Plan indicated that all fish would be speciated; however, two fish could not be successfully speciated. Also, it was not possible to successfully extract otoliths from all fish captured; however, sufficient otolith data is available from other studies.

- The Study Plan required determination of the sex and sexual maturity of the fish, however, determination of gender for the fish proved to be problematic in the field, and the sex of only 12 fish was determined. The proposed field collection period for fish was from August to September; however, the sample period was extended into October to obtain sufficient samples. Polyethylene sheets rather than Teflon sheets were used for the fish when placed in the sample bag. See subsection 4.2.6.1.

Study 5.7 Summary of Results in ISR (ISR Study 5.7, Part A – Section 5)

- Samples collected in 2013 include:
  - Vegetation and soil samples collected from ten locations at five different sites within each location.
  - Water quality samples collected from 17 baseline sites and 7 focus areas.
  - Sediment and sediment porewater samples collected from 4 sites.
  - ~~60~~ 67 fish tissue samples collected including tissues from trout, longnose sucker, Dolly Varden, Arctic grayling, slimy sculpin, burbot, and whitefish.

- 2013 Lab results for mercury concentrations in vegetation, soil, water, sediment, sediment porewater, and fish tissue were not received in time for inclusion in the ISR. Results have been QA/QCd and will be included in the USR.

Study 5.7 Summary of Results since ISR

(Evaluation of Continued Mercury Monitoring Beyond 2014, September 2014 Tech Memo)

- Average concentration of dissolved mercury in the water column was 1.06 ng/L from 2013 results . This concentration is substantially lower than the criterion for chronic effects.

- The average sediment mercury result was 23.01 ng/g . One result from mercury in sediment (220 ng/g) exceeded the recommended SQuiRT Threshold from a total of ~~13~~ 14 results.

- Background information for mercury in fish tissue was acquired from recent fish tissue analysis by ADEC with results ranging from 29.07ng/g (total mercury in Sockeye salmon) – 380.0 ng/g (total mercury in lake trout) in the Susitna Drainage (ADEC 2012). The average concentration among several species of fish sampled in 2013 from the Susitna drainage was within the range described by ADEC.

Study 5.7 Summary of Results since ISR Cont.

(Evaluation of Continued Mercury Monitoring Beyond 2014, September 2014 Tech Memo)

Sample Matrix	Maximum (ng/g dry or ng/L wet)	Minimum (ng/g dry or ng/L wet)	Mean (ng/g dry or ng/L wet)	Standard Deviation	No. of Observations	Criteria or Threshold
Hg in Dry Vegetation	16.1	6.71	9.16	1.90	50	
MeHg in Dry Vegetation	5.15	2.54	3.17	0.53	50	
Hg in Dry Organic Matter	129	26.8	58.25	20.04	55	
Hg in Dry Soil	119	27.1	60.46	21.07	55	
MeHg in Dry Soil	4.34	0.096	0.61	0.89	55	
[1]Dissolved Hg in Water Column	58.7	0.5 (DL)	1.06	4.21	375	Acute = 2,040 ng/L
Total Recoverable Hg in Water Column	See note [2]	See note [2]	See note [2]	See note [2]	See note [2]	Aquatic Life: Chronic = 12 ng/L Acute = 2,400 ng/L Human Health = 50 ng/L
Hg in Sediment (4 Sites)	220	1.82	23.01	54.76	14	(SQuiRT) 174 ng/g
Hg in Sediment Porewater (4 Sites)	12.5	0.5	2.67	3.98	14	
Dry Fish Tissue Hg (no liver included)	2,920	26.9	354.23	428.47	67	[3]29.07 ng/g – 380 ng/g
Dry Fish MeHg (no liver included)	2,860	25.2	328.69	307.79	67	
[4]Dry Mink Fur Hg	**7,670**	**4,180**	**6,258**	**1,278**	**4**	
[4]Dry Otter Fur Hg	**6,330**	**2,070**	NA	NA	**2**	
[5]Wet Wt. Otter Fur Hg	**417**	NA	NA	NA	**1**	

[1] Dissolved acute criterion is 85% of total recoverable mercury.

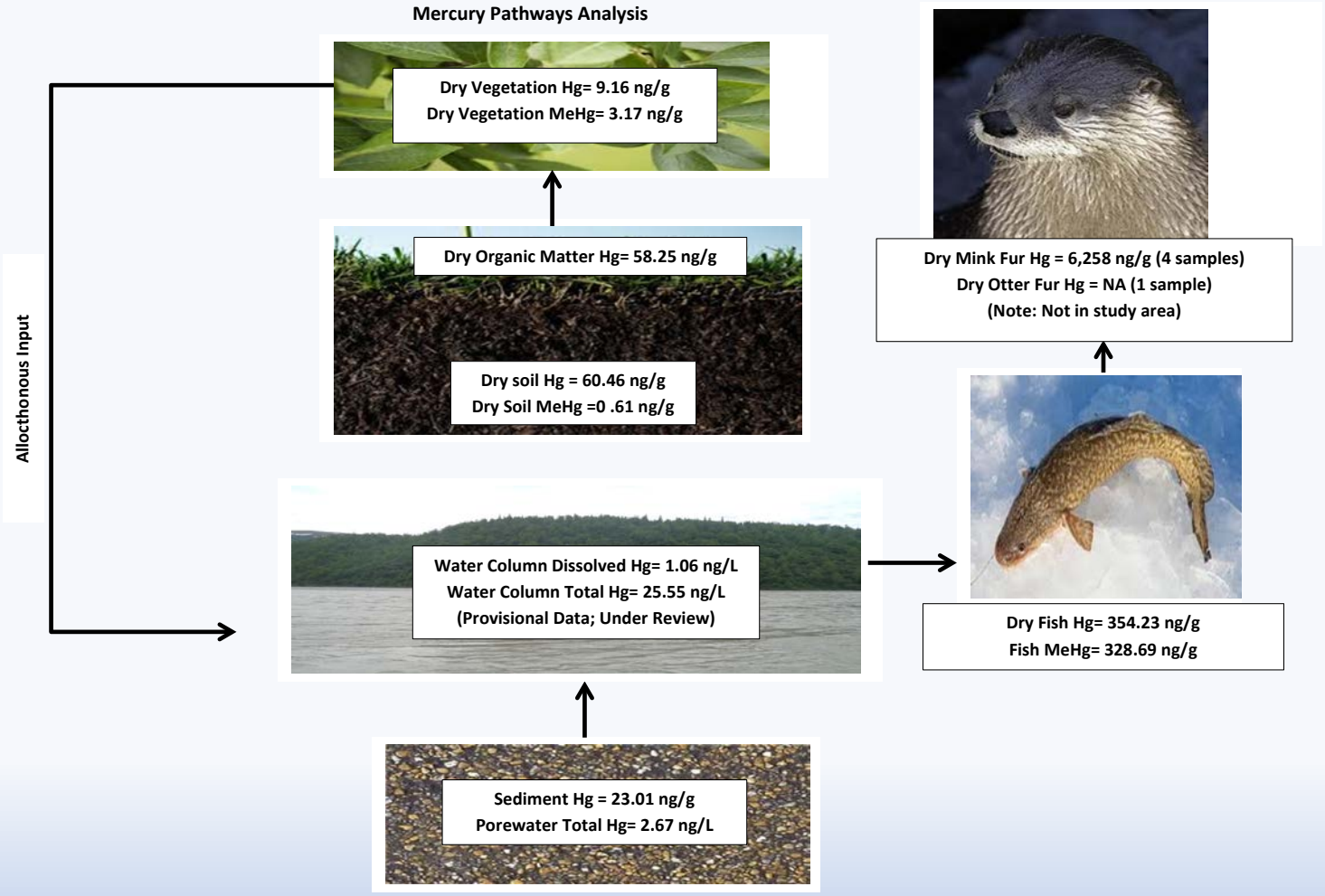
[2] Based on results from 2013 sampling, the total mercury concentrations for 2013 from water column samples are considered high estimates as results did not meet acceptance limits for laboratory performance. A correction factor will be developed for the 2013 results following QA/QC review of 2014 data

[3] Indicates range of total mercury reported from ADEC (2012) Susitna Basin study from several species with minimum concentration in Sockeye Salmon and maximum concentration in lake trout. (not an AWQS).

[4] Fur samples were collected **outside the study area** in 2014 and results are considered **provisional** until the full quality assurance review is completed by mid-December 2014. Range of concentrations of Hg in Mink combine results from fur and fur & pelt results.

[5] River otter fur collected **in the study area** in 2014 and results are considered **provisional** until the full quality assurance review is completed by mid-December 2014. A single sample consisting of 4 hairs provided a single result.

Study 5.7 Summary of Results since ISR Cont. (Evaluation of Continued Mercury Monitoring Beyond 2014 Tech Memo)



AEA Proposed Modifications to Study 5.7 in ISR (ISR Study 5.7, Part C – Section 7.1.2)

7.1.2.1. Extension of Mercury Water Quality Sampling

- "Estimated" laboratory results call for more total mercury sampling in 2014 (change from RSP Section 5.7.4.2.3.)
  - Parameters affected: total metals (except Ca and Mg), total mercury, total phosphorus, total Kjeldahl nitrogen, total nitrate+nitrite-nitrogen, and dissolved aluminum

7.1.2.2. In-Accessible Sediment Sampling Locations

- Six sediment samples (planned for 2013) located on CIRWG lands will be collected for mercury analysis in 2014 (change from RSP Section 5.7.4.2.4.)

7.1.2.3. Modifications to Sediment Sampling Methods

- Originally planned to use a Van Veen sampler lowered from a boat (RSP Section 5.7.4.2.4.), but a boat in the upper river has proven impractical
  - Back to sediment sampling methods used in 2013 (ISR 5.5; Section 4.5)

AEA Proposed Modifications to Study 5.7 in ISR (ISR Study 5.7, Part C – Section 7.1.2) (Continued)

7.1.2.4. Modification of Sediment, Water, and Porewater Sampling Locations

- Sample locations for water, sediment, and sediment porewater sites in Upper River were modified slightly due to lack of access
  - Available data shows river as well mixed and water quality to have little variability

7.1.2.5. Modification of Fish Tissue Sampling

- Previous fish sampling in Upper Susitna Basin indicate humpback whitefish to be rare, they have been taken out of the study
- Rainbow trout and stickleback not found in inundation zone and also take out of the study
- Round whitefish were added to the study (all changes from RSP Section 5.7.4.6.1. and 5.5.4.7.)
- Only older aged burbot were caught, no younger (no additional sampling planned)

AEA Proposed Modifications to Study 5.7 in ISR (ISR Study 5.7, Part C – Section 7.1.2)

7.1.2.6. Modification of Piscivorous Wildlife Tissue Sampling

- Initial evaluation of the potential for bioaccumulation will focus on the aquatic environment
  - Samples for mercury study collected in 2014 only from water and sediment for analysis of mercury and methylmercury
- Collection of tissue samples from piscivorous wildlife for mercury analysis described for various species groups in Studies 10.11, 10.14, 10.15, and 10.16 is being consolidated under Study 5.7
- Very few samples of river otter or mink hair have been attained (trappers and hair snags)
  - Last resort would be to hire trappers for lethal collection of animals in study area for mercury analysis

AEA Proposed Modifications to Study 5.7 in ISR (ISR Study 5.7, Part C – Section 7.1.2) (Continued)

7.1.2.6. Modification of Piscivorous Wildlife Tissue Sampling

- Collecting feathers from vacated nests of piscivorous birds was found to be unproductive
  - Study 10.14 added three tasks to assist Study 5.7: provide info on distribution, abundance, foot habits and diet of piscivorous raptors, collect feather samples from active nests after nesting season for characterization of mercury levels, and provide information on the effects of methylmercury on piscivorous raptors
  - Possible use of contractor to capture live Bald Eagles to obtain blood and feather samples for mercury analysis
- Collecting feathers from vacated nests of piscivorous waterbirds (Study 10.15) was unsuccessful
  - Possible hiring of highly skilled specialty contractor to do live tissue sampling for mercury analysis
- Single target species of piscivorous landbird (Belted Kingfisher) because the species is rare and no nests were found
  - No longer considered suitable target species for mercury analysis

Current Status and Steps to Complete Study 5.7

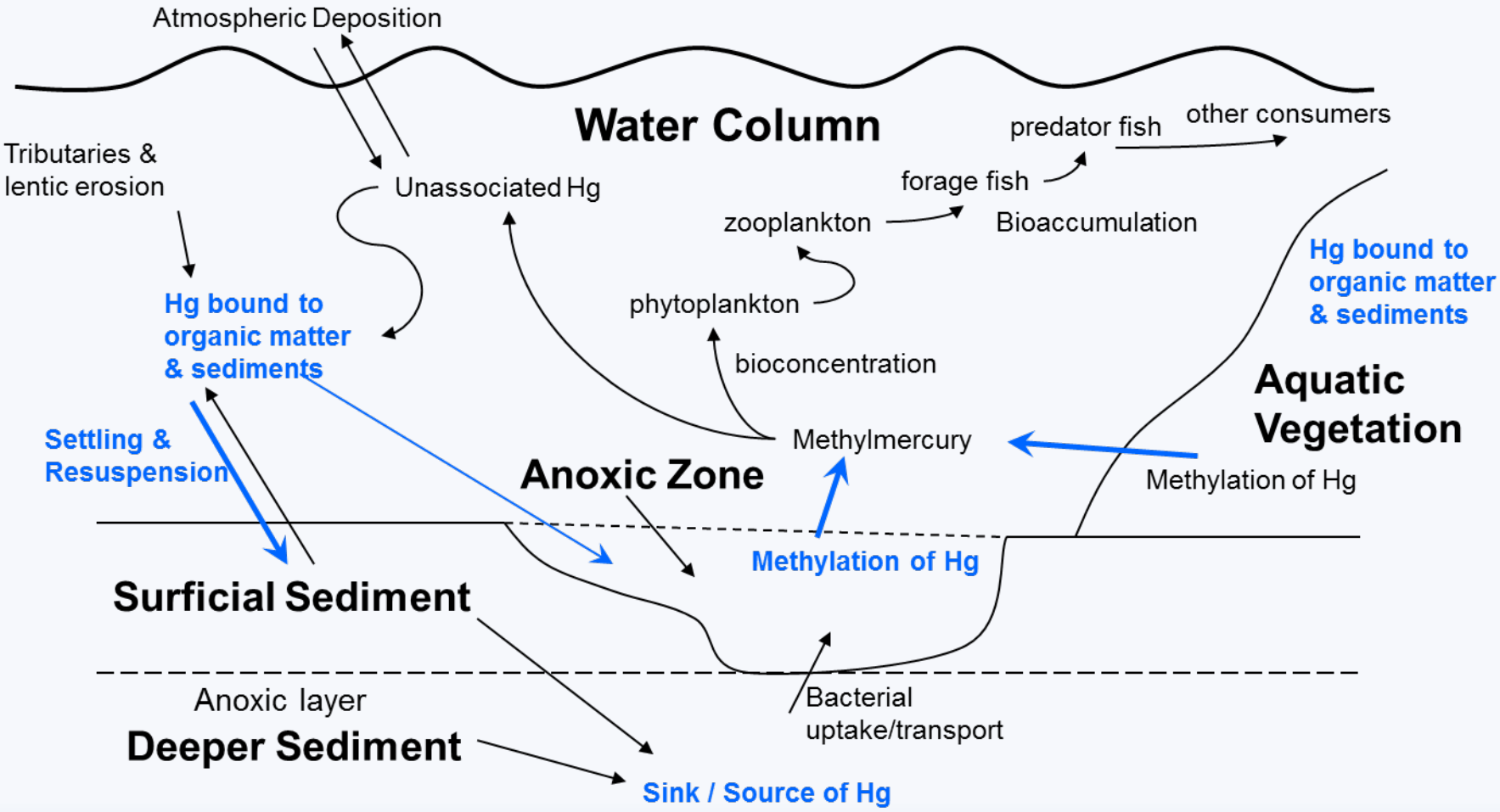
- In 2013, vegetation, soil, and fish tissue mercury sampling was completed and referenced in the ISR Study 5.7 Section 5.

- Planned activities for 2014 as referenced in ISR Study 5.7, Part C- Section 7.1 that have been completed include
  - Collection of sediment samples at the six remaining sites located on CIRWG lands (RSP Section 5.7.4.2.4)
  - Limited winter water quality sampling occurred in January and March of 2014 (RSP Section 5.7.4.2.3)
  - Summer monthly water sampling from June to September 2014 (see ISR Section 5.5 for details)

- Pathway analysis has not yet been completed and is the next major component of this study that will determine potential sources for bioaccumulation.

- Based upon its preliminary review of the mercury results measured in each of the media, AEA is not proposing any additional sampling for mercury in 2015.

Potential Mercury Processes in Aquatic Ecosystems



Potential Mercury Pathway in a Mature Reservoir

Licensing Participants Proposed Modifications to Study 5.7?

- Agencies
- CIRWG members and Ahtna
- Public