MASON DAM WATER QUALITY TECHNICAL MEMORANDUM
BAKER COUNTY, OREGON
-Revised Draft-

Prepared for

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Table of Contents

1.0 INTRODUCTION

Baker County has applied to the Federal Energy Regulatory Commission (FERC) to develop hydroelectric energy at the existing Mason Dam. Mason Dam was built by the US Bureau of Reclamation (BOR) on the Powder River for irrigation water delivery and flood control. Water is stored behind Mason Dam in Phillips Lake, and released during the irrigation season by Baker Valley Irrigation District. As part of the licensing process, FERC and other resource agencies requested a number of studies to be completed. One of the requested studies was to describe the baseline condition of temperature and dissolved oxygen (DO) within Phillips Reservoir near the existing intake and then immediately downstream in the Powder River. Water quality data was collected by Baker County between May and October, 2007.

This technical memorandum primarily summarizes the temperature and DO results, describing the baseline condition according to the following objectives:

Phillips Lake

- Identify the dissolved oxygen and temperature profile within Phillips reservoir in the vicinity of the Mason Dam intake

- Describe any temporal variations of DO concentrations and temperature

- Identify and describe reservoir stratification

Mason Dam Intake

- Identify the DO concentration of water entering the Mason Dam intake at its approximate depth and vicinity

Mason Dam Stilling Basin

- Describe the DO concentration of water in the stilling basin immediately below Mason Dam

Powder River Downstream of Mason Dam

- Describe the attenuation of DO in the Powder River downstream of Mason Dam

This memorandum also summarizes the baseline data for pH, specific conductance, alkalinity and turbidity. This memorandum has been developed as part of a larger water quality report being pulled together by the County.

2.0 ANALYTICAL METHODS

Sampling was conducted between May 4 and October 12, 2007 according to the protocols in the original study plan. Sampling started two weeks after the 2007 Phillips Lake ice-off date of April 15. Sampling occurred at the following locations:

- Phillips Lake in the vicinity of the Mason Dam intake,

- Immediately below Mason Dam in the stilling basin, and

- Three Powder River sites located at approximately 1-mile intervals downstream of Mason Dam. The location of these river sites is depicted in Appendix A.

Sampling started at the most downstream river site about 1/2 hour after sunrise with sampling generally beginning in the lake between 8:00 to 9:00 am. Sampling occurred weekly except for during the weeks of July 9-15, July 30-August 15, and August 28-September 2 due to equipment malfunction.

Some measurements were suspected not to be accurate as they were out of the realm of feasible parameter ranges (e.g., pH values of 14). Values obtained during a period of known or suspected equipment malfunctions were excluded from subsequent data analysis. However, even with these missing values, the sampling provided a sufficient data set on which the analyses could be conducted

Temperature and DO were generally measured in Phillips Reservoir at 1 meter intervals using a DO meter. These measurements were subsequently often made at 5 meter-intervals using a grab sample and titration. Because the grab sample tends to artificially aerate the sample, only the DO meter measurement was used for those depths with duplicate measurements.

The Mason Dam intake is located between 3975.0 feet (top) and 3972.5 feet (bottom)above MSL. The field measurements were made at set intervals below the water surface, as it occurred at that date and time. The location of the intake was calculated by first (1) identifying the reservoir surface elevation during the sampling based on the BOR hydromet data (**www.usbr.gov/pn-bin/dfcgi.pl/?sta=PHL)** and (2) subtracting the intake top elevation from the water surface elevation to identify the intake distance below the surface. During some sampling events, a measurement was made at the exact location of the intake. If not, the nearest measurement to the intake was used for subsequent analysis.

Most of the analysis for the primary parameters of temperature and dissolved oxygen was conducted using time-series analysis. Correlations between temperature and DO on the Powder River sites were developed through regression analysis. Confidence intervals were calculated at a significance level of 0.05. Confidence intervals were only calculated where there were more than 3 degrees of freedom. Analyses for the other parameters were primarily qualitative.

3.0 RESULTS-TEMPERATURE AND DO

3.1 Phillips Lake

3.1.1 Vertical and Temporal Changes in Temperature and DO

The temperature and DO concentrations within Phillips Lake change both vertically and temporally during the growing season, from a fall condition of uniform parameters, regardless of depth, to strong differences in temperature and DO according to the depth below the water surface. In general, the relatively uniform temperatures and dissolved oxygen concentrations in Phillips Lake, begin to change in May as the upper surface layers are warmed faster than the lower layers. During the spring (May and June), average temperatures vary by up to 5 °C between the reservoir surface and the bottom of the water column. These differences increase to 10 °C by July, as the surface layer warms to more than 20 °C, while the temperatures near the bottom of the reservoir remain relatively constant between 10.4 to 11.2 °C.

DO concentrations change as both the temperature changes and the reservoir starts to stratify according to temperature and water density (see section 3.1.2). During May, average DO concentrations remain between 9.7 to 9.9 mg/L above 15 meters, and average 7.0 mg/L below 15 meters. The DO concentrations decrease throughout the water column during the summer, with the magnitude and timing of decrease varying by depth and the degree of reservoir stratification. These changes are described in detail below in section 3.1.2 Stratification.

Table 1 provides a summary of mean temperature and DO values by month and depth. Representative profiles depicting changes in these parameters by both depth and over time can be found in Appendix B.

3.1.2 Stratification

Description
The 2007 reservoir sampling was initiated on May 11. At that time, some weak stratification of the reservoir had started but there was no sharp thermocline (see Glossary in section 5.0 for term definitions). During May, temperatures averaged 14.4 °C near the surface, generally showed a gradual reduction with depth (i.e, less than 1 °C per meter) to 15 meters where the temperatures leveled off at 9.3 °C (Table 1). The DO levels showed little change with depth until 15 meters where the DO dropped from an average between 9.7 to 9.9 mg/L to an average of 7.0 mg/L.

Stratification continued to develop during June with strong stratification into three clearly defined layers by July. Concurrent with the distinct stratification, the oxygen concentrations declined to near zero in the hypolimnion. During the summer stratification,

- The thermocline, which developed between 7 and 15 meters below the surface, became sharper and narrower during August (between 10-15 meters) and September (between 12-14 meters).

- The surface layer (epilimnion) remained aerated, although oxygen concentrations dropped below 8.0 mg/L during the summer and continuing into the fall.

- Dissolved oxygen was close to anoxic levels below 15 meters (in the hypolimnion) between July and September (0.1-0.3 mg/L).

- Anoxic conditions extended into the thermocline during August.

The October 5 sampling yielded only a few data points, but these points indicated that there were still differences in temperature and DO by depth. Between October 5 and 12, the water column in the reservoir mixed or "turned over" and by October 12, there were no significant vertical differences in either temperature (10.8 ± 0.008 °C) or dissolved oxygen concentrations (6.5 ± 0.08 mg/L).

Based on the 2007 sampling data, the annual stratification pattern in Phillips Lake can be described as:

- Fall turnover occurring in mid-October. Reservoir likely staying mixed until April.

- Stratification starting to develop in May and June, with a thermocline developing between 7-15 meters. Oxygen concentrations decreasing in the hypolimnion but water still aerated.

- Stratification fully developed by July and persisting into September. Thermocline increasing in depth and narrowing during this time. Hypolimnion anoxic.

Figures 1-3 in Appendix B depict representative vertical profiles for fall turnover (October 12), weak stratification (May 17) and full stratification (August 14).

Temporal Changes by Layer
Based on the first year of sampling the changes in DO and temperature observed by layer during 2007 are as follows. These changes are described by layers, even though stratification was only weakly developed during the spring and there was still evidence of mixing among layers.

Epilimnion. The average monthly temperature near the water surface increased from 14.4 °C in May to highs of 21.8 °C in July and 20.2 °C in August. The maximum temperature of 22.7 °C occurred on July 17. Temperatures subsequently decreased until October when the fall turnover occurred.

DO concentrations decreased gradually from 9.9 to 8.6 mg/L between May and July, with no significant difference in DO concentrations in the epilimnion between May and June. There is a significant decrease in DO concentrations near the surface between July and August as DO decreases from 8.6 mg/L to 5.7 mg/L. DO concentrations remained relatively similar (5.7 to 6.5 mg/L, with no significant difference in values) through the rest of the summer and fall.

Hypolimnion. The average monthly temperature below 15 meters averaged 9.3 °C in May and significantly increased between May and June to 11.5 °C. The temperature remained relatively constant through the remainder of the summer and fall sampling period (11.5-10.4 °C for 5 months).

The DO concentrations changed significantly each month between May, June and July, from a high of 7.0 mg/L in May to 0.3 mg/L in July. The DO concentrations remained relatively constant between 0.1 and 0.3 for the remainder of the summer and early fall, changing abruptly in mid-October to 6.5 mg/L.

<u>Mesolimnion.</u> The mesolimnion represents the transition zone between the surface and bottom layers. This layer generally occurs between 7 to 15 meters, but changes in depth and width during the growing season. The most rapid changes in parameters occur in this layer, and there are significant temperature differences between the mesolimnion and each of the adjacent layers each month during the growing season, except for October. Over the growing season, the average temperature increases from 11.2 ¨C in May to between 15.8 to 14.2 ¨C in July and August before decreasing again. Due to the large vertical changes in the mesolimnion, the average temperatures have a wide variability associated with them and, therefore, the mesolimnion temperature changes between months are not always statistically significant.

The average mesolimnion DO concentrations decrease significantly each month from a high of 9.7 mg/L in May to a low of 0.1 mg/L in August, before they then significantly increase to 1.1 mg/L in September and 6.5 mg/L in October. There is no significant difference in DO concentrations between the epilimnion and mesolimnion in May as stratification is just starting to develop. There is no significant difference in DO concentrations between the mesolimnion and hyplimnion during August. In all other months examined, except for the fall turnover, there is a significant difference in DO concentrations between the mesolimnium and the adjacent layers .

Table 1. Monthly Summary of Phillips Lake Stratification Characteristics and Associated Dissolved Oxygen (DO) and Temperature Measurements.

Month	Degree of Stratification	Thermocline Depth	Mean Temperature (•C, top value) and DO (Mg/L, lower value)		
			Epilimnion	Mesolimnion	Hypolimnion
May	Stratification starting to develop, Still some mixing among layers	Gradual change between 7-15 m, no sharp thermocline	14.4 ±0.38 9.9 ±0.52 n=16	11.2 ±0.51 9.7 ±0.55 n=29	9.3±0.61 7.0 ±0.58 n=9
June		Depth varies during month between 5-15 m with a 5 - 8 m zone	16.0 ±0.42 9.3 ±0.16 n=43	14.0 ±0.59 6.9 ±0.28 n=30	11.5±1.21 4.8 ±0.58 n=11
July	Strongly stratified into 3 distinct layers; anoxic below 20 m by end of month	Sharp change between 7-15 m; 8 m zone	21.8 ±0.35 8.6 ±0.29 n=18	15.8 ±0.77 3.3 ±0.84 n=27	11.2±0.51 0.3 ±0.16 n=19
August	Strongly stratified into 3 distinct layers; anoxic at or below 10 m	Sharp change between 10-15 m; 5 m zone	20.2 ±0.24 5.7 ±0.98 n=38	14.2 ±1.16 0.1 ±0.02 n=19	10.7±0.12 0.1 ±0.02 n=16
September	Strongly stratified, but starting to change; anoxic at or below 13-15 m	Varies during month from 9-13 m (9/13) to 12-14 m (9/25) ; 2 m zone at month end	15.1 ±0.59 6.5 ±0.54 n=31	12.2 ±1.00 1.1 ±0.78 n= 9	10.4±0.07 0.3 ±0.04 n=19
October	None	No significant vertical change in temperature	10.8 ±0.008 6.5 ±0.08 n=19		

3.2 Mason Dam Intake

Table 2 and Figure 4 display the monthly average temperature and DO concentrations at or near the Mason Dam intake. Because of the low number of points per month (generally 2 to 3 per month, except for June), only the mean values are presented and not the confidence intervals. Appendix A contains the full data set including the elevation of the intake below the water surface for each sampling date and the nearest measurement point.

Table 2. Average Monthly Temperature and DO at or near the Mason Dam Intake.

Month	Temperature (°C)	DO (mg/L)
May	10.1	7.8
June	11.9	5.5
July	12.7	1.8
August	16.9	0.8
September	17.0	6.7
October	10.8	6.4

The location of the intake in relation to the water surface and reservoir layers changes over the season as the water surface is lowered, decreasing the depth of the water column above the intake. For most of the growing season, the intake is located within the hypolimnion. This changes in August when the intake is located within the thermocline, September when it is in the surface layer and October when the reservoir is uniformly mixed.

During the growing season, the intake water temperature increases gradually from a low of 10.07 °C in May to 12.7 °C in July. During this time period, the intake is located between 15 to 20 meters below the water surface. The water temperature rapidly increases near the intake during the late summer (17 °C) as the reservoir is drawn lower and the water surface is located 7 to 13 feet above the intake elevation. With the fall turnover, the intake water temperature is the same as the rest of the reservoir (10.8 °C).

Concurrent with the increase in water temperature, the DO decreases from 7.8 mg/l in May to 5.5 mg/L in June. The DO concentration is quite low during late summer, approaching anoxic conditions in August. As for temperature, the DO concentration near the intake is the same as the rest of the reservoir during fall turnover.

3.3 Stilling Basin

Between May and October, the average monthly stilling basin temperature ranged between 8.9 and 18.4 °C. However, the DO concentration exhibited much less variability ranging between 7.7 and 10.1, with a growing season mean of 9.0 ± 1 0.4 mg/L. In general, the stilling basin DO concentration stayed above 8.0 mg/L until October when it decreased to 7.7 mg/L. As shown on figure 5, there is a very low correlation between temperature and DO in the stilling basin with an overall R^2 of 0.08.

Table 3 provides a summary of monthly average temperature and DO measurements in the stilling basin (see also figure 6). Due to the low number of samples within each month, confidence intervals are not displayed for the means.

Table 3. Average Monthly Temperature and DO in the Mason Dam Stilling Basin.

Month	Temperature (°C)	DO (mg/L)
May	8.9	10.1
June	11.0	9.3
July	13.6	9.0
August	18.4	8.4
September	15.3	8.9
October	10.8	7.7

3.4 Downstream Temperature and DO Changes

Powder River water temperature generally decreases in a downstream direction from the stilling basin, but the magnitude of these changes varies during the growing season (Table 4, Figure 7). Between June and August, downstream changes are relatively small (less than a 0.4 °C change between sites, and 1 °C overall)[1]. Larger changes occur in September and October in which the temperature changes 3 °C between the stilling basin and the FS boundary and more than 1 °C between some sites.

[1] As described for the stilling basin results, confidence intervals are not displayed for the means due to the low degrees of freedom in an analysis of site by month.

Table 4. Changes in Average Monthly Temperature (°C) in the Powder River With Distance From Stilling Basin						
Sample Site	**Month**					
	May	**June**	**July**	**August**	**Sept**	**Oct**
Stilling Basin	8.9	11.0	13.6	18.4	15.3	10.8
#3	8.2	11.4	13.6	18.1	13.7	10.0
#2	8.7	10.7	13.5	17.9	12.9	9.5
#1	7.6	10.6	13.0	17.3	12.7	7.7

For all months, except October, the DO concentrations decreased from the stilling basin to site #3, and then either subsequently increased or leveled off (Table 5, Figure 8). In October, the average DO concentrations increased by a minimum of 0.5 mg/L between each site downstream of the stilling basin. To increase statistical power, measurement values were lumped for spring months (May and June) and summer months (July, August and September) to identify if there were any significant changes in DO concentrations by season. Although there are differences between sites, these differences are not statistically significant (Table 6).

Table 5. Changes in Average Monthly DO Concentrations (mg/L) in the Powder River With Distance From Stilling Basin						
Sample Site	**Month**					
	May	**June**	**July**	**August**	**Sept**	**Oct**
Stilling Basin	10.1	9.3	9.0	8.4	8.9	7.7
#3	9.3	8.8	8.8	7.8	8.0	8.5
#2	11.0	9.6	8.6	7.7	8.4	9.0
#1	10.9	9.6	8.6	7.5	8.5	9.5

Table 6. Changes in Seasonal DO Concentrations (mg/L) With Distance From Stilling Basin. Confidence intervals are calculated only where 3 or more degrees of freedom can be established.			
Sample Site	**Season**		
	Spring	**Summer**	**Fall**
Stilling Basin	9.7 ± 0.74 n=7	8.8 ± 0.32 n=10	7.7 n=2
#3	9.0 ± 0.52 n=6	8.2 ± 0.41 n=10	8.5 n=1
#2	10.0 ± 0.55 n=8	8.2 ± 0.34 n=11	9.0 n=1
#1	9.8 ± 1.24 n=5	8.3 ± 0.32 n=11	9.5 n=2

The patterns downstream of the stilling basin are not clear cut. There appears to be a trend towards a decreased temperature with distance from the stilling basin. There is also a trend towards an initial DO concentration decrease followed by a subsequent DO concentration increase. These trends are either not statistically significant, or can't be statistically tested. It may be that site differences or the nature of flow releases overshadow the effects of the stilling basin on the Powder River downstream of the stilling basin.

4.0 RESULTS-OTHER PARAMETERS

4.1 Phillips Lake

The chemical parameter with the greatest vertical and temporal change in Philips Lake is pH. In the spring, pH values are similar vertically. Beginning at the end of May and through June, the pH values exhibit high variability that is inconsistent from week to week, but show a tendency for the pH values to be highest between 10 to 15 meters as the thermocline develops. However, beginning in July and continuing through the summer, the pH values decrease from a high near the surface to a low in the epilimnion. During the fall turnover, pH values are similar throughout the profile with the exception of a high of 8.1 in the upper meter of the lake.

Seasonal increases in lake pH can be partially explained by the early spring influence of snowmelt (typically neutral to slightly less than neutral in granitic areas) followed by greater ground water input in the late season from Deer Creek which enters Philips Lake near the dam, and which drains a large area underlain by limestone (a carbonate rock that would provide higher pH water – typically up to a value of 8.3 for water saturated with carbonate)(Maidment 1992).

The vertical changes in pH are more difficult to interpret. It appears that a pH chemocline develops during summer as the lake thermally stratifies. pH values become very high near the surface, declining abruptly to near neutral pH between 7 to 15 meters below the surface. Values in the hypolimnion remain near 7 throughout the summer, increasing only during fall turnover.

Many of the pH values obtained near the lake surface during late summer were between 10 to 14 units. These values are uncharacteristically high, in spite of similar instrument readings with duplicate measurements (indicating high precision). In general, almost all of the pH measurements fell within the "A" category (less than 0.3 unit difference among duplicates) for measurement precision, but there is no data on field instrument accuracy. pH can be sensitive to temperature, with variation typically minor (0.1 unit), but with increasing variation (up to 1 pH unit) with both higher temperatures and pH (Barron et al. 2004). However, pH readings above 9 are unlikely at this site, and readings above 10 probably represent a problem with the sensor or unit calibration that only shows up during late summer when the reservoir is stratified.

Overall, (1) there appears to be a trend from a neutral or slightly below neutral lake pH in the spring to an increased pH later in the season, (2) pH values appear to be affected by lake stratification, and (3) some of the observed late season reservoir pH values are noticeably higher than the expected range and may not be reliable.

The values for the other chemical parameters exhibit only small changes seasonally and vertically. Specific conductance averages occur within a narrow range of 99.5 to 103.7 µS/cm (except during fall turnover) and alkalinity remains between 40 to 46.7 mg/L.

Turbidity is higher near the surface than in the thermocline during the growing season, likely reflecting both the increased wave action and the greater plankton growth near the surface.

Table 7. Representative Average Monthly pH, Specific Conductivity, Alkalinity and Turbidity in Phillips Lake by Layer.			
Month	**May**	**July**	**October**
pH			
Epilimnion	7.3	9.1	7.6 (8.1 upper 1 m)
Mesolimnion	7.6	7.3	7.6
Hypolimnion	7.3	6.9	7.6
Specific Conductivity (µS/cm)			
Epilimnion	103.7	99.5	109
Mesolimnion	99.8	97.1	109
Hypolimnion	102.8	100.1	109
Alkalinity (mg/L)			
Epilimnion	46.7	45.0	No data collected as per agreement with FERC
Mesolimnion	45.0	40.0	
Hypolimnion	46.7	40.0	
Turbidity (NTU)			
Epilimnion	3.5	4.3	3.2
Mesolimnion	1.5	1.4	3.8
Hypolimnion	2.3	2.2	no data

4.2 Mason Dam Intake

The pH at the Mason Dam intake is close to neutral (6.9-7.4) the majority of the growing season (Table 8), with the values increasing to above 8 in September as the reservoir releases result in the intake being close to the surface (within 7 meters) where higher pH values were recorded. This change in seasonal pH from neutral to slightly greater than neutral with changes in water inflow is reasonable (see additional pH discussion in section 4.1). Specific conductivity values do not change much, but roughly parallel the pH changes. Alkalinity values showed no change during the sampling.

Turbidity is relatively low at the intake (1.8 to 2.9 NTUs) during most of the growing season. The turbidity increases in September (4.2 NTU), when the intake is located within the epilimnion. The higher turbidity value most likely reflects increased phytoplankton production at this depth.

Turbidity is also slightly higher than the rest of the growing season (3.3 NTUs) during fall turnover as reservoir layers mix, which is to be expected. However, all turbidity values at the intake are relatively low (i.e., less than 5 NTU) which represents clear water.

Table 8. Average Monthly pH, Specific Conductivity, Alkalinity and Turbidity at the Mason Dam Intake.

Month	pH	Specific Conductivity (µS/cm)	Alkalinity (mg/L)	Turbidity (NTU)
May	7.3	102	45	1.8
June	7.1	97.2	45	2.5
July	6.9	97.7	45	1.5
August	7.4	106.5	45	2.9
September	8.2	110.5	No data	4.2
October	7.6	109	No data	3.3

4.3 Powder River Downstream of Mason Dam

4.3.1 Chemical Parameters

Tables 9 to 11 provide a summary of the changes in pH, specific conductance and alkalinity in the Powder River downstream of Mason Dam.

Powder River pH values generally approximate neutral (7.0) in May, June and July. The exception is during May, when the lower pH values (6.1 to 6.4) at sites 1 and 2 appear to reflect the local snowmelt runoff pH more than the pH of the reservoir releases. The pH at all sites increases in August, reaching a high of 8.0 to 8.3 at all sites in September. The seasonal shift among all sites likely reflects (1) the change from neutral to slightly acidic pH associated with snowmelt runoff in the mostly granitic Elkhorn Mountains, which affects the Powder River more than the reservoir releases, and (2) greater influence of reservoir releases on the Powder River later in the season (with the carbonate-reservoir influence discussed in section 4.1 above).

Table 9. Average pH in the Powder River Downstream of Mason Dam.						
Sample Site	**Month**					
	May	**June**	**July**	**August**	**Sept**	**Oct**
Stilling Basin	7.0	7.0	6.9	7.3	8.3	7.7
#3	6.9	7.3	7.1	7.5	8.0	7.7
#2	6.1	6.8	7.2	7.6	8.0	7.8
#1	6.4	6.8	7.4	7.8	8.0	8.1

The specific conductance values (table 10) generally parallel the pH trends in that (1) the river values appear to reflect snowmelt and tributary influence more than the reservoir releases during May, (2) the values for all sites are generally similar during the summer, and (3) specific conductance values increase between June to the fall (September and October), likely reflecting a greater carbonate influence via the reservoir releases.

Table 10. Average Specific Conductance (µS/cm) in the Powder River Downstream of Mason Dam.						
Sample Site	**Month**					
	May	**June**	**July**	**August**	**Sept**	**Oct**
Stilling Basin	102.5	96.2	97.0	103.0	108.7	109.0
#3	117.5	96.8	97.7	103.0	110.3	113.0
#2	112.5	97.8	98.3	103.0	111.0	114.0
#1	124.5	98.5	97.5	103.0	112.0	104.0

Alkalinity and pH are related parameters, but distinctly different from each other. pH measures the concentration of hydrogen ions in water, in terms of acidity or alkalinity. Alkalinity measures the buffering capability of water, or the ability to resist changes in pH. Because alkalinity and pH are so closely related, changes in pH can also affect alkalinity, especially in a poorly buffered stream. In general, alkalinity levels below 10 mg/L indicate that the system is poorly buffered, and is very susceptible to changes in pH; conversely, values between 100-200 mg/L tend to indicate streams with better buffering capabilities (Maidment 1992)

The alkalinity is generally similar among sites throughout the season, increasing slightly in the fall. Values for all sites are between 40 to 50 mg/L indicating a normal, but low end of normal range of buffering capabilities (table 11).

Table 11. Average Alkalinity (mg/L) in the Powder River Downstream of Mason Dam.						
Sample Site	**Month**					
	May	**June**	**July**	**August**	**Sept[1]**	**Oct[1]**
Stilling Basin	45	40	40	45	No data	50.0
#3	41.7	42.5	40.0	45.0	No data	No data
#2	42.5	42	40.0	45.0	50.0	No data
#1	43.8	42.0	40.0	45.0	46.7	50.0
[1] As per agreement with FERC, alkalinity was not collected in the fall due to the overall lack of differences among site values.						

4.3.2 Physical Parameters

Table 12 provides a summary of the average turbidity in the Powder River downstream of Mason Dam. Turbidity values are highest in the stilling basin during spring run-off and peak irrigation season, corresponding to higher releases during these two time periods. Turbidity is also highest in the stilling basin, and lower downstream, except in June when all values are similar. Except for site #2 in September, the Powder River turbidity values are more similar to each other (difference of 0 to 0.4 NTU's) than to the stilling basin values (difference of up to 1.2 NTU's) indicating that the stilling basin turbidity has little influence on the downstream Powder River turbidity.

Overall, the turbidity values are quite low for all sites and represent "clear water", defined by the Oregon DEQ (2005) as anything less than 5 NTUs.

Table 12. Average Turbidity (NTU) in the Powder River Downstream of Mason Dam.						
Sample Site	**Month**					
	May	**June**	**July**	**August**	**Sept**	**Oct**
Stilling Basin	3.0	1.8	2.6	3.1	3.8	3.1
#3	1.8	2.1	2.0	2.3	2.9	2.0
#2	1.8	2.0	2.3	2.0	1.6	2.2
#1	2.1	2.1	2.4	2.6	2.6	1.9

5.0 GLOSSARY

Stratification: a process in which some reservoirs develop an uneven distribution of properties within the water column during an annual cycle. This is primarily related to uneven heating and resultant differences in water density.

Epilimnion: the upper layer of warm, less dense water of similar temperature in a lake or reservoir.

Hypolimnion: the lower layer of cold, more dense water below the epilimnion which is completely sealed off from the surface - often having very low oxygen concentrations

Mesolimnion: the small zone where the temperature cools dramatically between the epilimnion and hypolimnion. A zone of rapid change in temperature, density, and chemical properties. Generally defined as a temperature change equal to, or greater than 1.0°C per 1.0 meter change in depth

Thermocline: the point in the mesolimnion where the temperature change is most drastic. Often, the terms mesolimnion and thermocline are used synonomously.

Fall Turnover: A process in which waters within an entire water body mix so that the reservoir develops a relatively uniform distribution of properties, such as temperature and dissolved oxygen. This process can be relatively sudden, with an entire reservoir turning over in less than a week during windy conditions

6.0 REFERENCES

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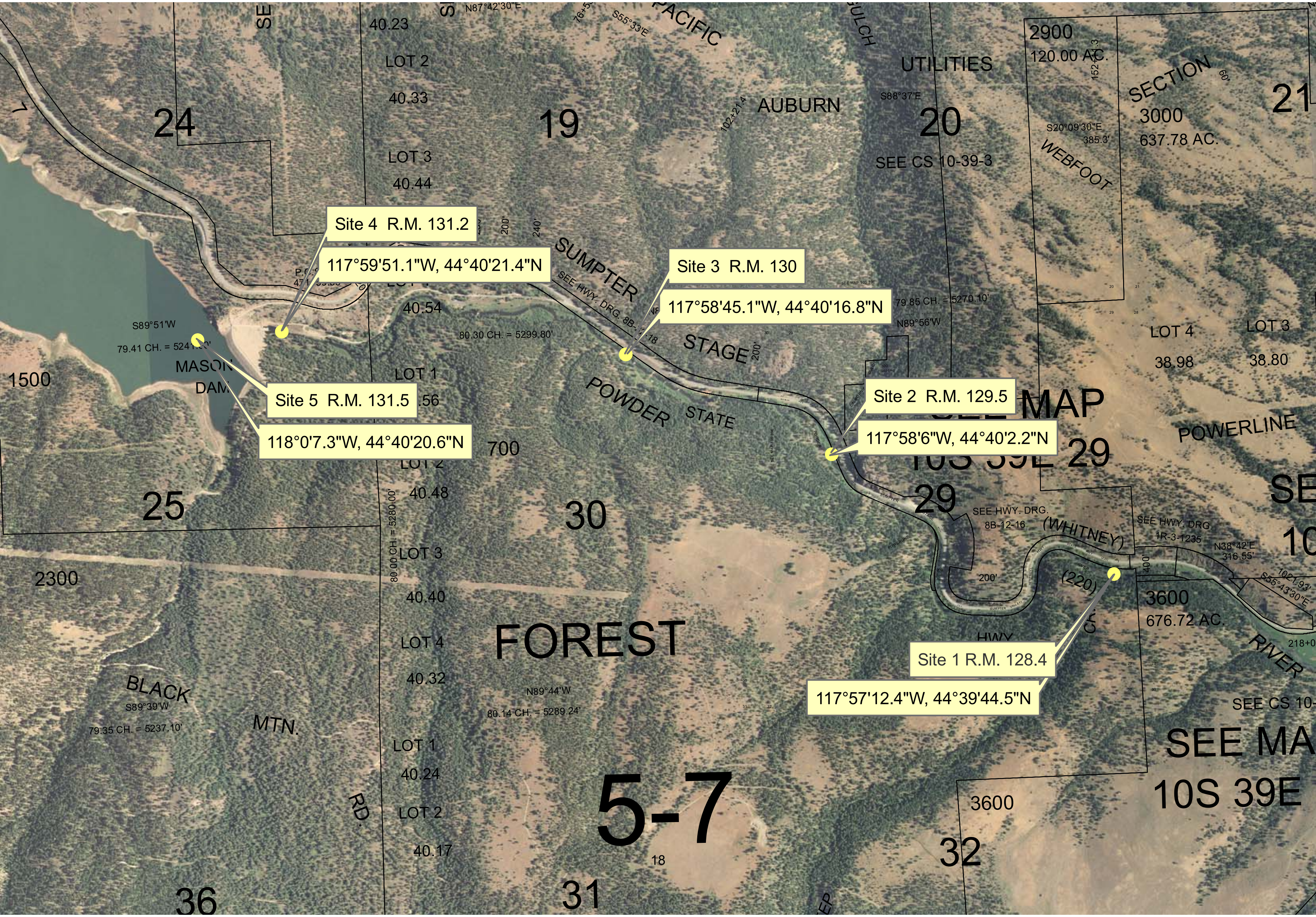
APPENDIX A

Location of Study Sites on the Powder River



Site 5 R.M. 131.5
118°0'7.3"W, 44°40'20.6"N
Site 4 R.M. 131.2
117°59'51.1"W, 44°40'21.4"N
Site 3 R.M. 130
117°58'45.1"W, 44°40'16.8"N
Site 2 R.M. 129.5
117°58'6"W, 44°40'2.2"N
Site 1 R.M. 128.4
117°57'12.4"W, 44°39'44.5"N
SUMPTER
STAGE
POWDER
STATE
FOREST
5-7
MASON
DAM
BLACK
MTN.
RD.
PACIFIC
UTILITIES
AUBURN
WEBFOOT
SECTION
POWERLINE
(WHITNEY)
RIVER
10S 39E
SEE CS 10-39-3
SEE HWY. DRG.
8B-12-16
(220)
3600
676.72 AC.
3000
637.78 AC.
2900
120.00 AC.
1500
2300
700
24
19
20
21
25
30
29
36
31
32

APPENDIX B
Mason Dam Intake Data

Mason Dam Intake Data				
Date	**Intake elev**	**Closest Msmt**	**T**	**DO**
11-May	21.9	20	11.1	8.6
17-May	21.4	20	8.9	7.6
25-May	21	20	10.2	7.3
1-Jun	20.6	20	10	5.9
9-Jun	20.1	20	10.8	6
15-Jun	19.5	17.5	13.5	6.6
22-Jun	19.5	20	11.3	4.2
28-Jun	18.9	20	14.2	4.8
6-Jul	18.1	15	12.7	3.5
17-Jul	16.8	17	12	0.9
24-Jul	15.7	16	13.5	1
7-Aug	13.2	13	14.8	0.1
14-Aug	11.8	12	17	0.1
21-Aug	10.2	10	18.9	2.3
7-Sep	7.7			
13-Sep	7.3	7	17	7.7
21-Sep	7	7	15.4	5.7
5-Oct	6.8	5		6.2
12-Oct	6.6	7	10.8	6.5

Intake elevation=depth of the intake below the water surface at the date and time of measurement
Closet Msmt=measurements were made at set intervals below the water surface and did not always occur at the exact intake point. The closet measurement identifies the data point collected closest to the intake depth.
T=temperature in degrees Centigrade.
DO=dissolved oxygen in mg/L

APPENDIX C- Figures

**Figure 1. Changes in Phillips Lake Temperature and DO Concentrations with Depth.
17-May-2007**

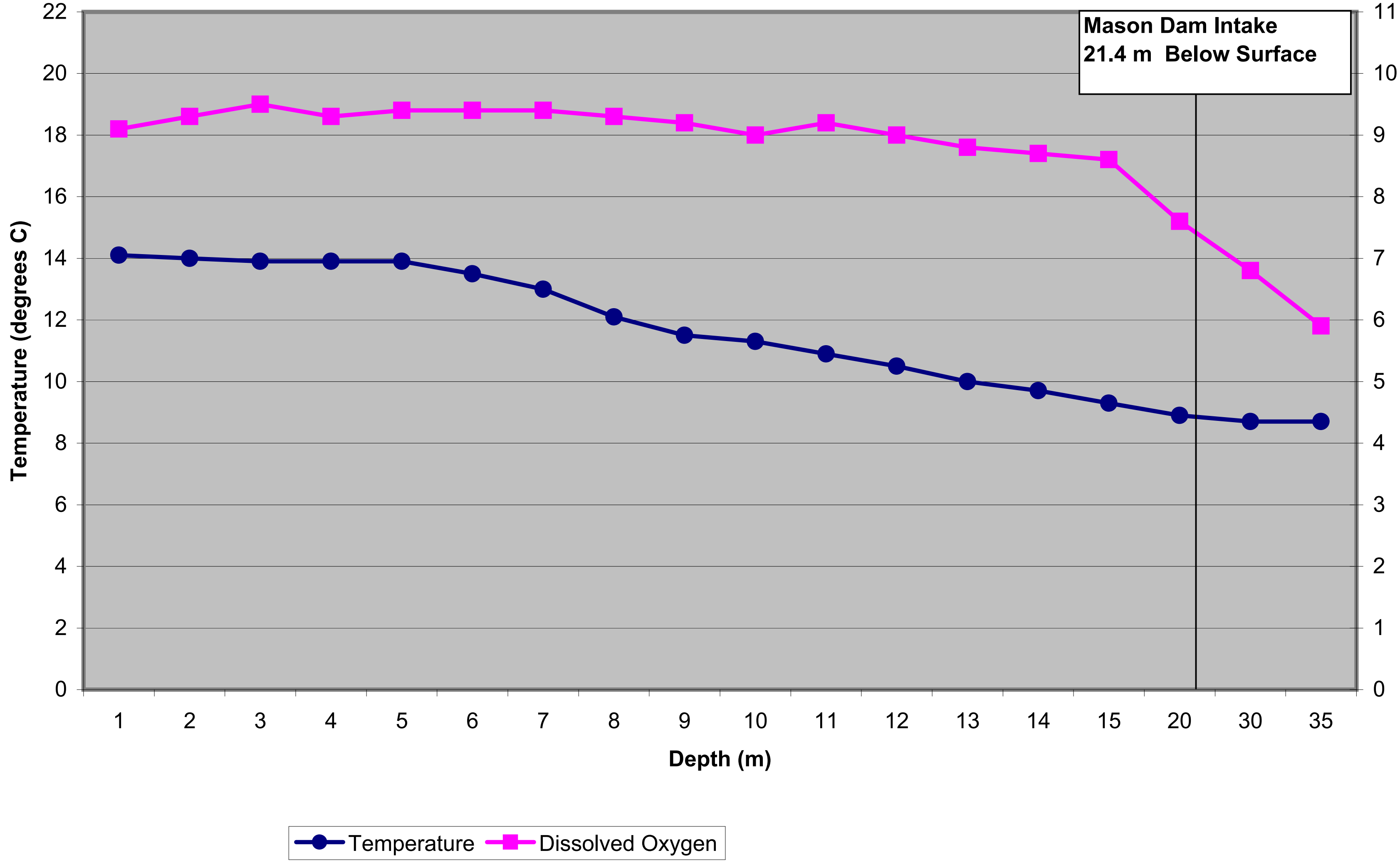


Figure 2. Changes in Phillips Lake Temperature and DO Concentrations with Depth
14-August-2007

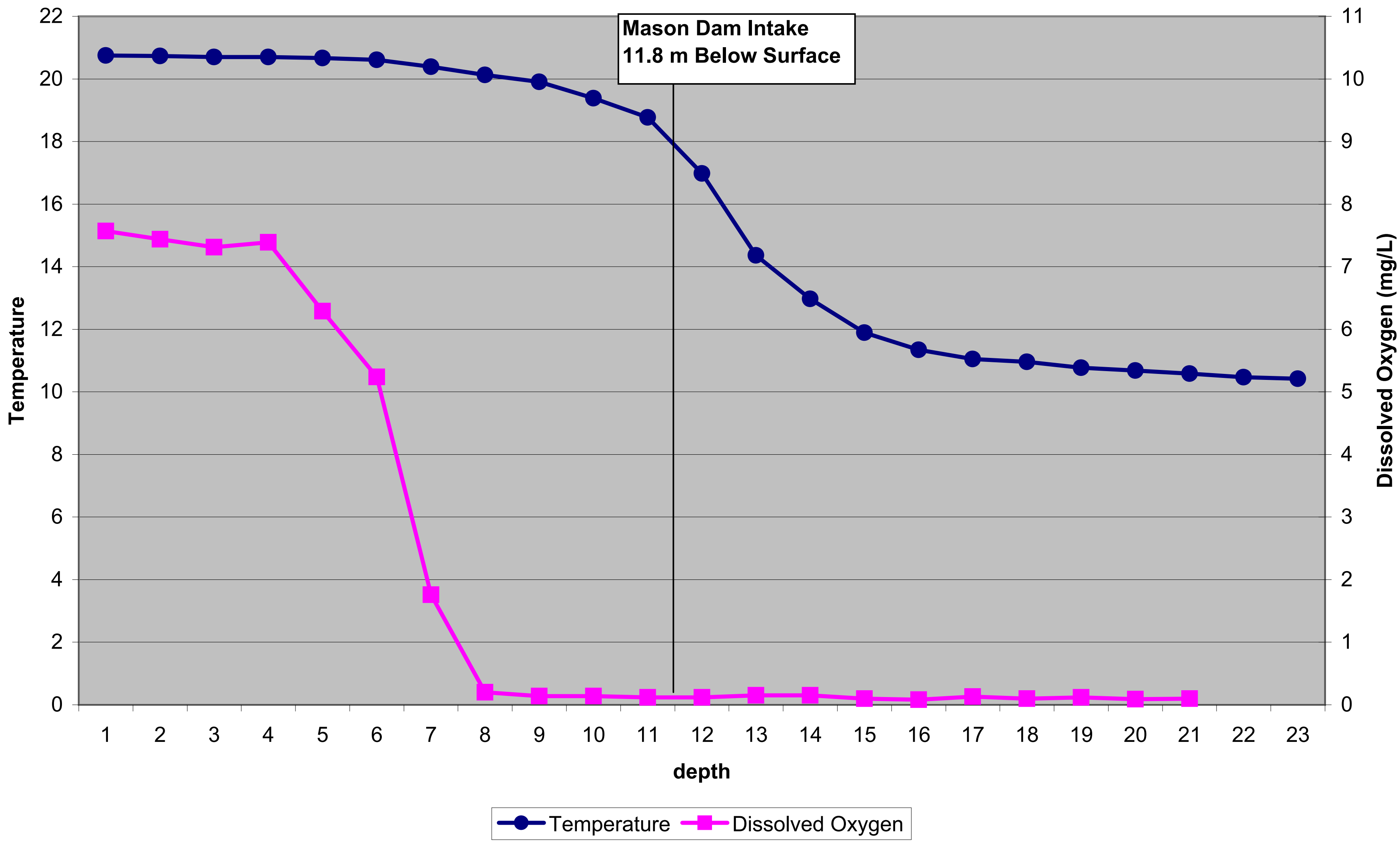


Figure 3. Changes in Phillips Lake Temperature and DO Concentrations with Depth. 12-October-2007

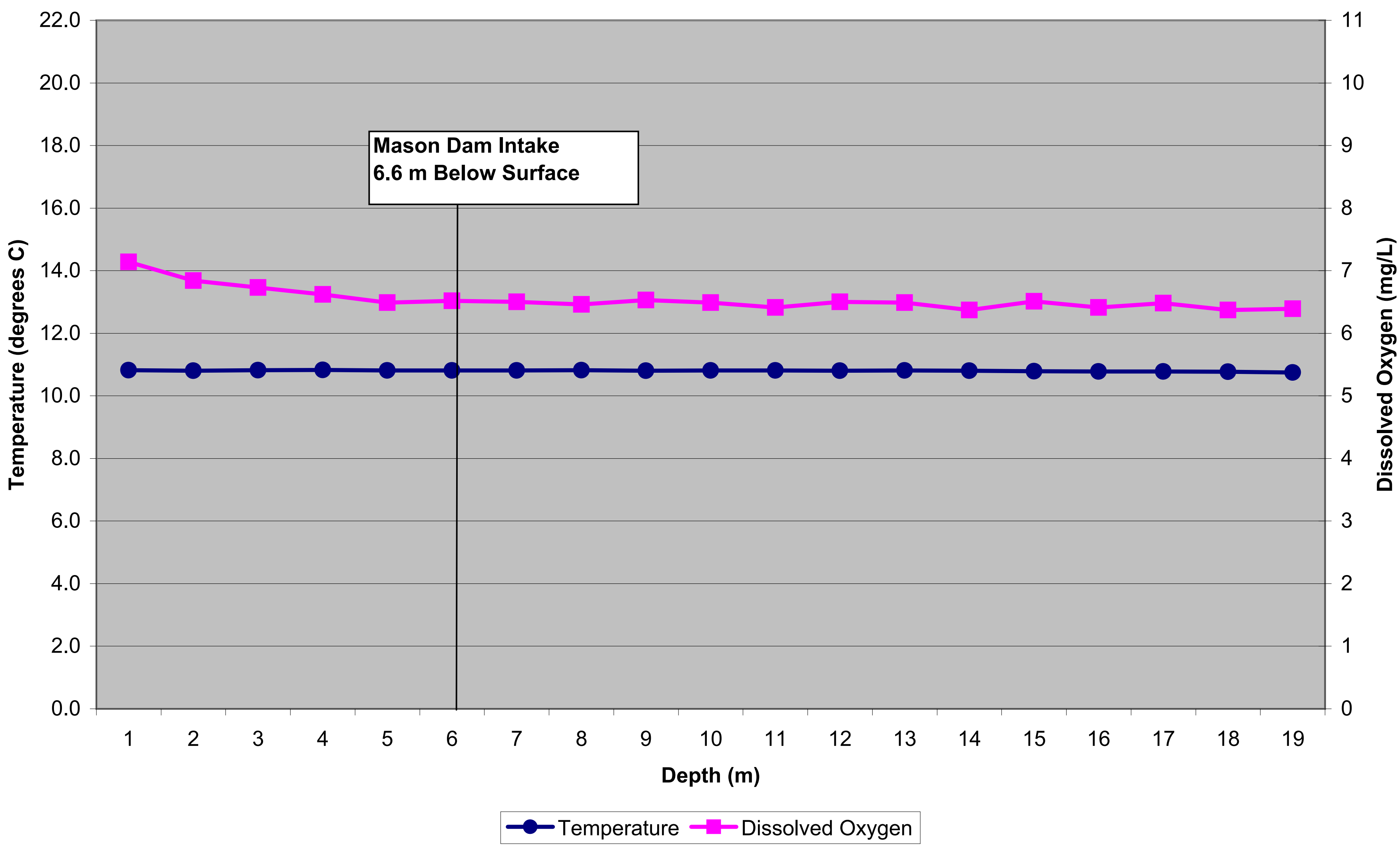


Figure 4. Average Monthly Temperature and DO Concentrations at the Mason Dam Intake.

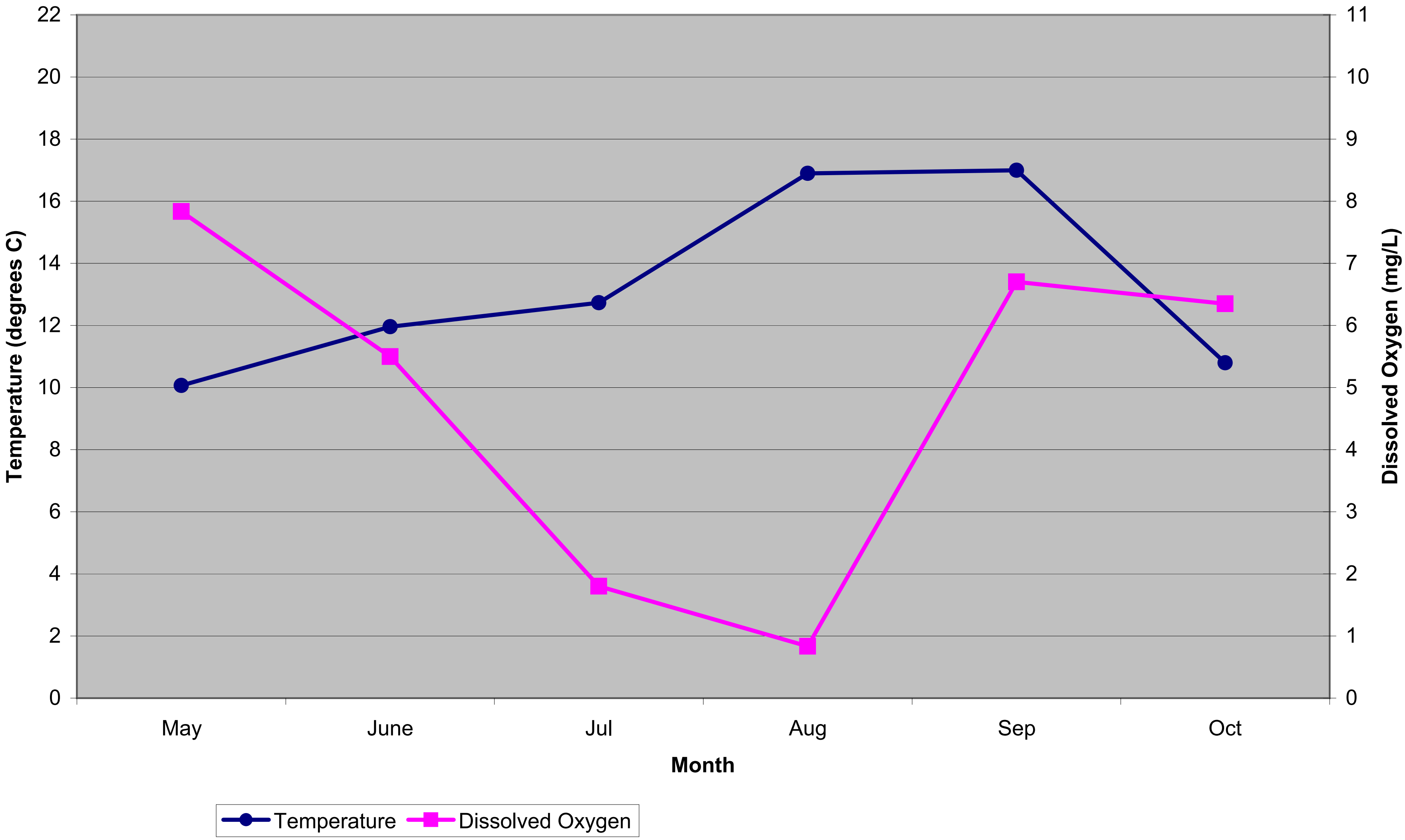


Figure 5. Correlation between Temperature and DO in the Stilling Basin.

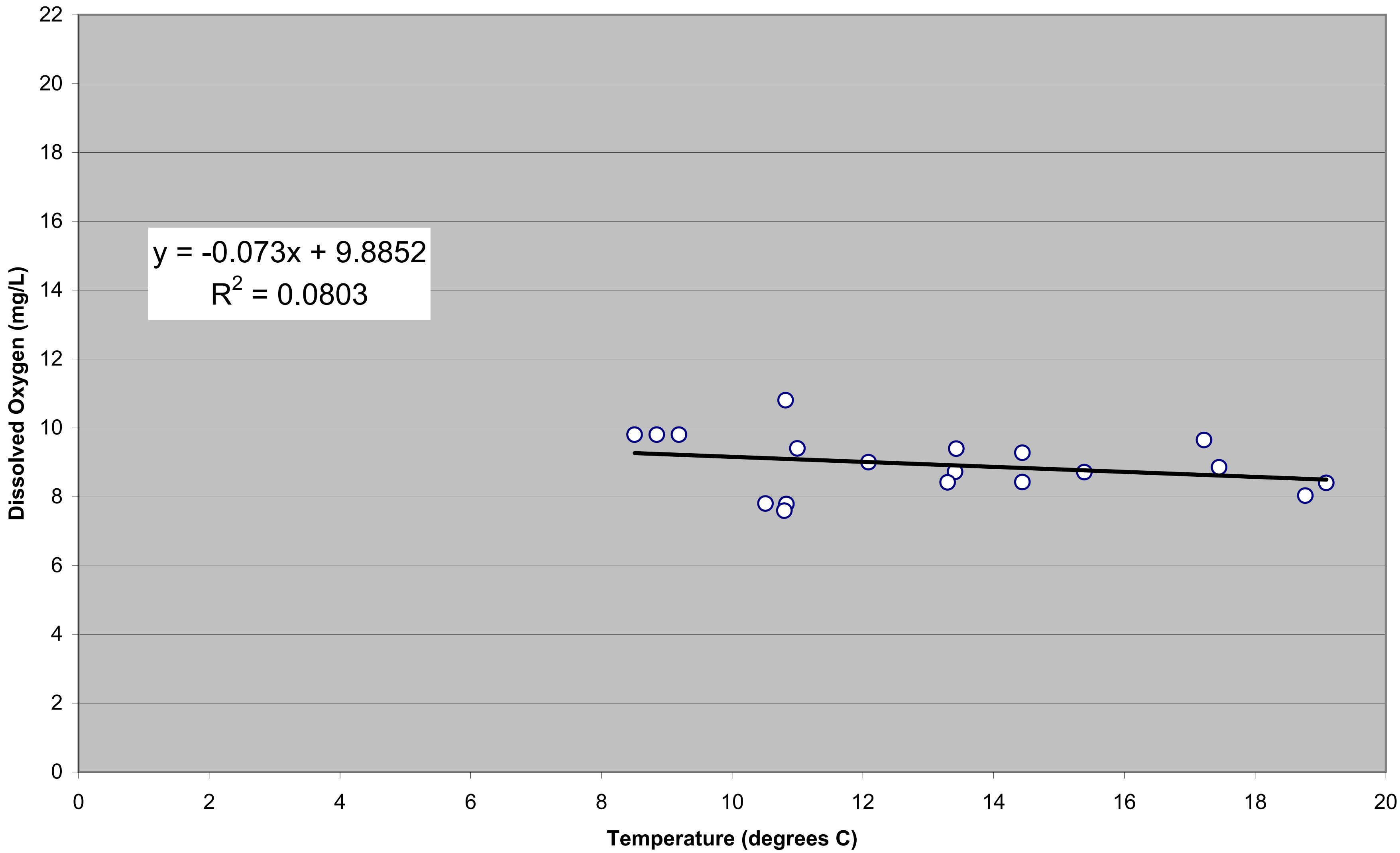


Figure 6. Average Monthly Temperature and DO Concentrations in the Stilling Basin.

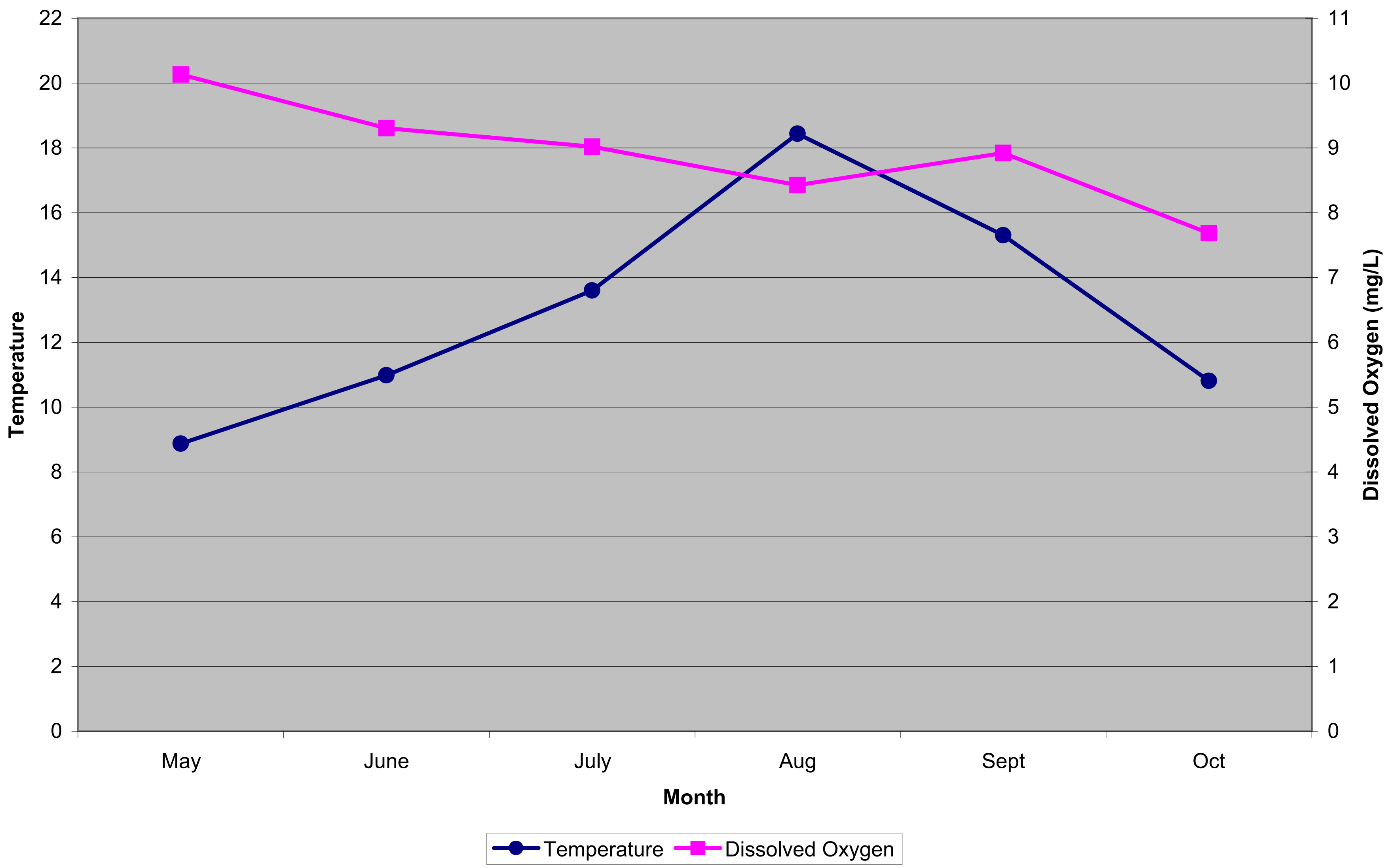


Figure 7. Average Monthly Changes in Powder River Temperature Downstream of Mason Dam.

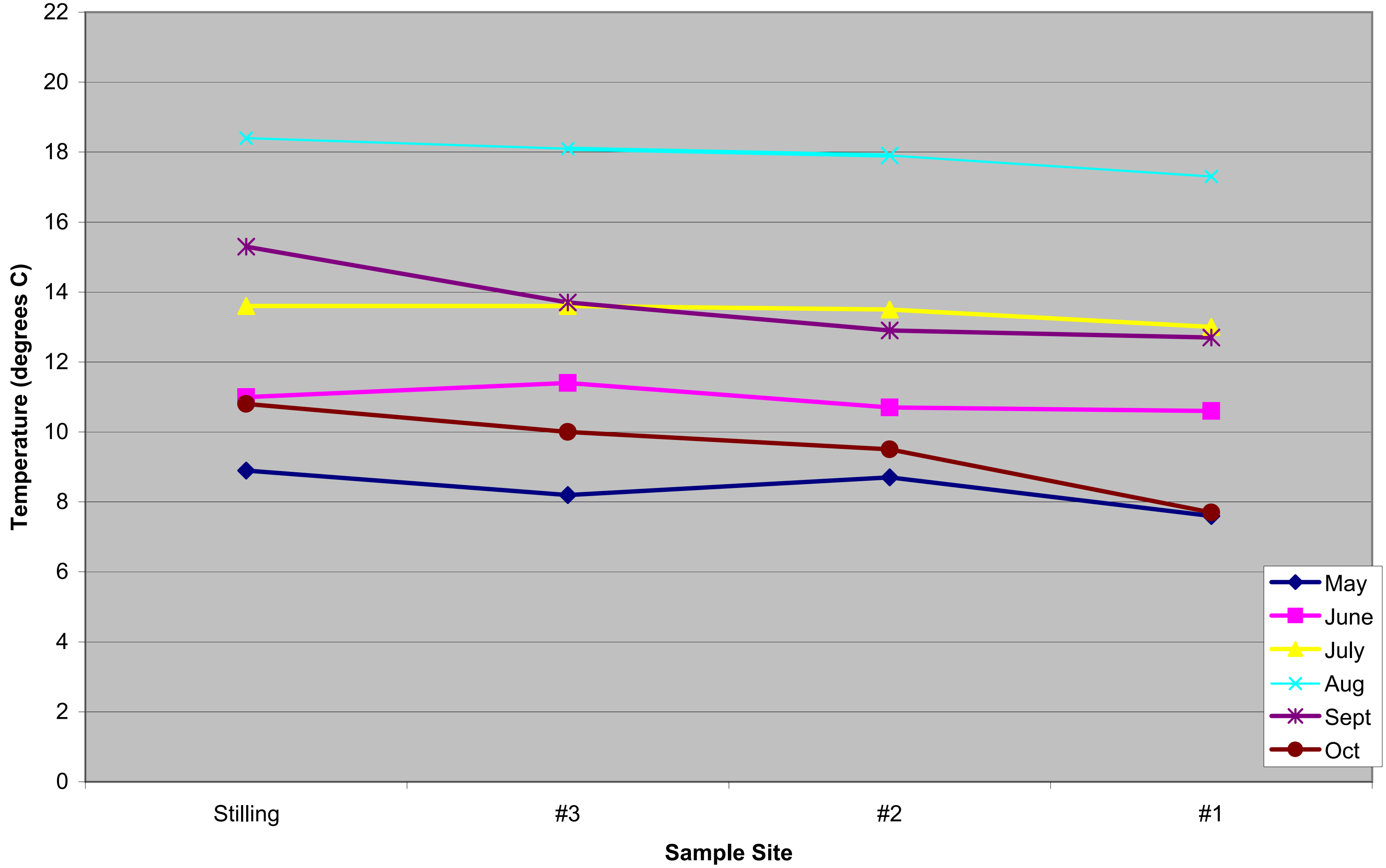
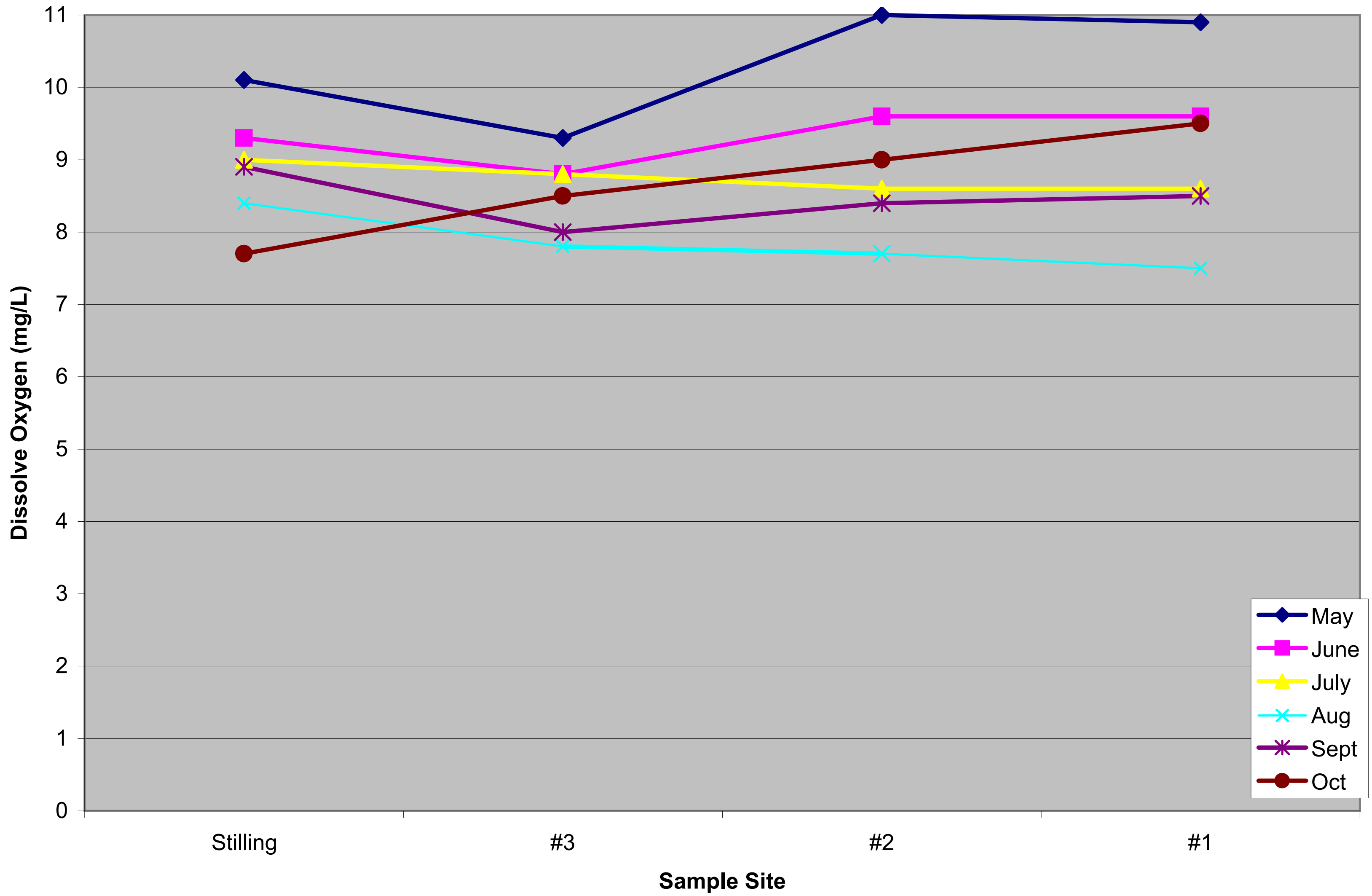


Figure 8. Average Monthly Changes in Powder River DO Downstream of Mason Dam.



APPENDIX D – Study Plan

STUDY PLAN 1: DISSOLVED OXYGEN, WATER QUALITY AND TEMPERATURE ASSESSMENT

1.0 Introduction

Baker County filled for their preliminary license and received it on October 8, 2003 for the 3 MW Mason Dam Hydroelectric Project (Project No. P-12058-002). The project is run of release meaning Baker County does not and will not have any control over the release of the water at Mason Dam. The Bureau Of Reclamation and Baker Valley Irrigation District have control of the release of water and will not change water flows at Baker County's request.

The project consists of two small turbines that will be housed in a power plant at the base of Mason Dam. The power generated will be sent approximately 1 mile to an existing Idaho Power Company 138kv transmission line. The 34.5kv power line connecting the power plant to the substation and then to the 138kv transmission line will be buried in the Black Mountain Road right of way.

The project boundary consists of 100 feet beyond the area that contains the powerhouse and tailrace facilities, and the substation to the interconnect with IPC transmission line. It also includes 50 feet on each side of the underground power line that will be placed in the Black Mountain Road right of way.

1. 1 Goals and Objectives

These studies were requested by the Oregon Department of Environmental Quality (ODEQ) and FERC. They contain requests for much of the same information and have been combined.

The goal of this study is to evaluate the dissolved oxygen (DO) concentration of water entering the Mason Dam intake within Phillips Reservoir, and then discharged immediately downstream of the Dam into the Powder River, during summer conditions. The objective of this proposed study is to define a baseline condition that will provide for a better understanding of the potential for project-related effects, and possible mitigation strategies. Specifically, the objectives of the study are to:

1. Identify the dissolved oxygen and temperature profile within Phillips Reservoir, in the vicinity of the Mason Dam intake.

2. Identify the DO concentration of water entering the Mason Dam intake at its approximate depth and vicinity.

3. Describe any temporal variations of DO concentration and temperature.

4. Identify and describe reservoir stratification.

5. Describe the DO concentration of water in the stilling basin immediately below Mason Dam.

6. Describe the attenuation of DO in the Powder River downstream of Mason Dam.

Work with ODEQ on developing a Section 401 application. We will consider Section 303 (water quality standards and implementation plans) in applying for a 401-certification evaluation for the FERC license.
As the parameters and specifics of the project are finalized, Baker County will work with ODEQ staff on the necessary studies to achieve 401 Certification.

Construction activities associated with the building of the Project will be ‘best management practices’ as identified by consensus of all resource agencies.

1.2 Relevant Resource Management Goals

Adequate concentrations of dissolved oxygen are required by aquatic organisms for subsistence, and are therefore essential to the integrity and sustainability of a healthy ecosystem.
Ensuring that the effect of the project construction and operation pertaining to this resource is considered in a reasoned way is relevant to the Commissions public interest determination.

401 Certification with the State of Oregon is mandated by federal and state laws and guidelines. Baker County is a public entity and as such is bound by best management practices and the preservation of all natural resources.

1.3 Background and Existing Information

The project does not propose changing the intake point for water from Mason Dam. The effect on water quality should be minimal but baseline data is lacking for possible effects to the project. This data will be needed in order to receive 401 certification from ODEQ.

1.4 Project Nexus

Water quality issues do fall within the Project boundary. Currently, water releases made from Mason Dam are drawn from the hypolimnetic region of Phillips Reservoir. The water released from Mason Dam demonstrates high levels of kinetic energy as demonstrated by its extremely turbulent nature. Turbulence increases the surface area of water, allowing for greater assimilation of atmospheric gases (including oxygen) into the water. Project-related actions, such as the installation of a turbine, will harness the kinetic energy of the water, thereby reducing the turbulence of water entering the stilling basin. This will result in a reduction in the amount of surface area, limiting the water’s ability to dissolve oxygen into solution. If water in the vicinity of the intake structure within Phillips Reservoir has a low dissolved oxygen content, operation of the project could result in the perpetuation of low DO waters downstream of Mason Dam; Potentially resulting in biological consequences. Since the project's intake system will remain the same, little impact to temperature and thermal stratification are anticipated.

The dissolved oxygen study will help establish a baseline condition for the system in question, and form the basis for inclusion of potential license articles to protect the water quality of the Powder River downstream of Mason Dam. All other water quality studies as identified by ODEQ to achieve 401 Certification will result in sound water quality baselines and results.

1.5 Proposed Methodology

The proposed methodology for this study is contained in the following Quality Assurance Project Plan.

1.6 Level of Effort and Cost

Baker County will work with all agencies to tie together, when possible, all studies effecting water and fish issues.

The estimated cost of dissolved oxygen and temperature assessment work is approximately $6400. The study should be completed within one year. When this study will be performed will be determined after consultation with all involved agencies. It is expected to take one or two technicians four or five hours per week, for approximately 12 weeks to conduct the fieldwork. Report preparation should take a biologist half a workday.

The cost of 401 Certification and level of studies are to be determined.

QUALITY ASSURANCE PROJECT PLAN

Water Quality Monitoring Project on the Powder River prior to construction of Hydro-Electric Power Plant at Mason Dam

Version 2.0a – May 21, 2007

Baker County
1995 Third Street
Baker City, OR
97814
Phone: (541) 523-6416
(jyencopal@bakercounty.org)

Project Management

A1. Title and Approval Sheet

Jason Yencopal
Project Coordinator | Date

Jason Yencopal
Laboratory Manager | Date

Jason Yencopal
Field Sampling Leader | Date

Jason Yencopal
Quality Assurance Officer (QAO) | Date

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A2. Table of Contents

List of Tables & Figures

Appendices

A3. Distribution List

The following personnel will be emailed regarding all aspects of this Quality Assurance Project Plan/Sampling Analysis Plan (QAPP/SAP). Final reports will be faxed/emailed and mailed to the Project Manager, Field Sampling Leader, QA Officer and Laboratory Manager

This QAPP will be posted on the Baker County Government website at http://www.bakercounty.org. The official signed document will be filed at the Baker County Commissioners office in Baker City, OR. This project could continue through multiple seasons, thus revisions should be anticipated. The Project Manager may make revisions to this plan, which must be approved by the signatories in section A1. Baker County is not responsible for the control of reprinted copies from web sites or photocopies of the original plan. It is the responsibility of the reader to ensure that they are using the most current SAPP. The QAO will replace posted network files as the plan is revised.

Table 1 Distribution List

NAME	PHONE	EMAIL
Ms. Kimberly Bose, Secretary, Federal Energy Regulatory Com. 888 First Str., N.E. Washington, D.C.	(202) 502-8400	Kimberly.Bose@ferc.gov
Mr. Fred Warner Jr., Baker County Board. of Commissioners, 1995 Third Street, Baker City, Or	(541) 523-8200	fwarner@bakercounty.org
Mr. Carl E. Stiff M.D., Baker County Board of Commissioners, 1995 Third St., Baker City, OR	(541) 523-8200	cstiff@bakercounty.org
Mr. Tim L. Kerns, Baker County Board of Commissioners, 1995 Third Street, Baker City, OR	(541) 523-8200	tkerns@bakercounty.org
Colleen Fagan, OR Dept. of Fish and Wildlife 107 20th Street, La Grande, OR	(541) 963-2138	Colleen.E.Fagan@state.or.us
Mr, Steve A. Ellis, USDA FS, P.O. Box 907, Baker City, OR	(541) 523-1201	saellis@fs.fed.us
Mr. Ken Anderson, USDA FS, 3165 Tenth Street, Baker City, OR	(541) 523-1901	kenanderson@fs.fed.us
Mr. Paul DeVito, OR Dept. of Environmental Quality 2146 NE Fourth Street, #104 Bend, OR	(541) 388-6146	DEVITO.Paul@deq.stat.or.us
Mr. Gary S. Miller US Dept. of Fish & Wildlife, 3502 Highway 30, La Grande, OR	(541) 962-8584	Gary_Miller@fws.gov
CTUIR P.O. Box 638, Pendleton, OR	(541) 276-3629	michellethompson@ctuir.com tearafarrow@ctuir.com

A4. Project/Task Organization

Table 2 Project/Task Responsibilities

NAME:	PROJECT TITLE/RESPONSIBILITY
Jason Yencopal	Advisory Panel Representative
Jason Yencopal	Project Manager
Jason Yencopal	Quality Assurance Officer
Jason Yencopal	Field Sampling Leader
Jason Yencopal	Laboratory Manager

A5. Problem Definition/Background

Baker County is proposing to construct a hydroelectric power plant at the base of the existing intake structure at Mason Dam on the Powder River. Currently, the water released from Mason Dam is extremely turbulent, resulting in elevated concentrations of total dissolved gases (including oxygen).

The new hydroelectric power plant will harness some of this energy that will reduce the turbulent nature. The reduced turbulence in the release water will result in lower dissolved gas concentrations that could alter the water quality parameters such as dissolved oxygen.

At the present time, there is no existing baseline water quality data that could indicate potential detrimental effects on the Powder River from the construction and operation of the proposed hydroelectric plant. The water quality monitoring project described herein is designed to produce data which will be used to: (1) determine current stream conditions; (2) predict stream conditions during plant operations; and (3) compare with water quality data collected during the construction and operation of hydroelectric projects in the future.

The data from this project will also be shared with the Oregon Department of Environmental Quality (ODEQ), and the Federal Energy Regulatory Commission (FERC) to support their analyses of the 401 certification and licensing of the existing Mason Dam hydroelectric power plant.

A6. Project Task/Description

There will be four sample sites on the Powder River downstream of Mason Dam, and one sample site near the water intake in Phillips Reservoir. See Table 3 below for specific site information.

Table 3 Sample Locations

SITE #	SITE NAME	ELEV	RM	LATITUDE	LONGITUDE
1	**Powder River d/s of Dam near USFS boundary, between Sec. 28 & 29**			44° 39' 44.5" N	117° 57' 12.4" W
2	**Powder River approx. 1 mile u/s from Site No. 1**			44° 40' 02.2" N	117° 58' 06.0" W
3	**Powder River approx. 2 miles u/s of Site No. 1**			44° 40' 16.8" N	117° 58' 45.1" W
4	**Inside Mason Dam Stilling Basin**			44°40' 21.4" N	117° 59' 51.1" W
5	**Reservoir Site within a 10 meter radius of the intake of Mason Dam**			44° 40' 20.6" N	118° 00' 07.3" W

The field sampling work to be conducted at the five sites listed in Table 4 will be done weekly throughout the field season. Instantaneous grab samples of water and field measurements will be collected at all sites on the same day. Field sampling work will begin at Site No. 1 as close to daybreak as possible (see appendix D for a sunrise calendar), and proceed from site to site in numerical order as shown in Table 3.

Study parameters include: water temperature, pH, specific conductance, dissolved oxygen, turbidity, and alkalinity that will be tested for at each site. At the Reservoir site near the intake at Mason Dam, a multi meter will/may be used to gather data with 1 meter intervals starting 1 meter below the surface all the way down to within 1-2 meters of the bottom of the reservoir. A Van Dorn Bottle Sampler or similar Vertical sampler will be used to gather the grab samples at five meter intervals for duplicate samples. For the river sites a YSI brand automatic datasonde sampler (or similar multi meter) will also be deployed at each site to collect in stream measurements for the study parameters listed above. The duplicate samples for the in stream sites will be collected with a grab technique. Stream flow data will be recorded during each sampling event from the OWRD/BOR gage station located just downstream of Mason Dam. Reservoir elevation will also be recorded. This information can be found on the BOR website.

Sampling will begin during the 2007 field season. The field season will begin two weeks after the ice has receded from Phillips Reservoir (around May 1st), and end on November 1st. Termination of the field season may occur earlier than November 1st if the field data indicates that thermal stratification has already broken down. Water samples will be collected once a week with all laboratory work completed in the field. Progress reports will be sent to all stake holders each month.

Staff from Baker County will consult with ODEQ staff to review the first season's data and any changes to the construction and operation plans of the hydroelectric plant to determine if additional monitoring is required.

A7. Quality Objectives and Criteria

Document control procedures will be used to ensure the most recently approved Quality Assurance Plan document is available for implementation. This document is available through the Baker County Government webpage at (http://www.bakercounty.org).

Procedures for collecting Water Quality samples and conducting field analyses are described in the Watershed Assessment Section Mode of Operations Manual (MOMs) (DEQ03-LAB-0036-SOP).

Specific QA Objectives for this project are:

• Collect a sufficient number of samples and sample duplicates to evaluate the potential for contamination from sampling equipment and techniques.

• Analyze a sufficient number of QC duplicate samples to effectively evaluate results against numerical QA goals established for precision and accuracy.

• Implement sampling techniques in such a manner that the analytical results are representative of the media and conditions being sampled.

The following Data Quality Indicators describe the quality of the data required to satisfy the goals and objectives of this project, and they are assessed by the following QA/QC parameters:

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

Precision and accuracy control limits are defined in Table 4 for project specific parameters. Precision requirements for the field equipment (conductivity/salinity & turbidity meters, etc.) are consistent with the Data Quality Matrix in Chapter 4, “Data Quality” of the Oregon Plan for Salmon and Watersheds Water Quality Monitoring Guidebook, (2001).

A7.a Precision

Precision is a measure of the scatter of the data when more than one measurement is made on the same sample. Scatter is commonly attributed to sampling activities and/or chemical analysis. For duplicate measurements, precision will be expressed either as the difference or as the relative percent difference. Field duplicates must be collected at a frequency of one per set of ten stations sampled or at least one per sampling expedition (1 week period).

Field duplicates will be analyzed in the field through the following techniques.

DO- Winkler Titration with a Hach field kit (or similar)

Precision will be estimated from both field lab work and multi meter readings.

A7.b Accuracy/Bias

Accuracy is a measure of the error between reported test results and the true sample concentration. Inasmuch as true sample concentrations are not known, a priori, accuracy is usually inferred from recovery data as determined by calibrating equipment correctly. Through calibrating in the morning and then checking calibration at the end of the day field collection will provide the accuracy of the instruments and if there is any error. The following discusses calibrating equipment to ensure the accuracy of the data.

For dissolved oxygen, a sample will be taken and measured with an electronic meter and a Winkler titration will be performed. The meter then should be calibrated to match the Winkler titration. At the end of the day, this should be done again to determine any error. Procedures can be found in the MOMs, with specific procedures to the equipment actually used in the owner's manual.

For turbidity, standards will be used and placed in the meter that are close to what will be present in the field. For example if the field data is around 4 NTU then a 1 NTU and a 5 NTU standard should be used to check the meter. Procedures can be found in the MOMs, with specific procedures to the equipment actually used in the owner's manual.

A7.b Sensitivity

Field duplicates will be collected at a 10 percent frequency of the stations sampled during a sampling expedition. Field duplicates will be used to assess sample handling contamination and method variation. If corrective action measures fail to resolve field-sampling errors, the sampling expedition results will be flagged.

Table 4 lists the parameters of interest for this project and the target Minimum Reporting Level (MRL).

A7.c Representativeness

Representativeness is a qualitative term that should be evaluated to determine whether in situ and other measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the media and phenomenon measured or studied.[1] The intent of this project is to collect baseline data with emphasis on dissolved oxygen by taking its reading at its lowest point which, usually occurs in the early morning.

Representativeness is controlled by using well defined sampling and sample handling SOPs. Sampling procedures are designed so that results are representative of the matrix being sampled. Sample handling protocols for storage, preservation and transportation have been developed to preserve the representativeness of the collected samples. Proper documentation will establish that protocols have been followed and sample identification and sample integrity assured. If it is determined that sample integrity has been compromised data will be flagged.

Samples that are not representative of the population often occur in judgmental sampling because not all the units of the population have equal or known selection probabilities[2]. The rational for selecting sampling stations is described in section B1 below.

The location of the sample will be referenced to latitude and longitude using a GPS. Pictures will also be taken in order that samples are taken from the same location. Samples will be collected where there is sufficient current to ensure the water is well mixed. All efforts will be made to confirm the accuracy of this sample meta-data.

[1] USEPA 1998. EPA GUIDANCE FOR QUALITY ASSURANCE PROJECT PLANS EPA QA/G-5, pp 76.

[2] ibid, pp 94.

Quality analytical measurements with poor field duplicate precision may point to sampling problems or heterogeneous samples and thus not representative of ambient conditions. To ensure the representative data quality indicator is correct, field duplicates must be collected within 15 minutes and 15 meters of each other, where the sample matrix is assumed to be homogeneous. Evaluation of field duplicate and accuracy data will provide information if there is error in the hypothesis that the sample is homogeneous. If field duplicate data exceeds precision limits and accuracy data is acceptable, the sampling design may be in error and the data may not represent the environmental conditions for which it was collected. If field duplicate data indicates Representativeness is acceptable, data users may assume other project data is accurate.

If it is determined the field duplicate data is heterogeneous within a 15 minute period or 15 foot radius, the subproject/project station data will be flagged data and the data user should use their professional judgment to determine if other project data meets their data quality needs.

If station data is not indicative of the streams normal ambient conditions and the variances are attributable to anomalous environmental conditions, the project station data will be flagged as “Failed” data.

A7.d Comparability

To ensure data will be comparable to similar environmental data, the field and analytical staff will use documented procedures for sampling, sample handling, and sample analysis, which are written to comply with nationally accepted methods. Coordination with other agencies is emphasized to ensure that data is comparable. Either use documented procedures as found in the MOMs or document the procedures used.

A7.e Completeness

It is expected that samples will be collected from all sites described in this Sampling and Analysis Plan (SAP) unless seasonal-related events or safety issues prevent sampling. The Project Manager may authorize re-sampling to obtain more information of qualified data.

Table 4 Data Quality Criteria

Parameter	Method Reference	Target MRL	LCS or SRM [i]	Lab or Field Duplicate [ii]	Holding Time	Container	Sample Preservation
Dissolved Oxygen	SM 4500-O C	1 mg/L	≤ ± 0.2 mg/L[iii]	≤ ± 0.3 mg/L	Analyze Immediately[iv]	Field	NA
Percent DO Saturation		N/A	N/A		Analyze Immediately	Field	NA
Sample Depth		1 ft	N/A		NA	Field	NA
Temperature	EPA 170.1	1 °C	≤ ± 0.5°C[v]	≤ ± 0.5°C	NA	Field	NA
pH	EPA 150.1	Sensitivity to 0.1 SU	≤ ± 0.2 S.U[vi]	≤ ± 0.3 S.U	Immediate (24 hours)	Field + QC – P: 1000 ml Poly	<4°C
Specific Conductivity (@ 25°C)	EPA 120.1	1 µmhos/cm	±10-15%		28 days	Field + QC – P: 1000 ml Poly	<4°C
Turbidity	SM 2130 B	1 NTU	±10-15%	± 20%	48 hours	Field + QC – P: 1000 ml Poly	<4°C
Flow	MOMs[vii]	10 cfm	N/A	N/A	NA	Field	NA
Alkalinity	2320 B	1 mg/L	±10-15%	± 20%	14 Days	Field + QC – P: 1000 ml Poly	NA

[i] Accuracy of analytical methods will vary based upon calibration and equipment employed.

[ii] Precision will be estimated from both in-lab replicate analyses and field duplicate samples. Results will be flagged as "B" data, if corrective action measures do not resolve precision errors.

[iii] Winkler titration or calibrated Oxygen meter.

[iv] Winkler allows stabilization and holding time for 8 hours until titration

[v] Thermometer Accuracy checked with NIST standards.

[vi] Calibrated pH electrode

[vii] Stream flow measurements will be conducted according to the ODEQ methodology derived from USGS stream flow protocols.

A8. Special Training and Certification

Training in proper field sampling procedures is available upon request from the staff in the Watershed Assessment Section of the Oregon Department of Environmental Quality Laboratory in Portland, OR. Contact: Larry Marxer, 503-229-6859, or email: marxer.larry@deq.state.or.us.

A9. Documentation and Records

For the purposes and requirements of this project, the field sampling staff will prepare field data sheets prior to each weekly sampling event in order that all preparatory work is completed prior to conducting field sampling. The information to be recorded on the field data sheets will include the following: Project name, date & time of sampling events, water body name, major basin name, general weather conditions, names of field staff, time of each sample or field measurement, site ID numbers, equipment ID numbers, and field data results

It is recommended that the field staff maintain a bound field notebook to provide a daily record of significant events, observations, and measurements during field investigations. This notebook will be a permanent record of the project and should include water level data, field measurements, personnel, weather observations and general physical habitat conditions.

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Group B Data Generation and Acquisition

B1. Sampling Process Design

This Sampling and Analysis Plan (SAP) was written for the specific field HUC for the section of the Powder River that includes Phillips Reservoir. This section of the SAP describes the logic behind selecting the sampling locations. The general rule for selecting the sampling sites for this project was to select sites most indicative of water quality conditions in the immediate vicinity of the Mason Dam hydroelectric project. The purpose of this sampling process is to get a full profile of the reservoir with in the vicinity of the intake and down stream of Mason Dam as requested by DEQ with an emphasis on DO and water temp. Sampling will occur weekly. The use of a datasoned may be used to collect all data except for duplicate samples. The site that will be chosen for duplicate samples will be selected by rolling a die. If the dice lands on a six it will be re-rolled until a number that corresponds to a sampling site is displayed. Duplicate sampling will be done through water grabs. For sites 1-4, one grab will be taken along with the other samples. The grab should take place as soon as possible not to exceed 15 minutes. For site 5 water grabs samples will be taken every five meters starting at one meter under the surface and all the way down to within 1-2 meters of the bottom. The purpose of sites 1-4 is to get a longitudinal profile of how the gases re-equilibrate after discharge from the reservoir.

Site No. 1: This site occurs in an area of the river that is likely to re-aerate due to the amount of turbulence during release and is the furthest site from Mason dam.

Site No. 2: This site was selected because it is less than a five minute drive from Site No. 1. There is safe access to this site and easy vehicle parking off the road.

Site No. 3: This site was selected because it is less that a five minute drive from Site 2. Access to this site is also safe, and there is easy parking off the road. Sites 2 & 3 divide the distance between Site No, 1 and Site No. 4 equally.

Site No. 4: This site is in the stilling basin of Mason Dam, and was selected so that reservoir water could be compared to the water discharged through Mason Dam.

Site No. 5: This site is in Phillips Reservoir within a 10 meter radius of Mason Dam intake structure. A GPS unit will be used to gather water samples in approximately the same location every time due to the fact the intake is not visible. It was selected so that current ambient water quality conditions could be monitored before the water passes through the Dam. Sampling will be conducted vertically starting 1 meter under the surface with 1 meter intervals to within 1-2 meters of the bottom.

Sampling frequency is based upon resources, priorities; and statistical needs for trending. Table 3 lists sample stations.

Where site locations safely allow, samples should be collected from the center of the main channel, at a depth of one meter or half the total depth, whichever is greater. This ensures a sample representative of environmental conditions.

B2. Sampling Methods

Water sample collection and field measurements will be accomplished using the standard protocols, as recommended and described in the ODEQ Laboratory MOMs Manual. Specific sample preservation methods and holding times are summarized in Table 4 above.

B3. Sample Handling and Custody Procedures

Once a sample is collected, it will be handled in a way that will provide data that is accurate to the environment in which it was taken. Since lab work will be performed in the field, samples for laboratory analysis as identified in Table 4 will not be need to be executed unless a sample is transported to a lab. If a sample is transported to a lab field staff will follow the chain of custody procedures as outline in the MOM.

B4. Analytical Methods

All parameters will be measured using the protocols previously mentioned above. The suggested reference for field analytical methods can be found in the ODEQ Laboratory Watershed Assessment Mode of Operations Manual (MOMs) which is available on the DEQ Laboratory website at http://www.deqlab3\SOP\Watershed Assessment\DEQ03-LAB-0036-SOP.pdf. Manuals provided with the equipment and kits can also provide some information.

B5. Quality Control

Duplicate field quality control samples will be collected at a minimum of 10% of the total number of monitoring sites, or at least one duplicate per sampling expedition. Accuracy will be determined by calibrating equipment before the first sample and after the last sample.

B6. Instrument/Equipment Testing, Inspection, and Maintenance

All field monitoring equipment will be tested for accuracy and /or calibrated in accordance with MOMs or the owners manual. Equipment must be maintained and inspected according to required laboratory field protocols.

B7. Instrument Calibration and Frequency

All field monitoring equipment will be tested for accuracy and/or calibrated in accordance with the required procedures from the MOMs and manufacturers manuals.

If instruments can not be calibrated as required, data will be qualified or voided. Inspection/Acceptance of Supplies and Consumables will be done prior to each field day.

Field kits used to conduct lab analysis must be checked to ensure reagents have not reached their expiration dates.

B8. Non-direct Measurements

Historical flow information will be collected and compiled as availability allows. No additional acceptance criteria will be required for this data.

B9. Data Management

Separate field data sheets will be maintained for each sampling event. Information recorded on data sheets is to include Project name, data and time of sampling events, water body name, basin name, site ID numbers, general weather conditions, and names of field staff, time of each sample or measurement, results and equipment ID numbers. Quality assurance staff reviews data sheets for all continuous, field and laboratory data.

Data management will be provided through the Data manager. He/she will receive all field forms and laboratory analysis data is a laboratory is used. The manager will check forms for completeness before entering the data in the computerized forms. The original forms will be scanned and then filed. All information will be stored on the c: drive of the computer, a removable thumb drive, and the server.

Group C Assessment and Oversight

C1. Assessment and Response Actions

Surveillance and data management will be performed once a month to ensure data being collected will meet the needs of the project. Information collected during this project is intended to meet the needs of section A7. All results of the individual assessments will be compiled and managed by the Data Manager, contract firm, or professional.

Response actions will be developed as data becomes available. Any stop work orders or change in project scope will come from the Project Manager. Corrective actions will be documented as addendums to this QAPP/SAP.

C2. Reports to Management

Reports will be sent to the personnel listed in Table 1 for approval and/or review.

Group D Data Validation and Usability

D1. Data Review, Verification and Validation

The Project Manager, the QA Officer and the Data Manager will review all data resulting from this project as data becomes available and determine if the data collected meets the QA Plan objectives. Decisions to accept, qualify or reject data will be made by the Project Manager/Basin Coordinator, QA Officer and Data Manager.

D2. Verification and Validation Methods

As required by the project QA Program, field duplicate samples will be collected at a rate of 1 duplicate per 10 samples collected, or at a minimum of 1 duplicate per sample event. Any data or sample values outside of the expected range for the parameter being measured will be rechecked for validity in the field by the field team, and if necessary, the field team will re-sample. Data that continues to be outside expected values will be further investigated to determine the cause, using alternate methodology, if available. Additional sampling may be used to verify or refute outliers collected during the prescribed sample events.

Once the data has been entered in the project database the Data Manager will print a paper copy of the data and proofread it against the original field data sheets. Errors in data entry will be corrected at that time. Outliers and inconsistencies will be flagged for further review or be discarded. Data quality problems will be discussed as they occur and in the final report to data users.

D3. Reconciliation with User Requirements

As soon as possible after each sampling event, calculations and determinations for precision, completeness, and accuracy will be made and corrective action implemented if needed. If data quality indicators do not meet the project's specifications, data may be discarded and re-sampling may occur. The cause of the failure will be evaluated. If the cause is found to be equipment failure, calibration and/or maintenance, techniques will be reassessed and improved. If the problem is found to be sampling team error, team members will be retrained. Any limitations on data use will be detailed in both interim and final reports, and other documentation as needed. If failure to meet project specifications is found to be unrelated to equipment, methods, or sample error, specifications may be revised for the next sampling session. Revisions will be submitted to the QA Officer and Laboratory Manager for review and/or approval.

Appendix A

See map of sampling sites (Attachment A). Site five will be located when an agreement with a boat has been secured.

Appendix B - Field Data Forms

The Filed Data Sheet associated with this Sampling and Analysis Plan is located on page 17 and 18. Additional forms that will be used are attached (Form 1,2,and 3)

Appendix C - Revision History

The plan author must increment the revision number with each approved revision. A new document is assigned a revision number of 1.0. The revision number of a plan that receives routine or minor editing is updated by incrementing the minor number by one (i.e., 1.0 becomes 1.1) The revision number of a document that has undergone major revisions is updated by incrementing the major number by one and setting the minor number to zero (i.e., 1.1 becomes 2.0). Revisions to documents should be clearly identified in a "Revision History" section of the document. The Revision History documents the specific changes made to the controlled document; who made the changes, and the date (month and year) the changes were made.

Table 5 Revision History

Revision	Date	Changes	Editor
2.0	5/2007	Additions to become more specific, Sections A6, A7 a-e, B1, Tables 3 & 4	JY
2.1	5/2008	More accurate locations for Table 3	JY

SURVEY: ____________ **Major Basin:** ____________

Collected by: ____________ **Date Sampled:** ____________

Report Data to: ____________ **Time center:** ____________

SAMPLING EVENT # ____________
DATE RECEIVED: ____________
RECEIVED BY: ____________
DATE RELEASED: ____________

Sub-project	STATION ID #	SITE NAME (RM)	Elev QA	DO BOD	Nutrients Basic	Bact DP	Chl a Vol. (ml)	Time (HH MM)	FpH (SU)	FAlk (mg/l)	Temp (C)	FCond (umhos)	DO (mg/l)	DO Sat %	FTurb (NTU)
					R	C									
					P	DP			.		.		.		
					R	C									
					P	DP			.		.		.		
					R	C									
					P	DP			.		.		.		
					R	C									
					P	DP			.		.		.		
					R	C									
					P	DP			.		.		.		
					R	C									
					P	DP			.		.		.		
					R	C									
					P	DP			.		.		.		
					R	C									

pH meter ____________ **Weather** ____________

Cond meter ____________ **Comments** ____________

Turb meter ____________

QA(QA_QC_TYPE):Sample=S,Field Primary=FP,Field Duplicate=FD,Field Blank=FB

Mason Dam Water Quality Pre Field Check List Form 1

BOR lake elevation information filled out on field From 2. ☐

Prepared by: ____________________

Date: ____________________

Equipment Needed for each study test

pH

Sampling

- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

Testing

- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

Is equipment clean and ready to go?	Y	N
Was equipment stored correctly?	Y	N
Has equipment been calibrated?	Y	N
Has equipment been maintained?	Y	N
Chemicals are up to date?	Y	N
Is there enough quantity of chemicals?	Y	N
If no has more been requested/ordered?	Y	N

Comments:

____

____

DO

Sampling

- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

Testing

- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

Is equipment clean and ready to go?	Y	N
Was equipment stored correctly?	Y	N
Has equipment been calibrated?	Y	N
Has equipment been maintained?	Y	N
Chemicals are up to date?	Y	N
Is there enough quantity of chemicals?	Y	N
If no has more been requested/ordered?	Y	N

Comments:

____

____

Temperature

Sampling

- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

Testing

- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

Is equipment clean and ready to go?	Y	N
Was equipment stored correctly?	Y	N
Has equipment been calibrated?	Y	N
Has equipment been maintained?	Y	N
Chemicals are up to date?	Y	N
Is there enough quantity of chemicals?	Y	N
If no has more been requested/ordered?	Y	N

Comments:

____

____

Turbidity

Sampling

- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

Testing

- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________
- ☐ ____________________

Is equipment clean and ready to go?	Y	N
Was equipment stored correctly?	Y	N
Has equipment been calibrated?	Y	N
Has equipment been maintained?	Y	N
Chemicals are up to date?	Y	N
Is there enough quantity of chemicals?	Y	N
If no has more been requested/ordered?	Y	N

Comments:

____

____

Mason Dam Water Quality Form 1

Pre field check list

Prepared by: ____________________

Date: ____________________

Alkalinity

Sampling

- [ ] ____________________
- [ ] ____________________
- [ ] ____________________
- [ ] ____________________
- [ ] ____________________

Testing

- [ ] ____________________
- [ ] ____________________
- [ ] ____________________
- [ ] ____________________
- [ ] ____________________

Is equipment clean and ready to go?	Y	N
Was equipment stored correctly?	Y	N
Has equipment been calibrated?	Y	N
Has equipment been maintained?	Y	N
Chemicals are up to date?	Y	N
Is there enough quantity of chemicals?	Y	N
If no has more been requested/ordered?	Y	N

Comments:

____

____

Hydro Lab/Datasonde

Sampling

- [ ] ____________________
- [ ] ____________________
- [ ] ____________________
- [ ] ____________________
- [ ] ____________________

Testing

- [ ] ____________________
- [ ] ____________________
- [ ] ____________________
- [ ] ____________________
- [ ] ____________________

Is equipment clean and ready to go?	Y	N
Was equipment stored correctly?	Y	N
Has equipment been calibrated?	Y	N
Has equipment been maintained?	Y	N
Chemicals are up to date?	Y	N
Is there enough quantity of chemicals?	Y	N
If no has more been requested/ordered?	Y	N

Comments:

____

____

Mason Dam Water Quality Field Record Sheet (Form 2)

Sampling Event #: ____________

Survey: Mason Dam and Upper Powder River
Major Basin: Powder Basin
Date Received: ____________

Collected by: ____________
Report Data to: Jason Yencopal
Received by: ____________

Date of collection: ____________

Site #: 1 2 3 4 5
Site Elevation: 1- , 2- , 3- , 4-

Resevoir Elevation: ______ ft
Intake Elevation: ______ ft
Equals: ______ ft
Multiply answer by 3.2808399 m/ft
Equals: ______ m
Add 2 meters 2 m
Equals # of meter intervals. ______ m

Equipment Used:
pH meter: ____________
Alkalinity: ____________
Turbidity meter: ____________
Hydro Lab/Datasondes: ____________
Temputure: ____________

Sample Bottle #	Time of Sample	DO (mg/l)	DO Sat %	Turbidity (NTU)	Temp (C)	Alk (mg/l)	pH (SU)	QA

QA(QA-QC-Type): S=Sample, FP=Field Primary, FD= Filed Duplicate, FB= Field Blank

Weather: ____________

Comments: ____________

Mason Dam Water Quality Return from Field Form 3

Prepared by: ____________________
Date: ____________________

All equipment has been cleaned and stored properly. Y N

Does any equipment need maintenance? Y N (List)

- ☐
- ☐
- ☐
- ☐
- ☐

Does any equipment/supply need replaced? Y N (List)

- ☐
- ☐
- ☐
- ☐
- ☐

Find stream flow data information from BOR and fill in on Form 2. ☐

Do all calculations needed to complete field form. ☐

Are all field forms complete? Y N

Turn in all the Forms to the Project Manager. ☐

Comments:

____

____

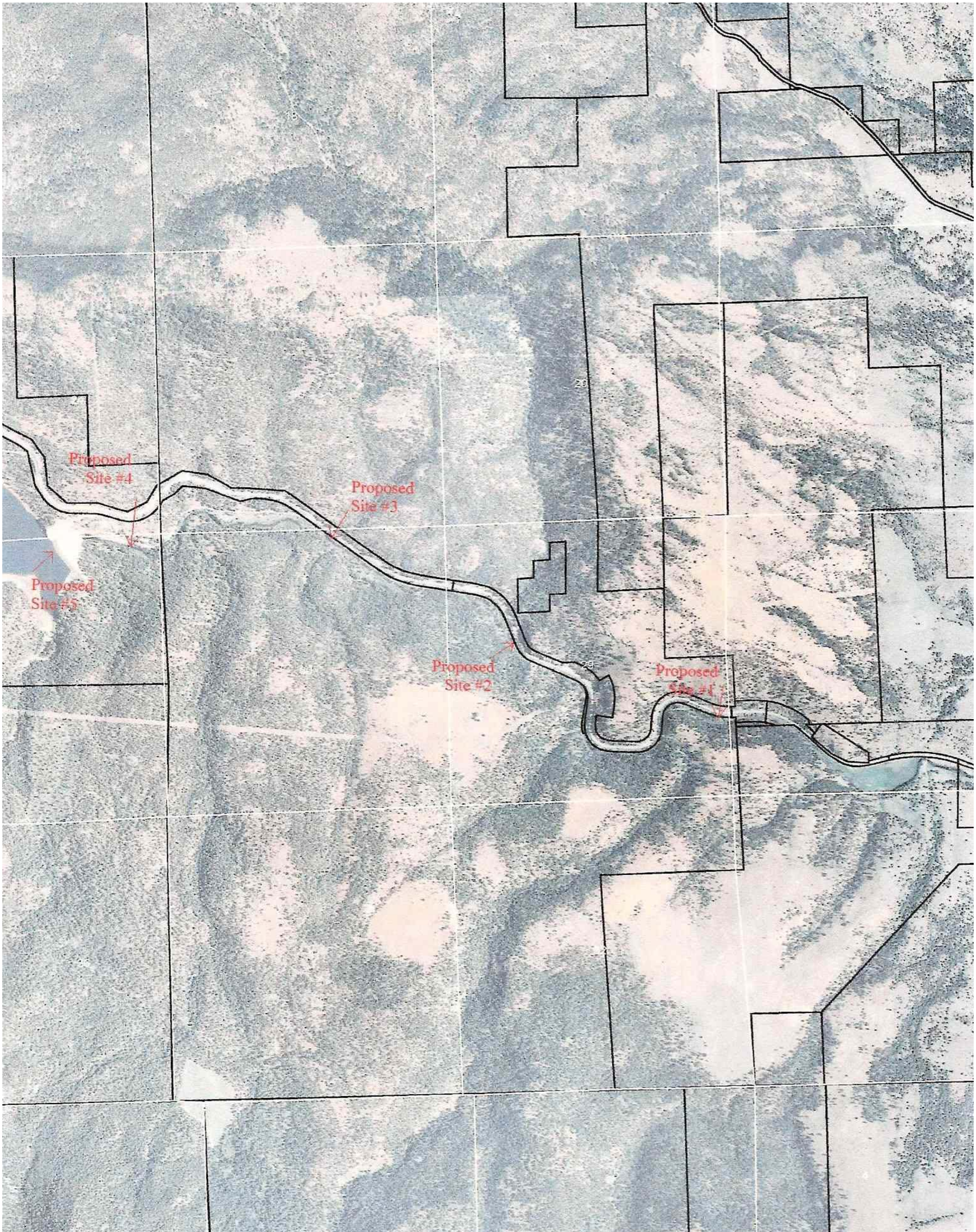
____

____

____

____

____



Proposed Site #4
Proposed Site #3
Proposed Site #5
Proposed Site #2
Proposed Site #1