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Chief Joseph Dam Fish Hatchery Water Source Water Quality Study, 2004

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Introduction

The Seattle District Corps of Engineers Hydrology and Hydraulics Section (COE) conducted a baseline water quality assessment of fish hatchery water sources at Chief Joseph Dam during the 2004 water year. Potential sources of water identified for this study include the relief tunnel, the irrigation inlet structure located near the right bank in the forebay, and the Bridgeport State Park irrigation well located along the right bank upstream of the forebay. The fish hatchery would utilize one or more of these sources of water during the entire year to meet the quantity and quality of water needed for hatchery operations.

The quality of the proposed hatchery source water is important because water quality can determine the success or failure of fish hatchery operations. Physical and chemical characteristics of the source waters must be properly analyzed and evaluated in order to select a suitable water source. Historical sampling conducted in 1989 and 1990 at the relief tunnel and a nearby well located on the site of the proposed hatchery detected mercury and nitrite in concentrations exceeding Washington State Department of Fish and Wildlife recommended water quality criteria for aquaculture programs. Consequently, the Colville Tribe expressed concerns about the quality of the relief tunnel and vicinity well water for hatchery operations. To address these concerns, the COE designed a water study to quantify more precisely the water quality of all potential water sources for the fish hatchery.

Purpose and Scope

The Seattle District Corps of Engineers conducted a water quality assessment of potential surface water and groundwater hatchery source waters during 2004. The purpose of the study was to characterize the quality of the relief tunnel, irrigation well and forebay waters during the winter, spring, and summer to determine if these waters are of sufficient quality for use at a fish hatchery. The objective of the monitoring program was to determine existing water quality conditions of possible hatchery source waters during a water year to determine whether seasonal differences exist.

These objectives were addressed using data collection and analysis methods to evaluate ground water quality and surface water quality. The study was conducted from February through August 2004. Data were collected from one (1) surface water station in the relief tunnel, one (1) surface water station in the forebay, and one (1) groundwater station at an irrigation well in Bridgeport State Park.

Methods

Site Characterization

Chief Joseph Dam is located at river mile 545 on the Columbia River in Washington, about 51 miles downstream of Grand Coulee Dam (Figure 1). The dam is a concrete gravity dam, 230 feet high, with 19 spillway bays which abut the right bank. The general location of the irrigation inlet structure, the relief tunnel, and the Bridgeport State Park irrigation well are shown in Figure 1.

The irrigation inlet structure is located on the face of the dam near the right bank at a depth of about 30 feet below the forebay water surface under normal pool conditions. The relief tunnel extends over 1,000 feet from the northwest end of the spillway into the right abutment. Access to the tunnel is by way of galleries in the interior of the dam. The tunnel captures water seeping from the forebay through the right bank and towards the right abutment. Water drains into the tunnel via wood stave wells located in the floor of the tunnel, flows down the tunnel into a sump located near the foot of the gallery stairs, and ultimately drains to the Columbia River via a 4-foot culvert. The Bridgeport State Park irrigation well is located about 1.5 miles upstream of the dam at a distance from the river of about 500 feet and an elevation above the river of about 20 feet. The well was drilled in 1967 and is 71 feet deep with a static water level of about 26 feet.

Data Collection

Sampling procedures were conducted according to the *Preliminary Scope of Work: Water Quality Sampling at Chief Joseph Dam for the Colville Tribe Fish Hatchery* (USCOE 2003), and generally followed Puget Sound Estuary Program (PSEP) protocols (U.S. EPA 1990). Water quality parameters monitored are shown in Table 1. Sampling locations are presented in Figure 1. Prior to the sampling event, all sampling equipment was thoroughly cleaned and decontaminated following PSEP protocols. The equipment was scrubbed with a brush and detergent (1 percent Liquinox), thoroughly rinsed with deionized water, rinsed with a 10 percent Nitric Acid solution, and given a final rinse with deionized water.

Surface Water Sampling Procedures

Surface water grab samples were collected from the center of the channel in the relief tunnel and from a depth of 30 feet in the forebay by field technicians wearing new vinyl gloves. Relief tunnel samples were collected by submerging laboratory-cleaned, prelabled sample containers below the water surface to a depth of about 1 foot. Forebay samples were collected from a depth of 30 feet by submerging a cleaned and decontaminated 2.2 liter (L) polycarbonate (Lexan) van-dorn style sampler with ultra-clean seals to depth and filling. All sample containers were rinsed

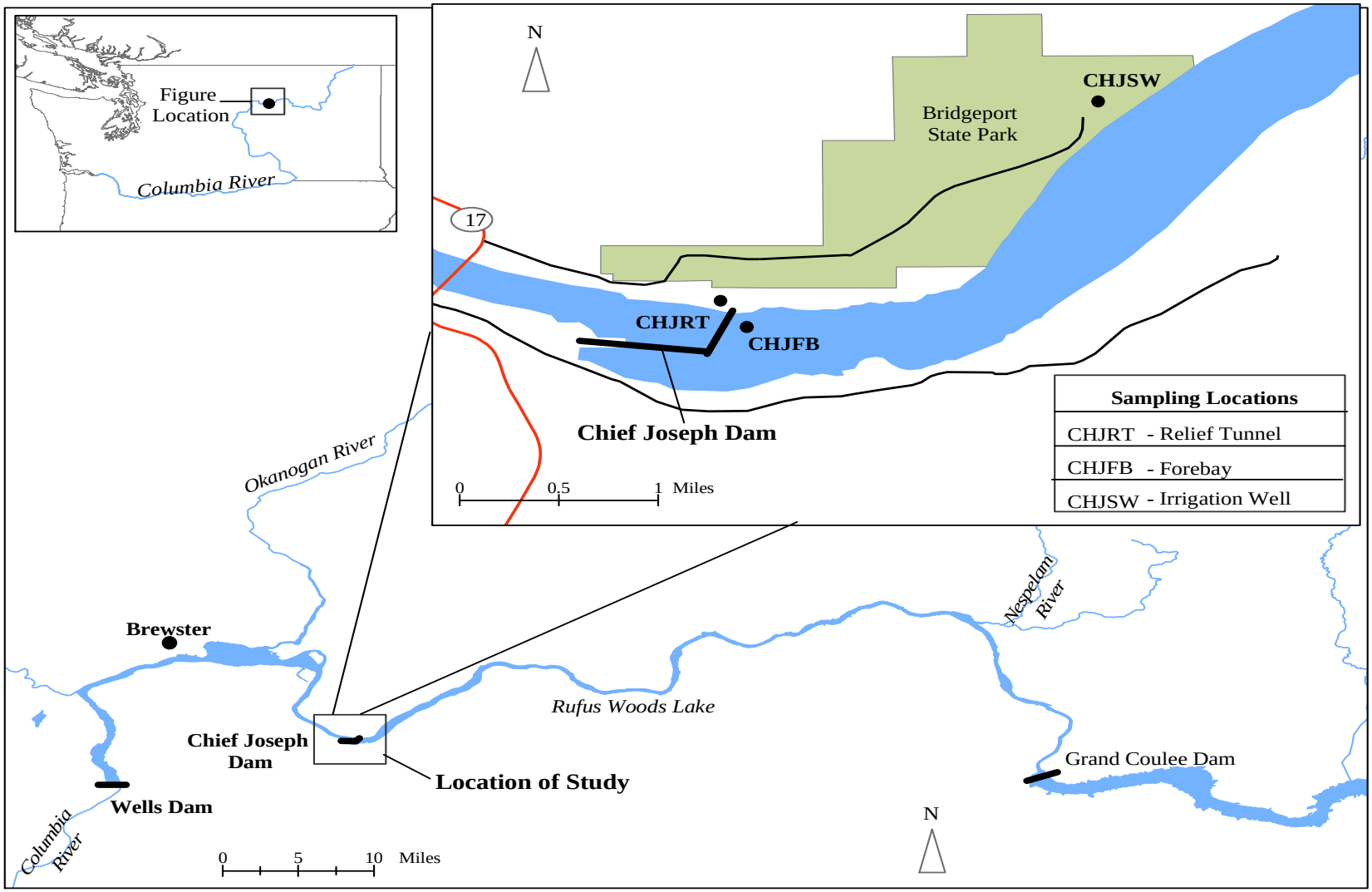

Figure 1. Location of the study.

Table 1. Methods and detection limits for water quality analyses.

	Matrix	Method Number [a]	Detection Limit/Unit
Field Parameters			
Temperature	Water	SM 2550-B	0.1°C
pH	Water	SM 4500-H	–
Conductivity	Water	SM 2510-B	1 µS/cm
Turbidity	Water	SM 2130-B	0.1 NTU
Dissolved Oxygen	Water	SM 4500-O-G	0.1 mg/L
Laboratory Parameters			
Total Phosphorus	Water	AM 4500PB	0.010 mg/L
Total Nitrogen	Water	EPA 351.2	0.100 mg/L
Nitrate+Nitrite	Water	EPA 353.2	0.010 mg/L
Nitrite	Water	EPA 354.1	0.010 mg/L
Ammonia	Water	EPA 350.1	0.010 mg/L
Alkalinity	Water	EPA 310.1	1.00 mg/L
Hardness	Water	SM182340B	1.00 mg/L
Calcium	Water	EPA 6010	0.100 mg/L
Magnesium	Water	EPA 6010	0.100 mg/L
Potassium	Water	EPA 6010	0.700 mg/L
Sodium	Water	EPA 6010	0.500 mg/L
Sulfate	Water	EPA 300	1.00 mg/L
Chloride	Water	EPA 300	0.50 mg/L
Fluoride	Water	EPA 300	0.100 mg/L
Aluminum	Water	EPA 200.8	0.020 mg/L
Arsenic	Water	EPA 200.8	0.002 mg/L
Barium	Water	EPA 200.8	0.005 mg/L
Cadmium	Water	EPA 200.8	0.0002 mg/L
Chromium	Water	EPA 200.8	0.0020 mg/L
Copper	Water	EPA 200.8	0.0010 mg/L
Iron	Water	EPA 200.8	0.020 mg/L
Lead	Water	EPA 200.8	0.0010 mg/L
Manganese	Water	EPA 200.8	0.005 mg/L
Mercury	Water	EPA 1631B	0.0020 µg/L
Nickel	Water	EPA 200.8	0.0020 mg/L
Selenium	Water	EPA 200.8	0.0030 mg/L
Silver	Water	EPA 200.8	0.0010 mg/L
Zinc	Water	EPA 200.8	0.005 mg/L
Total Dissolved Solids	Water	EPA 160.1	5.00 mg/L
Pesticide/PCB	Water	EPA 8081/8082	0.005 µg/L to 0.1 µg/L

[a] SM method numbers are from APHA et al. (1992); EPA method numbers are from U.S. EPA (1983, 1984).
mg/L Milligrams per liter
µS/cm Microsiemens per centimeter
NTU Nephelometric turbidity unit

3 times prior to filling, capped, and immediately placed on ice in a cooler. Measurements of field parameters (See Table 1) were performed by submerging a Hydrolab DataSonde 4

multiprobe directly into the forebay water or from a sample withdrawn from the relief tunnel. Equipment used for field measurements was calibrated prior to the sampling event. One set of field duplicates was collected at the forebay station to assess both environmental and analytical variability. All samples were transported to the laboratory within 24 hours, where they were analyzed for the parameters shown in Table 1.

Ground Water Sampling Procedures

The irrigation well was sampled according to the following procedures:

- Field sample collection was conducted by two people wearing new powderless vinyl gloves and utilizing the clean hands (CH)-dirty hands (DH) methodology.

- The well was purged prior to sampling by turning on the pump the night before sampling for 1 to 2 hours to remove a minimum of 3 well casing volumes prior to sampling. The day of sampling, the well was purged by fully opening the spigot and purging at a rate of about 5 gallons per minute for a minimum of 30 minutes or until pH, turbidity, and conductivity readings stabilized. Field parameters, purge volume, purge rate, and time were recorded in the field notebook.

- Equipment used for field measurements was calibrated prior to each sampling event. Water quality parameters (pH, conductivity, and turbidity) were monitored every three to five minutes during purging. Stabilization was achieved after all three parameters stabilized for three successive readings within ± 0.1 units for pH, ± 3 percent for conductivity, and ± 10 percent for turbidity.

- Upon sample stabilization, sampling was initiated by field technicians wearing new vinyl gloves at each sampling location. Sampling flow rate was maintained at the established purge rate and samples were collected from the spigot into containers prepared by the analytical laboratory for the given parameters.

- Prior to collecting the sample, the spigot was turned off and the spigot was scrubbed with a brush and detergent (1 percent Liquinox), followed by a de-ionized water rinse. The spigot was turned back on at the established purge rate and pumped to waste a minimum of 10 minutes prior to sample collection.

- Samples intended for dissolved metals analysis were delivered to the laboratory and filtered within 8 hours of sample collection.
- A duplicate ground water sample was collected to asses analytical variability and was labeled similar to the other samples and submitted blind to the laboratory.
- All sampling containers were appropriately labeled, immediately placed on ice in a cooler, and delivered to the appropriate laboratory following proper chain of custody procedures.

Quality Assurance Procedures

Quality assurance of water quality samples followed procedures set forth in the *Preliminary Scope of Work: Water Quality Sampling at Chief Joseph Dam for the Colville Tribe Fish Hatchery* (USCOE 2003). Data were validated according to the sampling and analysis plan, and quality control data provided by the laboratory were combined with results of field duplicates to check the precision and accuracy of the data. Data validation results are presented in Attachment A at the end of this report. Values qualified as estimates were used in the evaluation.

Water Quality Criteria

The Washington Department of Ecology (WDOE) and the Colville Confederated Tribe (CCT) determines surface water quality criteria for the Columbia River at Chief Joseph Dam in Washington. The WDOE has classified the Columbia River above and below Chief Joseph Dam as a Salmon and Trout spawning non-core rearing and migration aquatic life use water body, while the CCT has classified the Columbia River as a Class I water body above Chief Joseph Dam and a Class II water body below the dam. These criteria are designed for the protection of aquatic life in fresh surface waters of the state of Washington and the Colville Reservation. However, at the time of this report, water quality criteria for regulating source waters intended for aquaculture do not exist for the state of Washington. In lieu of aquaculture specific criteria, the Washington Department of Fish and Wildlife (WDFW) has compiled a list of recommended water quality criteria for source waters intended for aquaculture uses as shown in Table 2. For comparative purposes, WDOE and CCT surface water chronic criteria are also shown in Table 2.

Historical Data

Historical water quality data for the relief tunnel, forebay, and a water supply well located on the site of the proposed hatchery are presented in Table 3. Data collected in 1977 by Koch and Cochran (1977) from the relief tunnel and forebay are limited and represent only field parameters and conventionals. Relief tunnel samples were collected near the lower end of the tunnel, while

forebay samples were collected from the surface about 50 feet upstream of the dam. Data collected by the COE between 1989 and 2003 represent the most complete data set for these water sources. Samples from the relief tunnel, forebay, and hatchery site well were analyzed for field parameters, conventionals, metals and bacteria. Relief tunnel samples were collected near the lower end of the tunnel about 15 feet upstream of the sump while forebay samples were collected from the surface about 50 feet upstream of the dam.

Little difference in water quality for the relief tunnel, forebay, and hatchery site well was observed between samples collected in 1977, 1989, 1990, and 2003 except for mercury. Mercury was detected in the relief tunnel and hatchery site well in 1989 and 1990 at concentrations exceeding both the WDFW recommended criteria and the WDOE chronic criteria. Sampling at both sites on January 29, 2003 had a mercury detection limit above the WDFW and WDOE criteria, so re-sampling occurred on May 13, 2003 using a lower detection limit. The May 13, 2003 samples detected mercury in the relief tunnel and forebay at concentrations well below the WDFW and WDOE criteria. The WDFW criteria for nitrite was exceeded in the relief tunnel and forebay samples on January 29, 2003, while nitrate+nitrite concentrations were relatively low. No other exceedances of the WDFW or WDOE water quality criteria were observed from the historical data.

Results and Discussion

Water quality results are shown in Table 4. In general, water quality at the relief tunnel, irrigation well and forebay locations were good with few exceedances of the WDFW recommended criteria for aquaculture and no exceedances of the WDOE or CCT chronic criteria. Field parameters monitored include temperature, conductivity, pH, dissolved oxygen, and turbidity. These parameters show slight differences between sampling locations. Relief tunnel and irrigation well water had a higher conductivity, likely reflecting the influence of chemical interactions between the surface water and the overlying soil and bedrock along the right bank. Additionally, the irrigation well had higher pH levels, probably due to local geological influences. These higher pH levels exceeded the WDFW recommended criteria for aquaculture of 8.0, but were less than the WDOE and CCT chronic criteria. Temperature in the relief tunnel was cooler than the irrigation well. However, compared to the forebay the relief tunnel and irrigation well had warmer water in the winter and spring and cooler water in the summer.

Conventional parameters data indicate that the relief tunnel and irrigation well water quality is similar, with only minor differences to the forebay. Slightly greater alkalinity, hardness, calcium, potassium, sodium, and total dissolved solids concentrations in the relief tunnel and irrigation well suggest that chemical interactions between the forebay water seeping into the right bank and the overlying soil and bedrock may be occurring. The overall similarity in water quality between the relief tunnel, irrigation well and the forebay suggest that the major source of water to the relief tunnel and irrigation well is the Columbia River. However, the slightly greater concentrations of several major ions together with the observed differences in conductivity could also indicate that another source of water, possibly ground water derived from local precipitation, is influencing the relief tunnel and irrigation well water quality.

Four forms of nitrogen were sampled, total kjeldhal nitrogen (TKN), nitrate + nitrite-nitrogen ($NO_3 + NO_2$), nitrite (NO_2), and ammonia nitrogen ($NH_4^+ + NH_3$). The dissolved inorganic forms of nitrogen, ammonia and nitrate + nitrite are all readily available for plant growth. Total kjeldhal nitrogen includes ammonia plus organic nitrogen, while nitrate + nitrite-

Table 2. Washington State Department of Fish and Wildlife Recommended Water Quality Criteria for Aquaculture, and CCT and WDOE Chronic Criteria.

		WDFW Recommended Values			
Parameter	**Units**	**Piper Values [a]**	**U.S. EPA Values [a]**	**CCT Values [b]**	**WDOE Values [b]**
Alkalinity (as $CaCO_3$)	mg/L	10 – 400	At least 20	At least 20	—
Aluminum	mg/L	< 0.01	—	0.087	—
Ammonia (as NH_3)	mg/L	0.0125	0.02	0.028[c]	0.028[c]
Arsenic	mg/L	< 0.05	—	0.15	0.19
Barium	mg/L	< 5.0	—	—	—
Cadmium (Alk > 100 mg/L)	mg/L	< 0.0004	0.0004	0.0002[b]	0.0009[b]
Cadmium (Alk < 100 mg/L)	mg/L	—	0.003	—	—
Calcium Carbonate	mg/L	4 – 160	—	—	—
Carbon Dioxide	mg/L	0 – 10	—	—	—
Chloride	mg/L	< 4.0	—	230	230
Chlorine	mg/L	< 0.03	0.003	.011	0.011
Chromium	mg/L	< 0.03	0.03	0.062 [b]	0.148[b]
Copper (Alk > 100 mg/L)	mg/L	< 0.006	0.006	0.0074 [b]	0.0094[b]
Copper (Alk < 100 mg/L)	mg/L	—	0.03	—	—
Fluoride	mg/L	< 0.5	—	—	—
Hardness	mg/L	10 – 400	—	—	—
Hydrogen Cyanide	mg/L	< 0.01	—	—	0.0052
Hydrogen Sulfate	mg/L	< 0.0001	0.002	0.002	—
Iron	mg/L	< 0.15	—	1	—
Lead	mg/L	< 0.03	0.03	0.002 [b]	0.0020[b]
Manganese	mg/L	< 0.01	—	—	—
Mercury	µg/L	< 0.2	0.2	0.77	0.012
Nickel	mg/L	< 0.01	—	0.043 [b]	0.1302[b]
Nitrate	mg/L	0 – 3	—	—	—
Nitrite	mg/L	< 0.1	—	—	—
Nitrogen	% sat	< 100	—	110	110
PCBs	mg/L	< 0.002	0.002	0.000014	0.000014
pH	units	6.5 – 8.0	6.0 – 9.0	6.5-8.5	6.5-8.5
Potassium	mg/L	< 5.0	—	—	—
Salinity	ppt	< 5.0	—	—	—
Selenium	mg/L	< 0.01	—	0.005[d]	0.005[d]
Settleable Solids	mg/L	< 80	< 80	—	—
Silver	mg/L	< 0.003	—	0.0024[b]	0.0024[b]
Sodium	mg/L	< 75	—	—	—
Sulfate	mg/L	< 50	—	—	—
Total Dissolved Solids	mg/L	10 – 1000	—	—	—
Total Suspended Solids	mg/L	< 80	< 80	—	—
Uranium	mg/L	< 0.1	—	—	—
Vanadium	mg/L	< 0.1	—	—	—
Zinc	mg/L	< 0.03	—	0.0978 [b]	0.0865 [b]

a Sources: Piper et al (1982) and U.S. EPA (1973).
b Dissolved metals chronic criteria for waters with an average hardness of 80 mg/L, except Silver, which is an acute criteria.
c. Based on a typical pH value of 7.8 and a water temperature of 10°C.
d. Total recoverable fraction.

Table 3. Summary of historical water data collected in the relief tunnel, forebay and hatchery well at Chief Joseph Dam.

	Historical Data Relief Tunnel (1/19/1977)[1]	**Historical Data** Relief Tunnel (4/14/1989)[2]	**Historical Data** Relief Tunnel (5/26/1989)[2]	**Historical Data** Relief Tunnel (1/29/2003)[2]	**Historical Data** Relief Tunnel (5/13/2003)[2]	**Historical Data** Forebay (1/19/1977)[1]	**Historical Data** Forebay (1/29/2003)[2]	**Historical Data** Forebay (5/13/2003)[2]	**Historical Data** Well (9/19/1990)[2]
Field Parameters									
Temperature (°C)	—	—	—	—	—	—	—	—	—
pH	**8.77**	—	—	—	—	7.67	—	—	—
Conductivity (µS/cm)	162	170	—	161	—	141	138	—	270
Turbidity (NTU)	—	0.4	—	< 0.5	—	—	< 0.5	—	0.2
Conventionals/Bacteria									
Nitrate+Nitrite (mg/L)	—	—	—	0.32	—	—	0.4	—	—
Nitrate (mg/L)	0.75	0.3	—	0.16	—	0.49	0.21	—	2.5
Nitrite (mg/L)	—	—	—	**0.16**	—	—	**0.19**	—	—
Alkalinity (mg/L)	—	—	—	—	—	—	—	—	—
Hardness (mg/L)	88.5	80	—	72.9	—	72.7	67.2	—	120
Calcium (mg/L)	22.3	—	—	21	—	20.2	19.5	—	—
Magnesium (mg/L)	5.3	—	—	4.97	—	4.3	4.5	—	—
Potassium (mg/L)	1.5	—	—	—	—	0.65	—	—	—
Sodium (mg/L)	2.4	< 5	—	2.18	—	1.5	1.46	—	< 10
Sulfate (mg/L)	9.8	—	—	8.4	—	11.5	8.9	—	—
Chloride (mg/L)	0.5	< 5	—	< 0.5	—	0.5	< 0.5	—	< 5
Fluoride (mg/L)	—	< 0.2	—	0.15	—	—	0.12	—	< 0.2
Total Dissolved Solids (mg/L)	86.1	—	—	64	—	75	382	—	—
Total Coliform Bacteria (#/100mL)	—	—	—	< 2	—	—	< 2	—	—
Fecal Coliform Bacteria (#/100mL)	—	—	—	< 2	—	—	< 2	—	—

Table 3. Summary of historical water data collected in the relief tunnel, forebay and well at Chief Joseph Dam (Continued).

	Historical Data Relief Tunnel (1/19/1977)[1]	**Historical Data** Relief Tunnel (4/14/1989)[2]	**Historical Data** Relief Tunnel (5/26/1989)[2]	**Historical Data** Relief Tunnel (1/29/2003)[2]	**Historical Data** Relief Tunnel (5/13/2003)[2]	**Historical Data** Forebay (1/19/1977)[1]	**Historical Data** Forebay (1/29/2003)[2]	**Historical Data** Forebay (5/13/2003)[2]	**Historical Data** Well (9/19/1990)[2]
Dissolved Metals									
Arsenic (mg/L)	—	< 0.010	—	< 0.002	—	—	< 0.002	—	< 0.010
Barium (mg/L)	—	< 0.250	—	0.014	—	—	0.043	—	< 0.250
Cadmium (mg/L)	—	< 0.002	—	< 0.0003	—	—	< 0.0003	—	< 0.002
Chromium (mg/L)	—	< 0.010	—	< 0.0047	—	—	< 0.0047	—	< 0.010
Copper (mg/L)	—	< 0.250	—	< 0.002	—	—	< 0.002	—	< 0.250
Iron (mg/L)	—	< 0.100	—	0.0124	—	—	0.013	—	< 0.100
Lead (mg/L)	—	< 0.002	—	< 0.0005	—	—	< 0.0005	—	< 0.002
Manganese (mg/L)	—	<0.010	—	< 0.002	—	—	< 0.002	—	<0.010
Mercury (µg/L)	—	**0.6**	**0.6**	**< 0.3**	0.000171	—	**< 0.3**	0.000365	**0.5**
Nickel (mg/L)	—	—	—	< 0.010	—	—	< 0.010	—	—
Selenium (mg/L)	—	< 0.005	—	< 0.005	—	—	< 0.005	—	< 0.005
Silver (mg/L)	—	< 0.010	—	< 0.0047	—	—	< 0.0047	—	< 0.010
Zinc (mg/L)	—	< 0.250	—	< 0.020	—	—	< 0.020	—	< 0.250

1. Source: Koch and Cochran (1977)
2. Source: USCOE (2004)

mg/L Milligrams per liter
µg/L Micrograms per liter
µS/cm Microsiemens per centimeter
NTU Nephelometric turbidity unit
< Analyte not detected at specified detection limit
— Not analyzed/not available

0.001 Value Exceeds Washington State Department of Fish and Wildlife Recommended Criteria for Aquaculture (Piper et al. 1982; U.S. EPA 1973)

Table 4. Summary of current water data collected at Chief Joseph Dam.

	CHJRT Relief Tunnel (2/3/2004)	**CHJFB** Forebay (2/3/2004)	**CHJFB** Forebay (5/18/2004)	**CHJSW** Irrigation Well (5/19/2004)	**CHJRT** Relief Tunnel (6/6/2004)	**CHJRT** Relief Tunnel (8/8/2004)	**CHJFB** Forebay (8/17/2004)	**CHJSW** Irrigation Well (8/17/2004)
Field Parameters								
Temperature (°C)	12.8	2.7	10.0	14.8	10.0	9.4	19.2	14.0
pH	7.7	7.8	7.9	**8.2**	7.7	7.8	7.7	**8.2**
Conductivity (µS/cm)	157	135	117	159	159	161	129	181
Turbidity (NTU)	0.3	1.0	—	0.2	—	—	—	0.1
Dissolved Oxygen (mg/L)	6.9	10.5	10.9	9.0	7.5	9.1	8.2	6.0
Conventionals								
Total Phosphorus (mg/L)	0.031	0.016	0.008	0.024	0.021	0.024	0.013E	0.026
Total Kjeldahl N (mg/L)	< 0.2	< 0.2	0.25	0.13	< 0.12	0.32	0.43	< 0.10E
Nitrate+Nitrite (mg/L)	0.14	0.15	0.092	0.165	0.198	0.183	0.06	0.183
Nitrite (mg/L)	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010
Ammonia (mg/L)	0.017	< 0.01	0.03	0.017	0.04	< 0.010	0.013	< 0.010
Alkalinity (mg/L)	74	63	58.8	76.7	73.1	72.4	56.5	76.2
Hardness (mg/L)	66	67	63	74	78	73	56	79
Calcium (mg/L)	19	18.7	17.8	20	22.4	21.3	16	21.7
Magnesium (mg/L)	4.61	4.86	4.45	5.71	5.43	4.73	3.9	6
Potassium (mg/L)	1.4	0.7	0.78	2.57	1.44	1.61	0.59	3.04
Sodium (mg/L)	2.3	1.8	2.26	3.65	2.32	2.44	1.76	5.8
Sulfate (mg/L)	8.9	9.6	9.1	11.8	9.6	7.7	6.7	11.1
Chloride (mg/L)	0.9	1	1.1	0.9	1	0.9	0.8	1.1
Fluoride (mg/L)	< 0.1	< 0.1	< 0.1	0.14	0.12	0.1	0.1	0.1
Total Dissolved Solids (mg/L)	99	68	63	98E	89	100	79	117
Dissolved Metals								
Aluminum (mg/L)	< 0.02	< 0.02	< 0.02	**0.04**	**0.04**	< 0.02	< 0.02	< 0.02
Arsenic (mg/L)	0.0011	0.0004	0.0005	0.0022	0.001	0.001	0.0004	0.0024
Barium (mg/L)	0.015	0.025	0.027	0.0172	0.0141	0.014	0.0277	0.018
Cadmium (mg/L)	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002
Chromium (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	0.0007	< 0.0005
Copper (mg/L)	< 0.0005	0.0006	0.0006	0.0006	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Iron (mg/L)	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Lead (mg/L)	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Manganese (mg/L)	< 0.001	< 0.001	< 0.0005	< 0.001	0.0012	< 0.0005	0.0006	< 0.0005
Mercury (µg/L)	0.000118E	0.000256E	0.00062	0.000214E	0.000137E	0.0018	0.000444	0.000158E
Nickel (mg/L)	0.0005	0.0007	< 0.0005	0.0009	< 0.0005	0.0006	< 0.0005	< 0.0005
Selenium (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Silver (mg/L)	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	<0.0002	< 0.0002	< 0.0002
Zinc (mg/L)	< 0.006	< 0.006	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004

Table 4. Summary of current water data collected at Chief Joseph Dam (Continued).

	CHJRT Relief Tunnel (2/3/2004)	CHJFB Forebay (2/3/2004)	CHJFB Forebay (5/18/04)	CHJSW Irrigation Well (5/19/04)	CHJRT Relief Tunnel (6/6/2004)	CHJRT Relief Tunnel (8/8/04)	CHJFB Forebay (8/17/2004)	CHJSW Irrigation Well (8/17/2004)
PCBs (µg/L)								
Aroclor 1016	< 0.1	< 0.1	< 0.020	< 0.024	< 0.030	< 0.025	< 0.026	< 0.027
Aroclor 1242	< 0.1	< 0.1	< 0.020	< 0.024	< 0.030	< 0.025	< 0.026	< 0.027
Aroclor 1248	< 0.1	< 0.1	< 0.020	< 0.024	< 0.030	< 0.025	< 0.026	< 0.027
Aroclor 1254	< 0.1	< 0.1	< 0.020	< 0.024	< 0.030	< 0.025	< 0.026	< 0.027
Aroclor 1260	< 0.1	< 0.1	< 0.020	< 0.024	< 0.030	< 0.025	< 0.026	< 0.027
Aroclor 1221	< 0.1	< 0.1	< 0.020	< 0.024	< 0.030	< 0.035	< 0.026	< 0.027
Aroclor 1232	< 0.1	< 0.1	< 0.020	< 0.024	< 0.050	< 0.025	< 0.026	< 0.027
Pesticides (µg/L)								
alpha-BHC	< 0.0062 E	< 0.0052 E	< 0.0050	< 0.0060	< 0.0050	< 0.0050	< 0.0050	< 0.0058
beta-BHC	< 0.0062 E	< 0.0052 E	< 0.0050	< 0.0060	< 0.0050	< 0.0050	< 0.0050	< 0.0058
delta-BHC	< 0.0062 E	< 0.0052 E	< 0.0050	< 0.0060	< 0.0050	< 0.0050	< 0.0050	< 0.0058
gamma-BHC (Lindane)	< 0.0062 E	< 0.0052 E	< 0.0050	< 0.0060	< 0.0050	< 0.0050	< 0.0050	< 0.0058
Heptachlor	< 0.0062 E	< 0.0052 E	< 0.0050	< 0.0060	< 0.0050	< 0.0050	< 0.0050	< 0.0058
Aldrin	< 0.0062 E	< 0.0052 E	< 0.0050	< 0.0060	< 0.0050	< 0.0050	< 0.0050	< 0.0058
Heptachlor Epoxide	< 0.0062 E	< 0.0052 E	< 0.0050	< 0.0060	< 0.0050	< 0.0050	< 0.0050	< 0.0058
Endosulfan I	< 0.0062 E	< 0.0052 E	< 0.0050	< 0.0060	< 0.0050	< 0.0050	< 0.0050	< 0.0058
Dieldrin	< 0.012 E	< 0.010 E	< 0.010	< 0.012	< 0.010	< 0.010	< 0.010	< 0.012
4,4'-DDE	< 0.012 E	< 0.010 E	< 0.010	< 0.012	< 0.010	< 0.010	< 0.010	< 0.012
Endrin	< 0.012 E	< 0.010 E	< 0.010	< 0.012	< 0.010	< 0.010	< 0.010	< 0.012
Endosulfan II	< 0.012 E	< 0.010 E	< 0.010	< 0.012	< 0.010	< 0.010	< 0.010	< 0.012
4,4'-DDD	< 0.012 E	< 0.010 E	< 0.010	< 0.012	< 0.010	< 0.010	< 0.010	< 0.012
Endosulfan Sulfate	< 0.012 E	< 0.010 E	< 0.010	< 0.012	< 0.010	< 0.010	< 0.010	< 0.012
4,4'-DDT	< 0.012 E	< 0.010 E	< 0.010	< 0.012	< 0.010	< 0.010	< 0.010	< 0.012
Methoxychlor	< 0.062 E	< 0.052 E	< 0.050	< 0.060	< 0.050	< 0.050	< 0.050	< 0.058
Endrin Ketone	< 0.012 E	< 0.010 E	< 0.010	< 0.012	< 0.010	< 0.010	< 0.010	< 0.012
Endrin Aldehyde	< 0.012 E	< 0.010 E	< 0.010	< 0.012	< 0.010	< 0.010	< 0.010 R	< 0.012 R
gamma Chlordane	< 0.0062 E	< 0.0052 E	< 0.0050	< 0.0060	< 0.0050	< 0.0050	< 0.0050	< 0.0058
alpha Chlordane	< 0.0062 E	< 0.0052 E	< 0.0050	< 0.0060	< 0.0050	< 0.0050	< 0.0050	< 0.0058
Toxaphene	< 0.62 E	< 0.52 E	< 0.50	< 0.60	< 0.50	< 0.50	< 0.50	< 0.58

mg/L Milligrams per liter
µg/L Micrograms per liter
µS/cm Microsiemens per centimeter
NTU Nephelometric turbidity unit
E Estimated value
R Rejected value
< Analyte not detected at specified detection limit
— Not analyzed/not available

0.001 Value Exceeds Washington State Department of Fish and Wildlife Recommended Criteria for Aquaculture.

nitrogen represents total oxidized nitrogen, with nitrite being an intermediate state between ammonia and nitrate. Nitrate is an essential plant nutrient, while nitrite can be a plant nutrient but is toxic to animal life and is generally rapidly oxidized to ammonia in oxygenated waters. Ammonia nitrogen is largely produced by the deamination of organic nitrogen containing compounds and is a plant nutrient that is often utilized before nitrate. Ammonia is generally reported as the combined ionized (NH_4^+ -ammonium) and unionized (NH_3-ammonia) forms of ammonia. However, only the unionized form of ammonia (NH_3) is toxic to freshwater life and this form of ammonia has water quality criteria established (See Table 2). Equations can be used to estimate the concentration of unionized ammonia fraction from measured values of the pH and temperature of the water.

Ammonia was detected at all stations at very low concentrations, and ranged from <0.01 mg/L to 0.04 mg/L. Using an average unionized ammonia percentage of 1.8 percent in pH 8.0 water at 10 °C (APHA 1992), the calculated unionized ammonia concentrations at all stations are well below WDFW and WDOE criteria. In general, chronic ammonia toxicity is not a problem in pH 8.0 water at 10 °C when ammonia-nitrogen concentrations are less than about 2 mg/L (EPA 2002). Nitrate + nitrite concentrations were moderate at all locations with no discernable seasonal variation. Nitrite was not detected in the relief tunnel, irrigation well or forebay samples.

Concentrations of dissolved metals except aluminum did not exceed the WDFW recommended criteria for aquaculture or the WDOE and CCT chronic criteria. Aluminum concentrations in the relief tunnel on June 6, 2004 (0.040 mg/L) and in the irrigation well on May 19, 2004 (0.040 mg/L) exceeded the WDFW recommended criteria for aquaculture of 0.010 mg/L, but were below the CCT chronic criteria of 0.087 mg/L. Moreover, the laboratory aluminum detection limit of 0.02 mg/L was greater the WDFW criteria suggesting that exceedances may have occurred in non-detected samples. However, aluminum toxicity to salmonids is related to pH and hardness, with reduced toxicity at higher pH and hardness levels (Driscoll et al. 1980). It is likely that the pH range for the relief tunnel and irrigation well (7.7 to 8.2) would substantially reduce any aluminum toxicity. Concentrations of all other detected metals were well below the WDFW, WDOE, and CCT criteria.

Mercury concentrations in the relief tunnel (range of 0.000118 µg/L to 0.0018 µg/L), irrigation well (range of 0.000158 µg/L to 0.000214µg/L) and forebay (range of 0.000256 µg/L to 0.00062 µg/L) were similar to concentrations detected in the relief tunnel and forebay on May 13, 2003 (0.000171 µg/L and 0.000365 µg/L, respectively) and well below historic concentrations detected in the relief tunnel in 1989 (0.6 µg/L). These data suggest that mercury concentrations in the relief tunnel, irrigation well, and forebay waters may not be a water quality concern for the fish hatchery.

Polychlorinated biphenyls (PCBs) were not detected at the relief tunnel, irrigation well and forebay at the laboratory detection limits shown in Table 4. The WDFW recommended criteria of 2 µg/L was not exceeded. However, because the laboratory detection limits (about 0.025 µg/L) were greater the WDOE and CCT chronic criteria (0.014 µg/L), exceedances of the chronic criteria may have occurred in non-detected samples.

Chlorinated pesticides were not detected at the relief tunnel, irrigation well and forebay at the laboratory detection limits shown in Table 4. There are no WDFW recommended criteria for pesticides. However, for pesticides such as Chlordane, 4,4' DDT, and Toxaphene the detection limits were greater than the WDOE and CCT chronic criteria, suggesting that exceedances may have occurred in non-detected samples.

Conclusions

Water quality samples collected from the relief tunnel, irrigation well, and forebay during 2004 were characterized by good water quality with only a few exceedances of the WDFW recommended criteria for aquaculture and the WDOE and CCT chronic criteria for surface waters. Exceedances of the WDFW criteria for pH occurred at the irrigation well while exceedances of the WDFW criteria for aluminum occurred at the relief tunnel and irrigation well. No PCBs or pesticides were detected during the study. However, it should be noted that the detection limits for PCBs and some pesticides exceeded the WDOE and CCT chronic criteria suggesting that exceedances may have occurred in some non-detected samples.

Historical elevated concentrations of mercury and nitrite measured in the relief tunnel and forebay were not observed during the current study. Mercury concentrations measured during 2004 in the relief tunnel, irrigation well, and forebay were low and well below water quality criteria. Additionally, nitrite was not detected in any sample during the study.

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Attachment A

Quality Assurance Report

This report presents results from the quality assurance review of data collected for the Chief Joseph Dam Fish Hatchery Water Quality Monitoring Project. Data assessment procedures used in this quality assurance review are based on the following eight control elements:

- Completeness
- Methodology
- Holding times
- Detection limit
- Blanks
- Duplicates
- Matrix spikes
- Control samples.

No major problems were associated with the data collected in connection with this project. The following sections provide specific details for each of the quality control elements reviewed and any resultant corrective action required.

Completeness

Completeness was assessed by comparing valid sample data values with total number of sample values. Because the number of valid sample data divided by the total number of samples was greater than the quality assurance objective of 95 percent, no corrective actions were required to address problems related to completeness.

Methodology

Methodology was assessed by examining field notebooks, sampling data sheets, and laboratory reports for deviations from the monitoring plan and quality assurance plan. Subsequent to this review, it was concluded that there were no significant deviations in methodology that required corrective action.

Holding Times

Holding times were assessed by comparing analytical dates to sample collection dates. Corrective action was implemented for all values that exceeded the maximum holding times required by U.S. EPA. Holding time problems were encountered in the following analysis:

- Pesticide samples collected on 2/3/04 from all sites were extracted beyond the required 7-day holding time. Data qualified as an estimate (E).

- Forebay sample collected on 8/17/04 exceeded the holding time for total phosphorus. Data qualified as an estimate (E).

- Irrigation well sample collected on 8/17/04 exceeded the holding time for total kjeldahl nitrogen. Data qualified as an estimate (E).

Blanks

Preparation blanks, which are composed of reagent water that is prepared as a sample, were analyzed with collected samples, and the results were reported in each laboratory report. If a blank value exceeded the detection limit, corrective actions were to be implemented for the associated samples. Blank problems were encountered in the following analysis:

- Mercury was detected in the method blank for relief tunnel and forebay samples collected on 2/3/04. Data detected at less than 5 times the blank value were qualified as estimates (E).

- A method blank for the relief tunnel sample collected on 6/6/04 failed to meet laboratory acceptance criteria. Data were qualified as an estimate (E).

Detection Limits

Laboratory data were reported with a method detection limit (MDL) and a reporting detection limit (RDL). The laboratory MDL represents the minimum concentration of a constituent that can be detected. All data values that were below the MDL were qualified as below detection with a < symbol next to the reported detection limit. Detection limit problems were encountered in the following analysis:

- Mercury was detected in the irrigation well sample collected on 5/19/04 at a concentration above the MDL but below the laboratory quantitation limit. Data were qualified as an estimate (E).

- Mercury was detected in the irrigation well sample collected on 8/17/04 at a concentration above the MDL but below the laboratory quantitation limit. Data were qualified as an estimate (E).

Duplicates

Laboratory duplicates are two aliquots of a sample processed concurrently and identically. Corrective action was implemented for all laboratory duplicates with a relative percent difference (RPD) greater than 20 percent. No duplicate problems were encountered.

Matrix Spikes

Matrix spikes are used as an indicator of matrix effects on sample recovery and precision. If a percent recovery from a matrix spike was not within 80 to 120 percent for conventionals and metals or a pre-determined laboratory range for organics, corrective actions were implemented where necessary. No matrix spike problems were encountered.

Control Samples

Control samples refer to check standards, blank spikes, or standard reference materials. If the percent recovery for a control standard was not within 80 to 120 percent for conventionals and metals, and a pre-determined laboratory range for organics, corrective actions were implemented, where necessary. Control sample problems were encountered in the following analysis:

- A low recovery (7.5 percent) was measured for Endrin Aldehyde for forebay and irrigation well samples collected on 8/17/04. Data were rejected (R).