2016 LOWER DESCHUTES RIVER WATER QUALITY STUDY RESULTS

Prepared for Deschutes River Alliance
April 2017

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Last, thanks to all those not mentioned here who care about the Deschutes River and have contributed hours of their time and money to better understand the river's changing ecology, and protect its health. Many hundreds of people and numerous companies and foundations have made it possible to keep this work moving forward - THANK YOU.

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SUMMARY

Before December 2009, water released from Lake Billy Chinook (LBC), the reservoir formed by Round Butte Dam, was drawn entirely from the bottom of LBC. Since that time, however, water releases from the dam have consisted entirely of surface water from November through early-to-mid June, and a blend of surface and bottom water the remainder of the year. This change was made possible by the construction of a Selective Water Withdrawal (SWW) tower in the forebay of Round Butte Dam. One purpose of the surface water releases is to aid reestablishment of anadromous fish runs above the three dam Pelton-Round Butte Hydroelectric Complex by creating surface currents to attract downstream migrating salmonid smolts through LBC to a collection trap at the SWW tower. It was also expected that surface water releases would return the lower Deschutes River to a more "natural" temperature regime by blending warm surface water with cold bottom water before discharging downstream.

To address potential negative impacts to water quality in the lower Deschutes River, the Oregon Department of Environmental Quality (ODEQ) established critical water quality requirements for the dam complex in a Clean Water Act (CWA) § 401 Certification. In order to ensure that the dam complex would adhere to those requirements, the Joint Operators (Portland General Electric and the Confederated Tribes of the Warms Springs Reservation of Oregon) were required to prepare a Water Quality Management and Monitoring Plan (WQMMP), submit the WQMMP to ODEQ, and agree to its requirements. The Plan then was incorporated into the CWA § 401 Certification, and the Certification was issued to the Joint Operators in 2004. The CWA § 401 Certification was made part of the new operational license issued in 2005 by the Federal Energy Regulatory Commission (FERC) to Portland General Electric (PGE) and the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWS) (hereafter, the Joint Applicants), the owners of the dam complex. The new Selective Water Withdrawal tower commenced operation in December 2009.

As early as the summer of 2010, changes in water clarity and temperature were noted by long-time anglers and fishing guides on the lower Deschutes River. Later, changes in aquatic insect emergence timing, decreases in adult aquatic insect abundance, and the growth of slime-like algae on stream substrate were observed. These observations were followed by notable declines in swallows, bats, and other insectivorous birds along the river. These changes raised more concerns about the negative effect the new water management approach was having on water quality and instream ecology in the lower 100 miles of the Deschutes River. As a result, in 2013 the Deschutes River Alliance (DRA) was established to study changes in water quality and advocate for protection of the fish and aquatic life in the lower Deschutes River. Several reports have been completed to date, which can be found on DRA's website: http://www.deschutesriveralliance.org .

In 2016, the DRA completed a water quality monitoring study on the lower Deschutes River at a site at River Mile 99 (RM 99), one mile below the Pelton Reregulating Dam (hereafter, Reregulating Dam) tailrace. Installation of a continuous monitoring data sonde (YSI 6600) allowed hourly measurements of water temperature, pH, dissolved oxygen, turbidity, conductivity, and chlorophyll-a. Data were collected from February 18 through November 22.

Results of this study found significant problems with water quality, including extensive violations of the Deschutes Basin pH standards. Temperature and dissolved oxygen also failed to meet the water quality requirements explicitly defined in the CWA § 401 Certification for project operation.

Overall, the water quality data collected by this study identified violations of Oregon water quality standards (OARs 340-041-001 to 340-041-0036 and 340-041-0046) and the license issued to the Joint Applicants by FERC. Primary findings include:

1) Releasing 100% surface water from LBC from November through early June raises the water temperature in the lower Deschutes River throughout the late winter, spring, and early summer by up to 7 degrees Fahrenheit above pre-SWW tower levels (Figure 10). This increase in downstream water temperature has altered aquatic insect life cycles and likely contributes to early growth of nuisance algae that has had further impacts on aquatic invertebrates. Additionally, a disturbing increase in the polychaete worm, *Manayunkia speciosa* has occurred, with populations increasing from zero per square meter

before SWW tower operation to >8,000 per square meter in 2016. This small polychaete worm is the intermediate host of the salmonid parasite *Ceratonova shasta* that has recently been found to have high infection rates in salmonids, especially spring Chinook, in the lower Deschutes River. The impacts this might be having on salmon and trout populations in the lower river are presently unknown, although they are potentially serious for spring Chinook.

2) 234 days out of the 279 days sampled (84%) had some pH measurements that exceeded the upper pH standard of 8.5 for the Deschutes Basin.

3) 120 days sampled (43%) had pH measurements recorded above 9.0.

4) pH first exceeded the 8.5 standard early in the spring (March 27th).

5) pH levels did not drop below 8.5 throughout April, May, and June, and consistently exceeded 9.0 during this time period (Figure 7).

6) Mid-day pH continued to exceed the 8.5 standard until the monitoring equipment was removed from the river in late November.

Despite numerous pH violations, no management plan for lowering pH has been developed by the Joint Applicants as required in the WQMMP when pH requirements therein are exceeded.

Further, a series of Interim Agreements (IAs) were entered into annually between ODEQ and the Joint Applicants starting in 2011. Under these IAs, ODEQ has agreed not to hold the Joint Applicants to the CWA § 401 Certificate's water quality requirements for temperature and dissolved oxygen. Moreover, each of the IAs were adopted without public notification and with no opportunity for public comment, as required under Oregon Administrative Rules (OARs). DRA's detailed review of these IAs finds that in all cases the Interim Agreements provided for lower (less protective) water quality requirements than are found in the original (and never withdrawn) WQMMP, as follows:

First, the IAs consistently relaxed the temperature requirements, providing for release of warm surface water for a longer period of time into the lower Deschutes River.

Additionally, the IAs significantly relaxed requirements for dissolved oxygen (DO):

- The regulatory period protecting salmonid spawning and egg incubation was changed from year- round to October 15-June 15.
- The DO requirement during spawning season was lowered from 11.0 mg/L to 9.0 mg/L based on an interpretation of an intergravel dissolved oxygen (IGDO) study that concluded IGDO remained above 8.0 mg/L.
- The spawning season set in the IAs (Oct 15-June15), fails to take into account trout spawning activity as required by OARs. Direct observation of trout spawning at RM 99 shows that it continues until late July. OARs dictate that an absolute minimum DO concentration of 9.0 mg/L should be applied throughout trout spawning, egg incubation, and fry emergence, which continues until late August.
- The DO requirements during non-spawning season were lowered from a standard of 8.0 mg/L as an absolute minimum, to the lowest standard allowed by ODEQ for cold-water aquatic life of 8.0 mg/L as a 30-day mean minimum, 6.5 mg/L as a 7-day minimum mean, and 6.0 mg/L as an absolute minimum (all three must be met).

The water quality results from this study confirm the many observations by long-time river users that water quality, and subsequently the health of the lower Deschutes River, has declined since the SWW tower began operation.

BACKGROUND

Selective Water Withdrawal Tower Operation

Beginning in December 2009, a new method of releasing water from Lake Billy Chinook (LBC), formed by Round Butte Dam, into the lower Deschutes River was implemented by Portland General Electric (PGE). The key component to this new method is a structure called the Selective Water Withdrawal (SWW)

Figure 1. Surface view of the selective water withdrawal tower located in the forebay of Round Butte Dam.

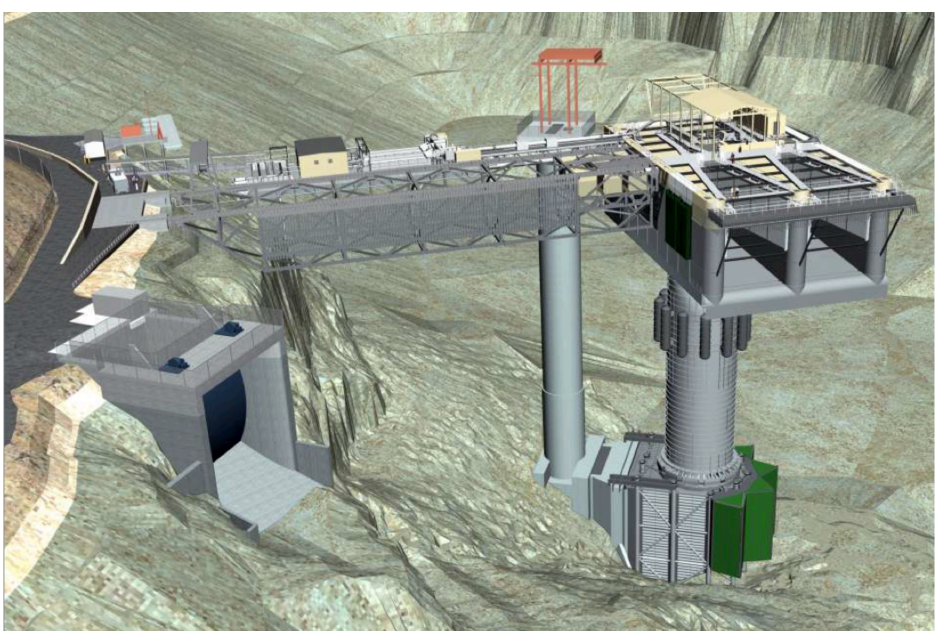


Figure 2. Underwater schematic view of the SWW tower showing surface intake and deep-water intake. (PGE diagram.)

tower (Figures 1 & 2). The tower's construction is a key part of PGE's and the Confederated Tribes of the Warm Springs Reservation's (CTWS) (hereafter, the Joint Applicants) new license from the Federal Energy Regulatory Commission (FERC) for operating the three-dam complex known as the Pelton-Round Butte Project (the Project) (Figure 3).

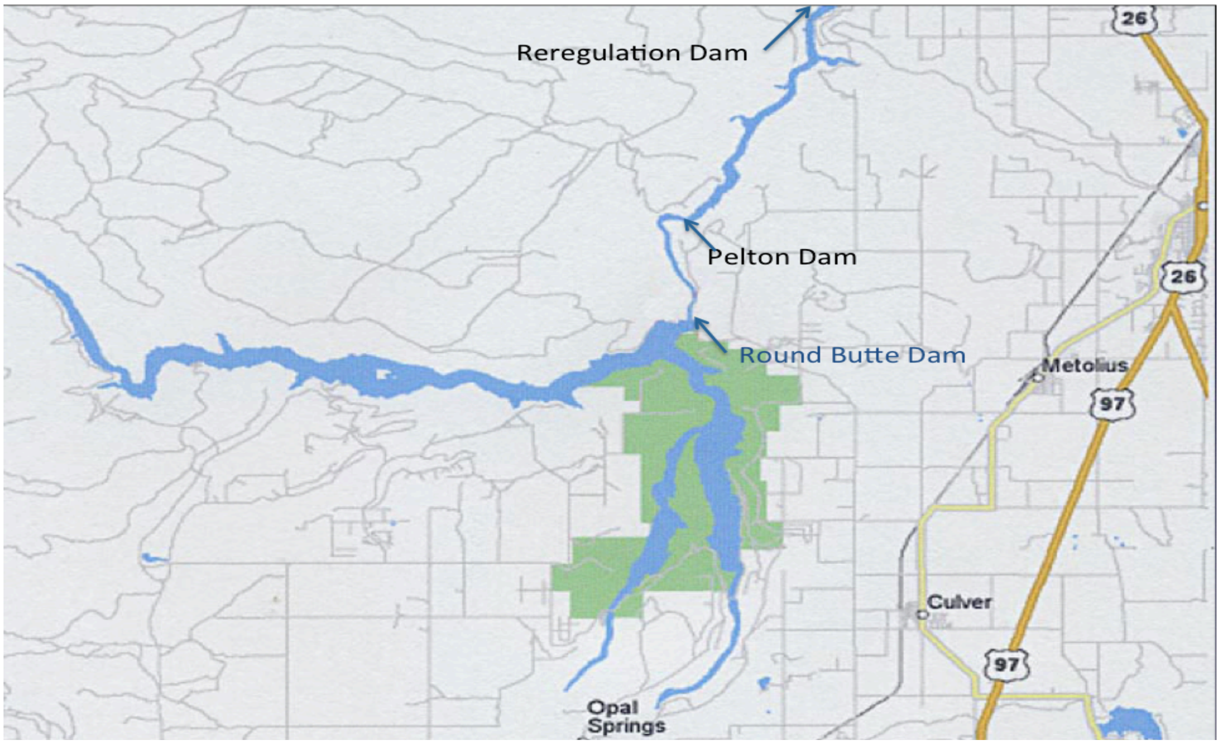


Figure 3. The three dams jointly owned and operated by PGE and CTWS: Round Butte Dam (creates Lake Billy Chinook reservoir), Pelton Dam (creates Lake Simtustus reservoir), and the Reregulating Dam (creates the reregulation reservoir).

The SWW tower has two water intakes, one at the surface and one at depth (~260 feet deep). The two intakes allow water from the surface and bottom of Lake Billy Chinook (LBC) reservoir to be mixed in a range of proportions. Prior to the construction and operation of the SWW tower, only water from the bottom of LBC could be released from Round Butte Dam. The change in operation from 100% bottom release to a mixture of surface and bottom water has significant implications for water quality in the lower Deschutes River. This is due to widely different water quality between surface water and bottom water in LBC: the surface water is warmer and of significantly poorer quality than the cold, higher quality water at depth (DRA 2015, 2016). Since the SWW tower began operation, 100% surface water has been released for seven to eight months of the year (November through early-to-mid June). A mixture of surface and bottom water is released the remainder of the year.

As part of the Joint Applicants' new FERC license, specific requirements for managing water quality in LBC and the lower Deschutes River were detailed in the Water Quality Management and Monitoring Plan (WQMMP) (CTWS & PGE 2002). The WQMMP is the central component of the Clean Water Act (CWA) § 401 Certification issued by ODEQ for project operation under the new FERC license. The WQMMP not only defines water quality management and monitoring goals, but also the reasons for building the SWW tower. Page 1, paragraph 4, of the WQMMP states:

As a major mitigation measure for the new license period, the Joint Applicants propose to reintroduce anadromous fish upstream of the Project. To enhance surface currents in Lake Billy Chinook, the reservoir upstream of Round Butte Dam, the Joint Applicants propose to construct a selective water withdrawal facility (SWW) at the existing Round Butte Dam intake tower. This new facility will allow water withdrawal from both the surface (warmer epilimnion) and the bottom (cooler hypolimnion) of the reservoir. This new facility will meet two significant purposes:

- *Help the Project meet temperature and water quality goals and standards in the lower Deschutes River and Project reservoirs, and,*
- *Allow the withdrawal of surface waters during salmonid smolt migration periods to facilitate the capture of downstream emigrating smolts from Lake Billy Chinook in support of the anadromous fish reintroduction goal.*

This language demonstrates a belief that the SWW tower operation would both improve water quality and create currents in LBC to attract salmonid smolts to a capture facility at the SWW tower. However, the WQMMP also admits to uncertainty about how the new project might actually impact water quality. Page 2, paragraph 4 of the document states:

In addition, actual impacts to water quality and currents will not be known with certainty until the selective withdrawal facility is constructed, operated, and monitored, ***highlighting the need for an adaptive management approach to ensure compliance with water quality standards.*** (Bold added for emphasis)

The above statement is clear; the purpose of adaptive management is to ensure that water quality standards contained in the WQMMP are adhered to. Unfortunately, as described in this report, the term “adaptive management” has been inappropriately employed to allow the continued release of surface water from LBC at the expense of water quality in the lower Deschutes River. This was accomplished through a series of “Interim Agreements” (IAs) to the WQMMP that purport to weaken the Project’s water quality requirements without public notice or comment as required under Oregon law.

Pre-tower Water Quality

The lower Deschutes River was placed on Oregon’s list of water quality limited streams (the Clean Water Act 303d list) as early as 1998, well before construction and operation of the SWW tower. This listing means that water quality in the lower Deschutes River was already impaired and known to not meet water quality standards for, in this case, temperature, pH, and dissolved oxygen.

To correct known water quality limitations such as these, the CWA mandates that streams placed on this list should have a total maximum daily load (TMDL) study completed by ODEQ. TMDL studies collect the water quality data necessary to determine the maximum amount of a pollutant that can be received by a water body and still meet water quality standards. The TMDL then “allocates” an acceptable load, or amount, of the pollutant to specific sources so that water quality improves and will meet the standards. To date, ODEQ has not completed or even scheduled the start of a TMDL study for the lower Deschutes River.

The Deschutes River Alliance (DRA) believes this is a serious oversight by ODEQ, especially since the CWA § 401 Certification for the Project submitted by ODEQ, identifies the TMDL and associated load allocations (LAs) as necessary to fully understand the impacts of the surface water releases from LBC on the lower Deschutes River, and to make appropriate adjustments to Project operations to ensure compliance with water quality standards.

Since 2013, the DRA has implemented several studies to assess the impacts of surface water releases on the aquatic life and water quality in the lower Deschutes River. Studies completed in 2016 monitored water quality parameters in LBC and the lower Deschutes River. This report presents the results of the lower Deschutes River monitoring effort.

OBJECTIVES AND KEY QUESTIONS

The DRA had one main objective for assessing water quality in the lower Deschutes River in 2016: Collect and analyze a complete set of data for specific water quality parameters in the lower Deschutes River from late winter until late fall to document water quality conditions and verify what, if any, violations of Oregon's water quality standards occurred.

The key questions this study was designed to answer were:

1. How does water quality for the key parameters of temperature, pH, and dissolved oxygen change on an hourly basis?
2. Which, if any, of these parameters exceed Oregon's water quality standards for the Deschutes Basin, and if so how frequently?
3. Is the water released from the Pelton Round Butte (PRB) complex through the SWW tower contributing to violations of water quality standards in the lower Deschutes River?

To answer these questions it was necessary to collect a full suite of water quality parameters on an hourly frequency at a location close enough to the tailrace of the Reregulating Dam (final discharge point and point of compliance of the PRB complex) to rule out other potential influences on water quality in the lower river, but far enough downstream to allow the river time to show a response to water released from the PRB complex. Fortunately, we were able to find a site that addressed both of these needs.

Collecting high quality hourly water quality data for a wide range of parameters is now possible with modern *in-situ* monitoring equipment known as hydrolabs or data sondes. With the help of a generous donation of $20,000 from a concerned landowner on the lower Deschutes River, the DRA was able to purchase the necessary equipment (YSI Model 6600 V2 data sonde w/sensors). In addition, the DRA was able to get access to private property located one mile downstream from the Reregulating Dam tailrace at River Mile 99 (RM 99) to install the equipment. This location provided an excellent place to assess the effects of water released from the PRB complex on the lower Deschutes River. The sample site also includes spawning habitat actively used by trout and salmon.

SAMPLING METHODS

A YSI 6600 V2 data sonde with 4 optical ports was used to collect hourly water quality data for pH, dissolved oxygen, percent oxygen saturation, temperature, conductivity, turbidity, and chlorophyll-a (Figure 4). Probes include self-cleaning optical sensors to avoid inaccurate results due to bio-fouling. More complete information about this YSI data sonde can be found at: https://www.ysi.com/6600-v2-4

Figure 4. YSI 6600 V2 data sonde.

The YSI data sonde was calibrated against lab standards for all parameters before being deployed in the field, and it was programmed to record hourly readings for each parameter. Field installation occurred on February 18, 2016, at RM 99, one mile below the Reregulating Dam tailrace (Figure 5). The data sonde was placed in an area of laminar flow approximately 20 feet from the east bank in three feet of water. The probes were positioned four to six inches above the stream bottom. Following field installation, field audits for all parameters except chlorophyll-a were completed monthly to ensure that the data sonde continued to collect accurate results (Appendix A).

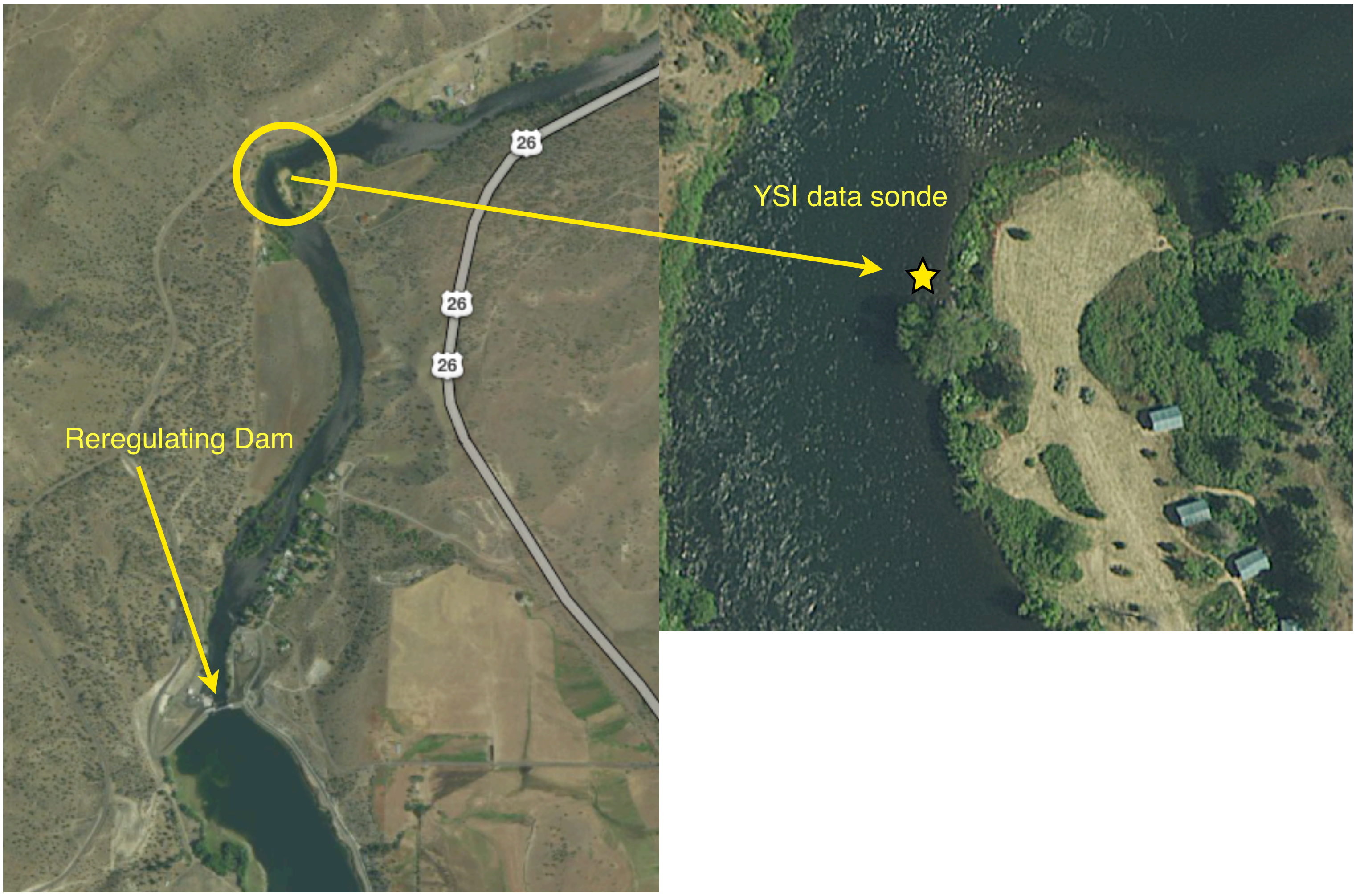


Figure 5. YSI data sonde installation location at River Mile 99.

No malfunctions of the data sonde were noted during its deployment, and based on the field audit checks, the data quality remained high throughout the sample period. The data sonde was removed from the river at 1200 hours on November 22, 2016. Data downloads were made during several field audits. The final data download was completed after the data sonde was removed from the river. Quality control and assurance procedures were followed throughout the study (Appendix B).

RESULTS

Temperature:

Hourly temperature readings from February 18, 2016 through November 22, 2016 are shown in Figure 6. The width of the line shows the range in temperatures over a 24-hr period. The difference between the daily minimum and daily maximum was slightly less than 0.5 °C in the late winter and spring and again in the fall. In the summer months this daily range increased to just over 1.5 °C (~3.0 °F). The larger difference between the daily minimum and maximum water temperature in the summer reflects the greater daily fluctuations in air temperature and longer exposure of the water's surface to solar radiation.

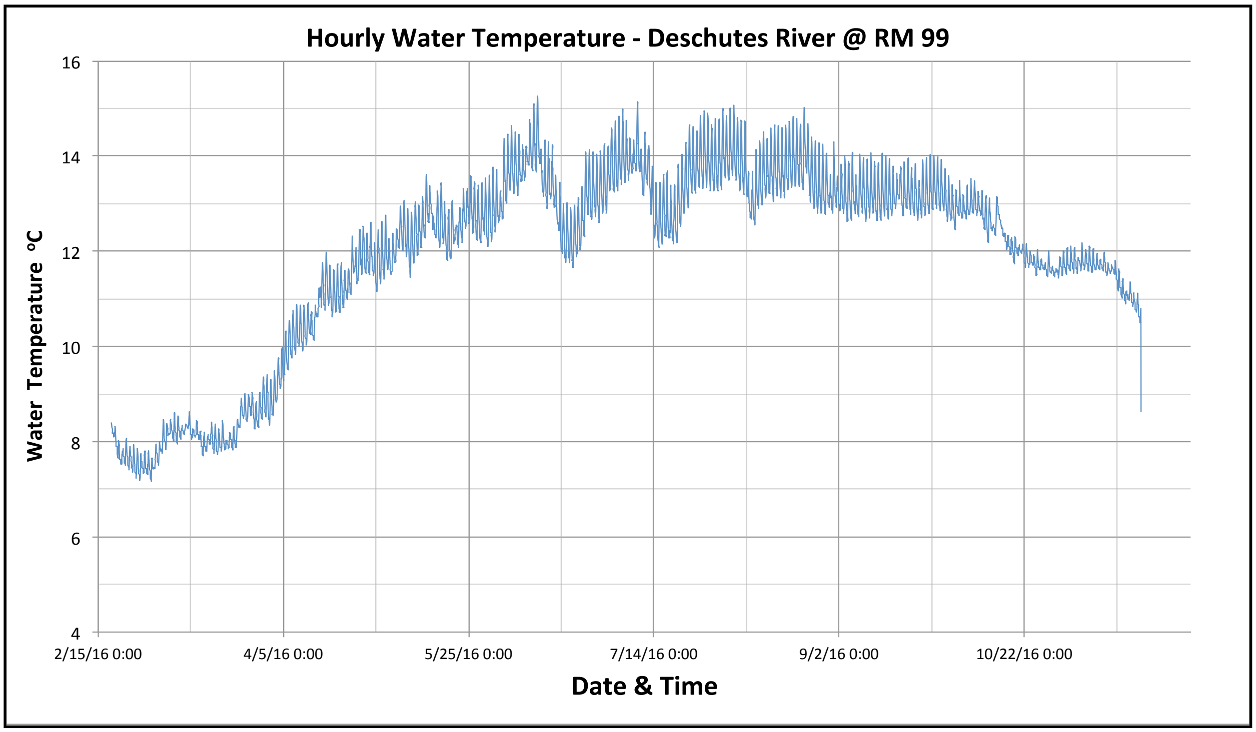


Figure 6. 2016 hourly water temperature at River Mile 99, one mile below Reregulating Dam tailrace.

The minimum recorded temperature at RM 99 during the monitoring season was 7.19 °C (45 °F), on February 26 at 0700 hours. The maximum water temperature was 15.26 °C (59.5 °F) recorded on June 12 at 1600 hours. This was followed by a noticeable drop in water temperatures, with a low water temperature of 11.7 ºC (53 ºF) recorded on June 22. Another period of rising temperature occurred until July 9, which had a recorded maximum of 15.14 ºC (59 ºF). Two other periods of high temperature occurred, one in early August (15.07 ºC, August 4 @ 1400 hours) and another in late August (15.01 ºC, August 23 @ 1400 hours). After August, maximum water temperatures remained relatively stable through September with daily maximum water temperatures near 14 ºC (57 ºF). Water temperatures then declined through October and November. Maximum daily water temperature in November was around 11 ºC (52 ºF).

Two periods with noticeable drops in temperature occurred during the summer (Figure 6). The first occurred around June 19-25, and the second from about July 14-22. The drop in temperature in June appears to have been weather related. In July, however, according to PGE reports submitted to ODEQ, the SWW tower had to be shut down from July 12-18 due to debris problems. As a result, 100% bottom water was released from LBC during this period. The corresponding water temperature downstream, as seen in Figure 6, declined roughly 1.5 ºC (3 ºF) from July 14-22, with maximum mid-day temperatures peaking at 13.5 ºC (56 ºF). Once blending of bottom and surface water began again on July 19, maximum daily temperatures rose to between 14.5 and 15.0 ºC (58-59 ºF) by July 23rd.

pH:

Figure 7 shows the hourly pH measurements recorded from mid-February to the end of November. As with temperature, the width of the line shows the difference in pH over a 24-hour period. Daily changes in pH are driven by the photosynthetic activity of aquatic plants and algae: pH rises with increased photosynthesis and drops when photosynthesis declines. As a result, maximum daily pH levels typically occur mid-afternoon between 1400 and 1600 hours, while minimum pH occurs early in the morning, generally just before sunrise. An increase in the range of pH between early morning and mid-day (shown by the width of the line) indicates greater algal biomass and sunlight, which results in more photosynthesis. Because pH changes in response to algal density, high pH levels are also a useful indicator of nutrient enrichment (U. S. EPA 2013).

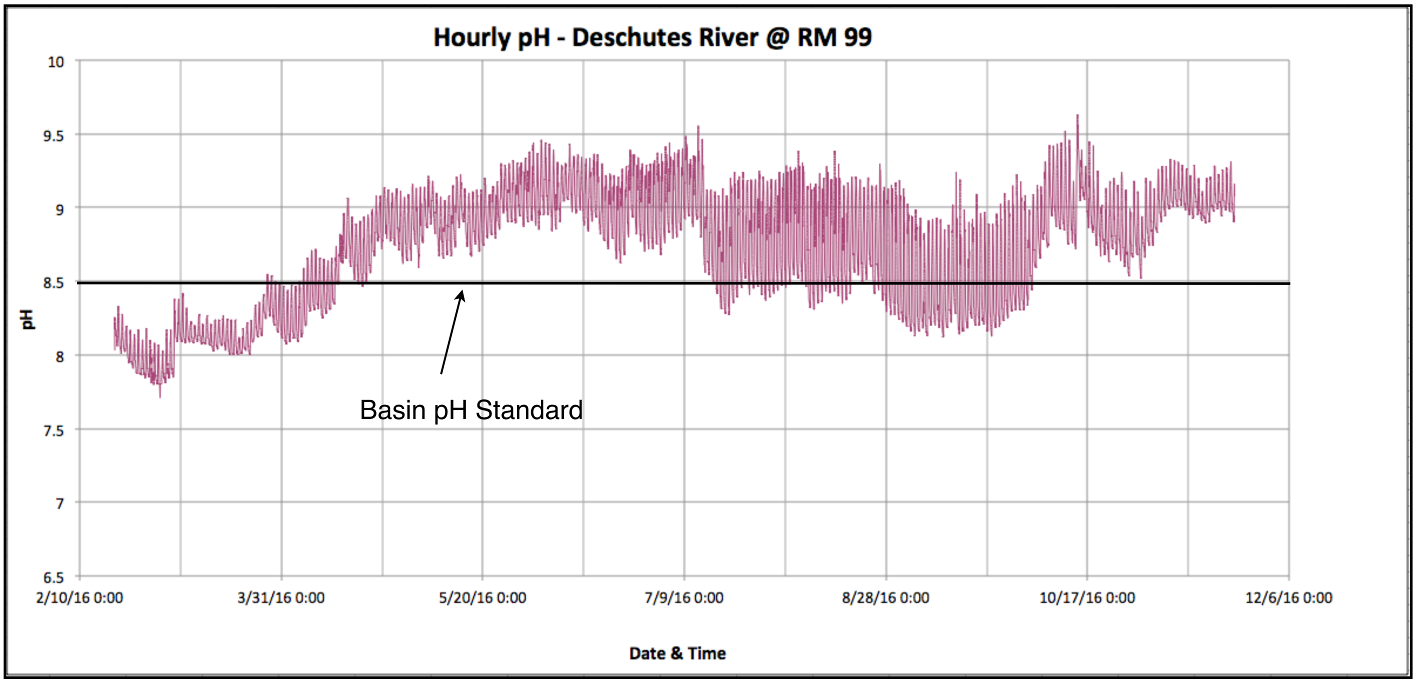


Figure 7. Hourly pH measurements at River Mile 99, one mile below Reregulating Dam tailrace.

Oregon's water quality standard for pH in the Deschutes Basin is a pH between 6.5-8.5 standard units (Oregon Division 41 Water Quality Standards 2016). Like other water quality standards, this standard was set to protect aquatic life. While a pH above 8.5 is not lethal to aquatic life, it does not provide adequate protection (Robertson-Bryan 2004), and also indicates excessive algal growth.

The first recorded pH above 8.5 was on March 27, at 1400 hours (pH of 8.55). After March 28, peak pH dropped below 8.5 until April 5, when pH rose to 8.59. From that date forward pH exceeded the Deschutes Basin standard every day until the end of November when the data sonde was retrieved from the river for the season (Figure 7). Starting on April 16, peak daily pH levels exceeded 9.0. Daily maximum pH stayed above 9.0 for most of the remaining monitoring season. The maximum pH recorded during 2016 was 9.63 on October 14, at 1300 hours. The pH also exceeded 9.5 on July 12 (pH of 9.55), at 1100 hours.

Dissolved Oxygen:

Dissolved oxygen (DO) in water is measured and recorded in two ways: 1) as the concentration of dissolved oxygen in the water recorded in milligrams per liter (mg/L); and 2) as the percent of oxygen dissolved in the water (% saturation) given the temperature, elevation, and barometric pressure at which the sample was collected. In most cases it is the concentration of DO that is applied to water quality standards. However, under the right temperature, elevation, and barometric pressure conditions, it is possible for a relatively low DO concentration - say <8.0 mg/L - to equal 90 to 100% saturation. Under such circumstances it is the percent saturation of DO that is applied when evaluating whether DO water quality standards are being met.

Oregon's water quality standard for dissolved oxygen varies depending on the presence of spawning steelhead, salmon, or trout: the DO standard is higher when trout and/or salmon are spawning and their eggs incubating, than when they are not. The DO standard currently being applied by ODEQ for the lower Deschutes River is 9.0 mg/L during spawning/incubation season (currently set by ODEQ as October 15 - June 15), and a lower, multiple standard of 8.0 mg/L as a 30-day mean minimum; 6.5 mg/L as a 7-day minimum mean; and 6.0 mg/L as an absolute minimum (all three must be met) during the non-spawning and incubation period (June 16 - October 14). More explanation of Oregon's DO standard and its application to this Project is covered in the "**Discussion**" section of this report.

Figure 8 shows the hourly DO concentration from February through November, while Figure 9 shows the % saturation of DO for the same time period. These graphs show a clear diel change in DO: minimum concentrations occurred an hour or two before sunrise, while maximum concentrations were measured mid-afternoon. The greatest range from daily low to daily high occurred during the summer months. Like pH, these daily changes are driven by biological activity in the water. During daylight hours, photosynthesis by algae and aquatic plants produces oxygen, increasing the DO levels. At night, when photosynthesis stops, respiration by plants and animals uses up the oxygen dissolved in the water, causing a decrease in DO concentration. The greater

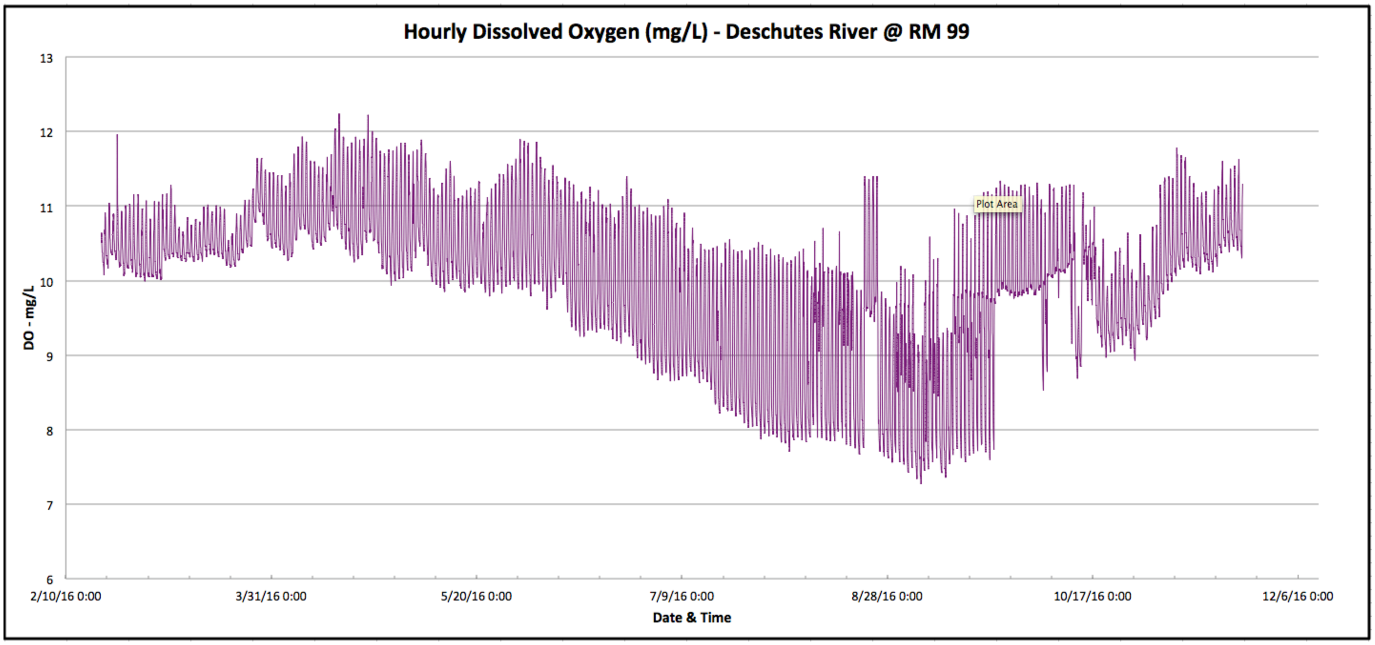


Figure 8. Hourly dissolved oxygen concentrations at River Mile 99, one mile below Reregulating Dam tailrace.

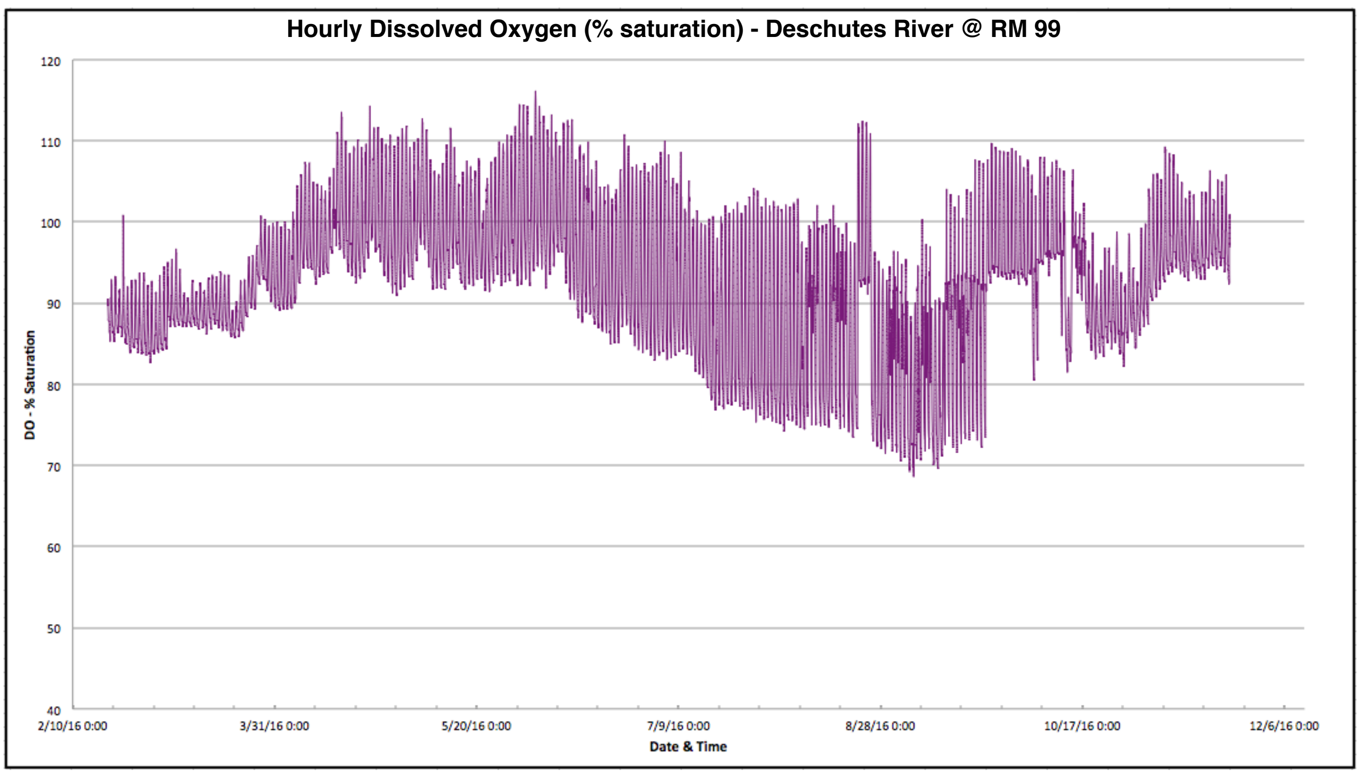


Figure 9. Hourly percent saturation of dissolved oxygen at River Mile 99, one mile below Reregulating Dam tailrace.

difference between the daily low and daily high DO concentration during the summer months (indicated by the wider line on the graphs), reflects a higher level of photosynthetic activity (and hence oxygen production) due to a greater biomass of algae and longer days with more sunlight exposure. The effect of high algal biomass is clearly shown by the large swings in the daily DO saturation levels throughout June, July, and August (Figure 9). In addition, DO saturation well above 100% was recorded from early April through June and again in the fall (Figure 9). These observed changes in DO saturation - large diel swings and supersaturation - commonly occur in response to nutrient enrichment problems (Hynes 1972).

The maximum daily DO concentrations remained above 9.0 mg/L throughout the sample period (Figure 8). The minimum concentrations, however, frequently dropped below 9.0 mg/L, and even fell below 8.0 mg/L. Dissolved oxygen concentrations below 9.0 mg/L began to occur on June 29. Beginning August 2, minimum DO levels began dropping below 8.0 mg/L, and continued through September 22. On September 23, a sudden rise in minimum DO levels took place. This increase in DO levels began abruptly, and is roughly correlated with a sudden drop in turbidity (27.5 NTU to 0.5 NTU in 2 hours). Temperature and pH values during the same period did not show these rapid changes. The reason for this sudden increase in daily minimum DO levels and changes in turbidity is not clear. Another sudden increase in DO occurred for two days in August (August 22 & 23) (Figure 8). A plausible explanation for this short sudden increase is that water was spilled for a short time at the Reregulating Dam, but we have no information to confirm this.

Exactly when DO concentrations drop below 9.0 mg/L and 8.0 mg/L is important, since higher DO standards apply during spawning and egg incubation periods than during non-spawning and incubation periods (see "Discussion" section - page 29 - for more details on salmon/trout spawning season in the lower Deschutes River).

DISCUSSION

Temperature:

Temperature requirements in the WQMMP and the changes made to these requirements in several Interim Agreements (IAs) between ODEQ and Project operators are displayed in Table 1. Temperature management is identified in the WQMMP as one of the two main objectives of the SWW tower. While the WQMMP was written in 2002, the operation of the SWW tower didn't begin until December, 2009. As shown in Table 1, after the first full year of operation in 2010, the annual IAs began to purportedly modify the WQMMP's temperature management requirements.

Table 1. Changes in temperature management requirements from original WQMMP through five interim agreements.

Original WQMMP	Interim Agreement 2011	Interim Agreement 2012
No increase in water temperature in Lower Deschutes River > 0.25°C **above what would occur if no dams were in place**, when surface water in LBC exceeds 50°F (10°C) or when federally listed threatened or endangered fish are in the river.	Use Blend 17 calculated by the ***Natural Thermal Potential (NTP)**: the 7-day rolling average of the modeled input temperature to LBC based on a regression equation from the Huntington 1999, study. DEQ and WCB will be consulted if a deviation from NTP of 1°C (NTP + .25°F) occurs.	During weather cooling events the 7-day average daily maximum discharge temperature at the Reregulating Dam can be up to 0.5°C above NTP for up to 3 days before discharge temperatures are back to NTP+.25°C.
Interim Agreement 2013	**Interim Agreement 2014**	**Interim Agreement 2015**
During weather cooling events the 7-day average daily maximum discharge temperature at the Reregulating Dam can be up to 0.5°C above NTP for up to 3 days before discharge temperatures are back to NTP+0.3°C. PGE will begin blending operations at the SWW when the temperature below the Reregulating Dam approaches 12.0°C.	No change from 2013	During weather cooling events the 7-day average daily maximum discharge temperature at the Reregulating Dam can be up to 0.5°C above ****Without Project Temperature (WPT)** for up to 3 days before discharge temperatures are back to WPT+.3°C. PGE will begin blending operations at the SWW when the temperature below the Reregulating Dam approaches 13.0°C.

* NTP, or Natural Thermal Potential, is calculated with a regression equation of the flow-weighted, 7-day average daily maximum temperatures of the three major tributaries to LBC, and the 7-day average daily air temperature at Redmond Airport.

** WPT, or Without Project Temperature, is calculated exactly the same as NTP.

One change that occurs over the course of the IAs summarized in Table 1 is that three different terms are used to describe the overall temperature management objective contained in the WQMMP:

1) From original WQMMP: No increase in water temperature in the lower Deschutes River *above what would occur if no dams were in place*;

2) From 2011 Interim Agreement: Temperature will be blended to meet the *Natural Thermal Potential (NTP)*;

3) From 2015 Interim Agreement: Temperature will be managed to target the *Without Project Temperature (WPT)*.

While these different terms suggest some change in approach, in fact, there was no change except the terminology. The method of calculating the target temperature for water released into the lower Deschutes River never changed. That method is based on the regression equation developed by Huntington et al. (1999), and is defined in the 2011 Interim Agreement as, *the flow-weighted, 7-day rolling average daily maximum temperatures of the three major tributaries to LBC, and the 7-day average daily air temperature at Redmond Airport*.

One explanation for these changes in terminology was found in an email between PGE and ODEQ that the DRA obtained through a public records request to ODEQ. In it PGE explained, "Neither the § 401 or WQMMP uses the term NTP, but instead *restricts the Project from warming the water discharged into the lower Deschutes River below the Reregulating Dam more than 0.25 °F over what would occur at that location in the river if the Project were not in place.* This is a *without project* temperature, which is not necessarily the same as the natural temperature." Our interpretation of this somewhat confusing explanation is that because the *without project temperature,* or WPT, is not the same as the *natural* temperature, the temperature management goal should not be referred to as NTP, or natural thermal potential. At the same time, the WPT goal is routinely referred to by the Joint Applicants as returning the river to its natural temperature regime.

Changes to Oregon's statewide water temperature standard between 2003 and 2013 are also worth noting.

In December of 2003, ODEQ submitted a new statewide temperature standard to the Environmental Protection Agency (EPA) for approval. A new concept in this standard was called the Natural Conditions Criteria for temperature, which was based on the "natural thermal potential" (NTP) of the waters within the State. This new criteria was defined in OARs as: *Where the department determines that the natural thermal potential of all or a portion of a water body exceeds the biologically-based criteria in section (4) of this rule, the natural thermal potential temperatures supersede the biologically-based criteria, and are deemed to be the applicable temperature criteria for that water body* (OAR 340-041-0028(8)).

In practice, this meant that if ODEQ determined that the maximum temperature for a particular stream or river was due to "natural" factors (typically determined by temperature models), then the modeled maximum temperature became the standard for that stream rather than the standard set to protect aquatic life. EPA approved ODEQ's new temperature criteria in March, 2004. In 2005, the Northwest Environmental Advocates (NWEA) filed suit challenging these new criteria, and in February 2012 the courts ruled in NWEA's favor (*NW Envtl. Advocates v. U.S. EPA*, 855 F.Supp.2d 1199 (D. Or. 2012)). As a result, EPA disapproved Oregon's Natural Conditions Criteria in August, 2013. The basic reason the court ruled in favor of NWEA was that water quality standards must protect the beneficial uses of the waters of the State, and, because the Natural Conditions Criteria was not biologically based to protect aquatic life, it failed to meet the goals of the Clean Water Act.

It is not clear if the changes to Oregon's water temperature standard influenced the changes in terms used in the IAs, but it is an interesting coincidence that following the official disapproval of the new standard by EPA in 2013, the 2015 interim agreement dropped the term "Natural Thermal Potential" and replaced it with "Without Project Temperature" (WPT).

A more important question that arises is this: do these changes in terms really matter? And the answer is no, not really, since the method of calculating the temperature of water released into the lower Deschutes remained the same regression equation that was applied in the original WQMMP. The DRA believes that these changes do suggest an effort by the Joint Applicants to continue to apply a water temperature management approach that allows the release of warmer water downstream into the lower Deschutes River using criteria that are not biologically based and thus, as found by the courts, do not meet Clean Water Act requirements.

The lack of any biological basis for the temperature management approach is further revealed when the regression equation itself is examined. The water temperature used in the equation is the 7-day rolling average of the **maximum daily temperature** of the three tributaries entering LBC. The DRA submits that using only the maximum temperature of the three tributaries does not, and cannot, result in, quoting from the WQMMP: *conditions that would exist as if the dams were not present*.

Streams in temperate regions of North America experience a natural diel or daily temperature flux (Hauer et al. 2006), meaning that water temperature changes over a 24-hour period from a mid-afternoon high to a late night/early morning low. This daily range in temperature in the Deschutes River at RM 99, is shown by the width of the graph line in Figure 6. A model that accurately predicts water temperature below the dams *as if the dams didn't exist*, should take into account the natural diel temperature range of the three tributaries entering LBC. Using only the maximum tributary temperatures, as is currently done, cannot mimic a natural temperature regime.

Another change made in the IAs is the temperature at which blending of bottom water with surface water must begin. The original WQMMP states that blending must begin when surface water in LBC approaches 10°C. In the 2013 IA, this was changed so that blending is to begin when water temperature below the Reregulating Dam approaches 12°C. Then in the 2015 IA, the requirement was changed again so that blending now begins when water temperature below the Reregulating Dam approaches 13°C. By implementing these changes, 100% surface water withdrawal is allowed to continue later into the summer, resulting in the continued release of much warmer water with higher pH than water from the bottom of LBC.

Figure 10 shows the result of the new temperature management scheme adopted in the 2015 IA, and used in 2016. In this graph the actual 7-day average maximum temperature at the Reregulating Dam tailrace, the calculated or modeled 7-day average maximum temperature, and the pre-SWW tower 7-day average maximum temperature averaged for the years 2006-2009 are compared. Comparing the actual observed temperature at the Reregulating Dam to the average maximum temperature for 2006-2009, shows that surface water releases resulted in an increase in water temperature throughout the late winter, spring, and early summer (up to 4°C or 7°F by May). This increase can affect aquatic invertebrates in several ways: 1) changes in egg development, 2) faster larval growth, 3) earlier adult emergence, and 4) smaller adults due to faster larval development and earlier emergence, which has been correlated with a decline in insect fecundity (Ward 1992).

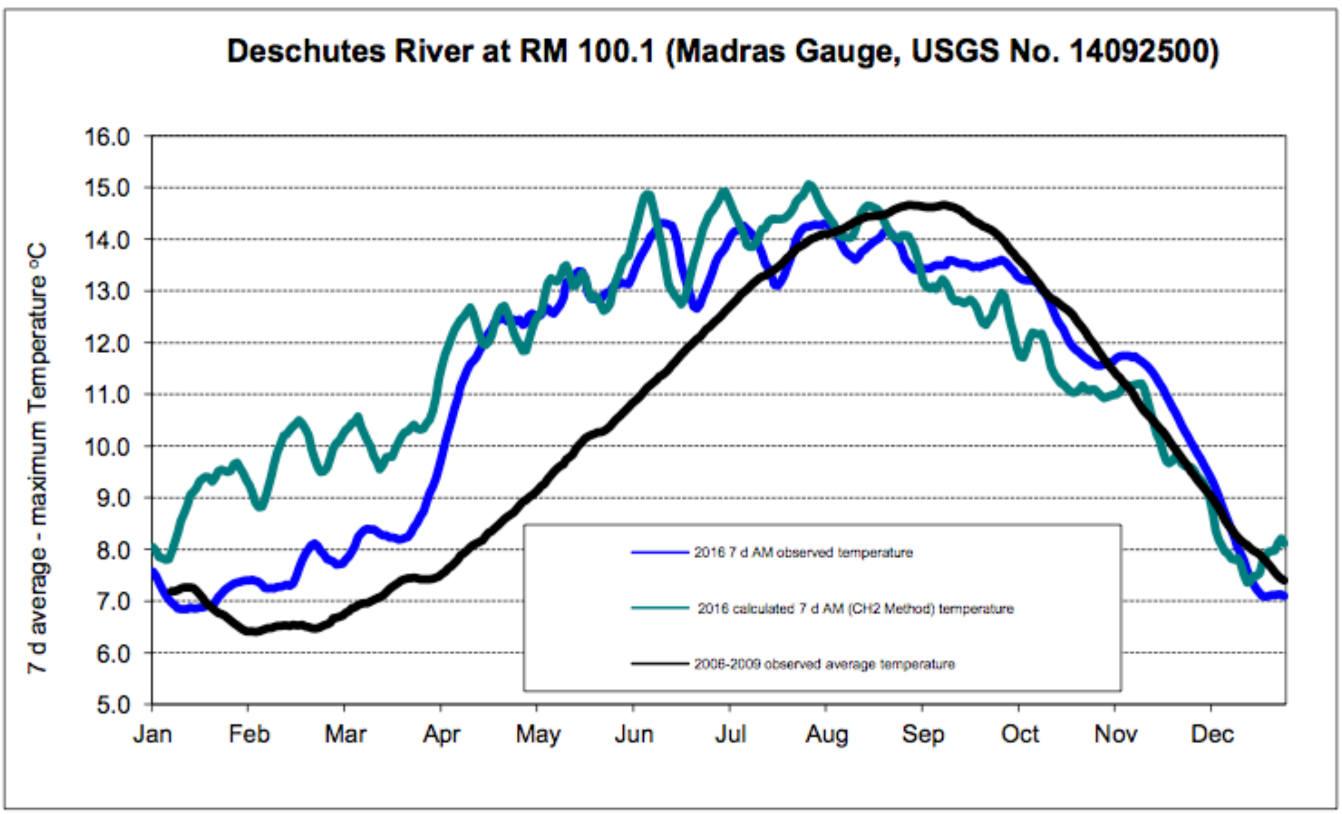


Figure 10. Comparison of the observed, modeled and pre-tower water temperature at the Reregulating Dam tailrace. (From PGE 2016 water temperature data report)

Another reason given by PGE for releasing more warm water early in the year is to save cold water for release in the late summer and early fall. However, as can be seen in Figure 10, the late summer/early fall temperatures in 2016 were only slightly cooler (about 1 to 1 1/2 °C) for a short period of time. Any late summer cooling is far out weighed by the increase in temperature for the first six months of the year. In addition, the maximum summer water temperatures in 2016 were no lower than the pre-SWW maximum temperatures, though the peak summer temperature did occur four to six weeks earlier (Figure 10). Thus, the new temperature management approach did not benefit the lower Deschutes River by lowering peak summer temperatures.

Algal growth is also accelerated by higher water temperature (Bellinger & Sigee 2010). Surface water releases resulting from SWW tower operation for anadromous reintroduction and an attempt to meet the flawed NTP or WPT modeled temperature has increased the temperature in the lower Deschutes River for the first six to seven months of the year (Figure 10). The DRA believes this is one important factor contributing to the increase in nuisance algal growth in the lower Deschutes River. As discussed below, the increased algal growth also directly affects pH and dissolved oxygen concentrations in the river downstream from the Project.

pH:

Oregon's water quality standard for pH in the Deschutes Basin is a minimum of 6.5 and maximum of 8.5 standard units. The pH standard is designed to protect aquatic life from the harmful effects of water that is too acidic or too alkaline. Like temperature, pH shows a daily range, with minimum values typically occurring just before sunrise, and maximum values reached in the mid to late afternoon. The mid-day peak in pH is the result of increased photosynthetic activity by algae and aquatic plants due to maximum sunlight exposure. Photosynthesis lowers the dissolved CO_2 concentration in the water, which in turn reduces the carbonic acid concentration, which raises pH. At night photosynthesis stops and CO_2 levels increase, causing increased carbonic acid production and a decline in pH. As algal biomass increases, the difference between the daily minimum and maximum pH also increases as evidenced by the large swings in daily pH noted in our data (Figure 7). Because both low (acid) and high (alkaline) pH levels are harmful to aquatic life, the water quality standard includes both a minimum and a maximum pH value. Since high pH levels (>8.5) are often the result of increased photosynthetic activity, pH is also a useful indicator of excessive algal growth and nutrient enrichment in freshwater (U.S. EPA 2013).

The hourly pH data collected at RM 99 showed that pH first exceeded the basin standard of 8.5 on March 27. Beginning April 5, the maximum daily pH continued to exceed the upper standard of 8.5 until late November when the data sonde was removed from the water for the winter. Table 2 summarizes the percent of pH measurements at RM 99 that exceeded the 8.5 pH standard, as well as pH levels above 9.0 and 9.5.

The results summarized in Table 2 confirm that a serious pH problem now exists in the lower Deschutes River and that the Deschutes Basin pH standard is routinely violated at the RM 99 site. The fact that pH levels were elevated above the 8.5 standard on 84% of the days sampled (April 5 - Nov 22), and exceeded 9.0 on 43% of the sampled days (April 16 - August 31), indicates excessive algal growth caused by nutrient enrichment. An example of the typical algal growth on the substrate at RM 99 is shown in Figure 11. Such a high level of sustained pH poses definite stress and health risks to aquatic life including salmon, steehead, and resident native trout (Robertson-Bryan 2004).

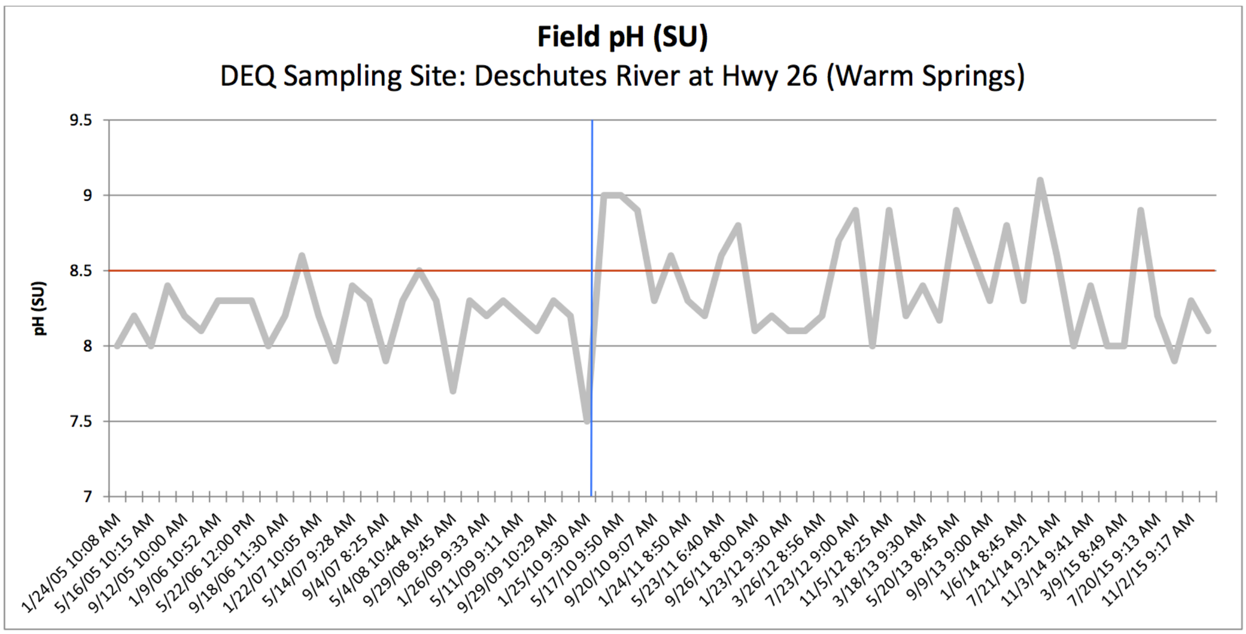
Figure 11. Algae and diatom growth on bottom substrate at Riffle Ranch (one mile below Reregulating Dam) on July 19, 2016.

Table 2. The number and percent of pH measurements recorded above the water quality standard from February through November, 2016.

	pH levels		
	> 8.5	> 9.0	> 9.5
First date with pH above:	March 27, 2016	April 16, 2016	July 12, 2016
Total number of hourly pH readings measured above:	4,655	2,015	8
Percent of hourly pH readings measured above:	70%	30%	0.12%
Number of days pH values collected: 279			
Number of days with at least one pH value measured above:	234	120	3
Percent of days with a pH value measured above:	84%	43%	0.01%

NOTE: 6,669 hourly pH measurements were recorded from February 18 through November 22, 2016.

Violations of the Deschutes Basin pH standard were known to occur before the SWW tower went into operation. An important question, then, is whether surface water withdrawal has made the pH problem worse. Figure 12 shows pH data collected by ODEQ at the Warm Springs Highway 26 bridge from January, 2005 through November, 2015. The vertical blue line indicates the beginning of surface water withdrawal in late December, 2009. These data demonstrate an immediate increase in pH levels when the SWW tower went into operation, and frequent violations of the basin standard in the years following. This clearly indicates that surface water releases through the SWW tower from LBC had a rapid and negative impact on water quality in the lower Deschutes River.



Red Line: Max pH value allowed under Oregon WQS

Blue Line: Beginning of SWW Operations

Figure 12. pH measurements collected by Oregon DEQ at the Warm Springs Hwy 26 bridge every other month from January 2005 through November 2015.

The only realistic explanation for the sudden increase in pH seen in Figure 12, is a significant increase in the growth of periphyton algae that was triggered by an increase in nutrients with the release of surface water from LBC. The statement below from the 1997 Final Report on Lower Deschutes Water Quality Study for Pelton Round Butte Hydroelectric Project raises a warning for just such an impact:

The lower Deschutes River periphyton exhibits mixed characteristics. Many of the species present are characteristic of cool, high elevation streams, while others are found in more nutrient enriched conditions. ***This may reflect the unique nature of the river and its hydrology. It may also indicate that the river will be susceptible to relatively small changes in nutrient input*** (from page 25, paragraph 2, in Raymond et al. 1998) (bold added for emphasis).

Dissolved Oxygen (DO):

It has long been known that the amount of oxygen dissolved in water has a direct effect on the health and survival of aquatic life. The dissolved oxygen levels needed to support the range of life functions - feeding, spawning, predator avoidance, etc. - varies with different species and life stages. In cold-water streams of North America, salmon and trout are typically the most sensitive and least tolerant species to low levels of dissolved oxygen (Willers 1991). In addition, the oxygen requirements for developing salmonid eggs and fry are greater than for adults. For these reasons, Oregon's water quality standards for dissolved oxygen are set to protect salmon and trout, with higher standards applied during spawning and egg incubation periods than during non-spawning and incubation periods. Oregon's DO criteria for the Deschutes Basin are described in Table 3.

Table 3. State of Oregon's dissolved oxygen criteria for the lower Deschutes River.

Beneficial Use	Dissolved Oxygen Criteria
Salmonid Spawning, including where and when resident trout spawn.	1) Not less than 11.0 mg/L, or - 2) If intergravel DO, as a spatial median, is 8.0 mg/L or greater, then DO criterion is not less than 9.0 mg/L
Cold-water Aquatic Life (includes salmon and trout rearing).	1) Not less than 8.0 mg/L. If DEQ determines *adequate data for DO exists, DEQ may allow: 2) 8.0 mg/L as a 30-day mean minimum, 6.5 mg/L as a 7-day minimum mean, and 6.0 mg/L as an absolute minimum. It is a violation if anyone of the three are not met. * No definition for what constitutes "adequate" data is given.

The criterion during spawning periods depends on intergravel DO levels. Intergravel dissolved oxygen (IGDO) is the amount of oxygen dissolved in the water that flows within the stream substrate. Adequate oxygen within streambed gravels is critical for developing salmon and trout eggs. When IGDO data are not available, or IGDO levels are not adequate, the water column DO requirement of 11.0 mg/L is applied. However, if IGDO data have been collected and show adequate oxygen within the substrate (>8.0 mg/L) then the water column criterion is lowered to 9.0 mg/L.

Just as the Interim Agreements signaled ODEQ's willingness to allow less restrictive temperature requirements, the IAs also claim to allow the Joint Operators to meet lowered dissolved oxygen requirements (Table 4).

Table 4. Changes to the dissolved oxygen requirements in the WQMMP through interim agreements from 2011-2015.

Original WQMMP	Interim Agreement 2011	Interim Agreement 2012
11.0 mg/L year-round, unless intergravel dissolved oxygen (IGDO) levels exceed 8.0 mg/L at all times, the water column criterion of 9.0 mg/L will apply.	No Change	- June 16-October 14: achieve DO concentration of 8.0 mg/L (or 90% saturation) in lower Deschutes River. - October 15-June 15: achieve water column DO of 11.0 mg/L (or 95% saturation). - If IGDO at least 8.0 mg/L then achieve water column DO of 9.0
Interim Agreement 2013	**Interim Agreement 2014**	**Interim Agreement 2015**
- Confirmed change of spawning criterion for the lower Deschutes River from year-round to October 15 to June 15. - 9.0 mg/L applies during spawning & incubation. - From June 16-October 14, criteria applied will be: 8.0mg/L as 30-day mean minimum, 6.5mg/L as 7-day minimum mean, and 6.0mg/L as absolute minimum.	No change from 2013.	No change from 2013.

Two key changes were made: 1) the defined spawning/incubation period for the lower Deschutes was changed from year-round to October 15-June 15; and 2) the DO requirement for the non-spawning/incubation period (June 16-Oct 14) was lowered from an absolute minimum requirement of 8.0mg/L to the lowest DO standard allowed for cold-water aquatic life of 8.0 mg/L calculated as a 30-day mean minimum, 6.5 mg/L calculated as a 7-day minimum mean, and

6.0 mg/L measured as an absolute instantaneous minimum (all three of these criteria must be met). In addition, during the spawning/incubation period of October 15 - June 15, the DO requirement was lowered from 11.0 mg/L to 9.0 mg/L. This last change is based on data from the Joint Applicants that suggest adequate intergravel dissolved oxygen (greater than 8.0 mg/L) is available during the spawning/incubation season.

The spawning/incubation season dates in the IAs are derived from maps that were developed with input from the Oregon Department of Fish & Wildlife (ODFW). These maps identify the location and time of year salmon and steelhead spawning occurs for the different river basins in Oregon. Figure 13 shows the map taken from OARs that defines the area and time of year for salmon and steelhead spawning in the Deschutes Basin. Spawning season for the reach from the Reregulating Dam to Warm Springs River (RM 84) (shown in yellow) is October 15 - June 15, while the spawning period from Warm Springs River to the mouth of the Deschutes at the Columbia River (shown in orange) is October 15 - May 15.

It is important to note, however, that this map identifies the time and place of spawning for only salmon and steelhead (and bull trout in some watersheds), but not where and when resident trout spawn. However, Oregon's water quality standards for DO clearly mandate that, when determining the DO standard for a particular water body, resident trout spawning must be incorporated as well. OAR 340-041-0016 states: *the following criteria apply during the applicable spawning through fry emergence periods set forth in the tables and figures* ***and, where resident trout spawning occurs, during the time trout spawning through fry emergence occurs*** (bold added for emphasis). In other words, Oregon's DO standard requires that the higher DO standard must be applied not just in the identified salmon and steelhead spawning time and place, but also during resident trout spawning through fry emergence. As described below, the DO criteria currently being applied for spawning/incubation in the lower Deschutes River cover only the time period identified for salmon and steelhead, but do not include the full period of resident trout spawning and egg incubation.

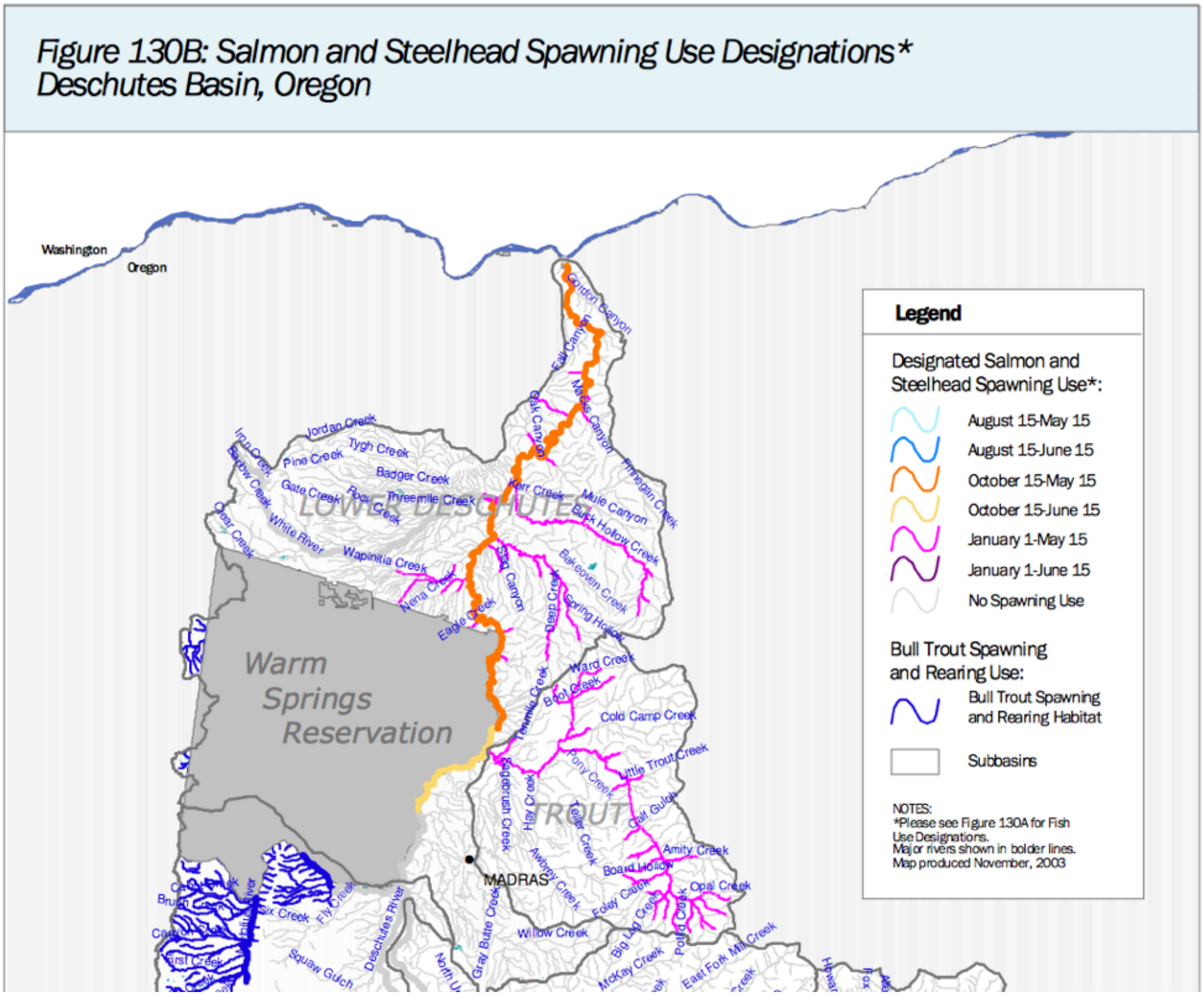


Figure 13. Map showing designated spawning periods for salmon and steelhead in Deschutes Basin. (Taken from Oregon OAR's section 340-041-0016)

The DRA has several concerns about the validity of the changes made in the IAs for DO. Perhaps the most important issue is the designated spawning/incubation period that was changed from year-round to October 15 - June 15. The rationale for this change, as we understand it, is that the OARs were updated in 2011 with new basin spawning maps as shown in Figure 13. However, based on the information for the Deschutes Basin contained in the OARs, the October 15 - June 15 period applies only to salmon and steelhead, and not to resident trout. DRA volunteers made first-hand observations at RM 99 that confirm resident trout in the lower Deschutes River continue to spawn until late July. As a result, the spawning/incubation criteria of 9.0 mg/L (11.0 mg/L if IGDO falls below 8.0 mg/L) should be applied until late August to take into account all salmonid egg incubation through fry emergence, which continues for weeks after spawning is completed.

Figure 14 shows that DO levels began dropping below 9.0 mg/L on June 29, and continued to fall well below 9.0 until September 22 (except for August 23 & 24, when DO suddenly increased then dropped again, which may have been caused by a water spill event at the Reregulating Dam). By using the spawning/incubation period for only salmon and steelhead (Oct 15-June 15) no violations of the DO criterion occurred. However, if trout spawning and incubation are taken into account, as required by the OARs, then DO concentrations were below the required 9.0 mg/L from June 29 until August 31 (with the exception of August 22 & 23). This failure to protect trout spawning and incubation is a violation of Oregon's water quality standards that must be corrected.

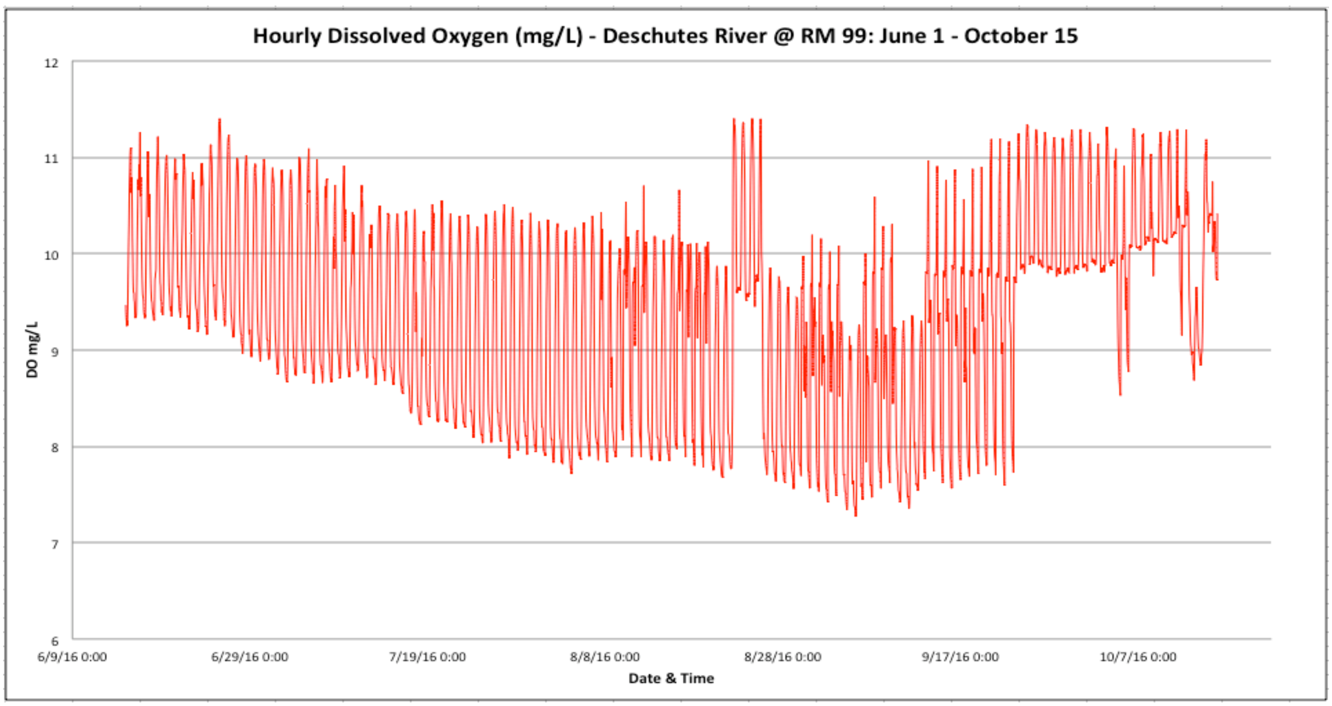


Figure 14. Hourly concentration of dissolved oxygen at River Mile 99, one mile below Reregulating Dam tailrace from June 15 - October 15.

Figure 14 also shows that DO concentrations dropped below 8.0 mg/L from August 2 until September 22. An absolute minimum of 8.0 mg/L **was** the criterion applied during non-spawning/incubation periods until the 2013 IA changed the criterion to the lower requirements of: 8.0mg/L as a 30-day mean minimum, 6.5mg/L as a 7-day minimum mean, and 6.0mg/L as an absolute instantaneous minimum (all three of these requirements must be met). OARs indicate this weaker standard is allowed, “at the discretion of the Department, when the Department determines adequate information exists...” Unfortunately, there is no definition of what constitutes “adequate” information under these circumstances.

This gray area in the OARs makes it easy to lower the DO standard without adequate vetting. The lack of adequate input and review is especially troubling in this case, since the IAs themselves were drafted and adopted without any public notice or opportunity for public input as required by OARs.

CONCLUSIONS

The water quality data collected and analyzed by the Deschutes River Alliance in 2016 point out several serious violations of water quality standards, and raise a number of questions about water quality management in the lower Deschutes River. Based on review of our 2016 data, the DRA feels it is of utmost importance to the health of the lower Deschutes River aquatic ecosystem, to say nothing of the people who recreate and make their living from the river, to manage water releases from the SWW tower so that water quality standards are met. The original WQMMP established clear management guidelines and water quality requirements for temperature, pH and dissolved oxygen. These standards and guidelines were established to adequately protect the aquatic life in the lower Deschutes River.

Hourly water quality data collected at RM 99 in 2016 found numerous water quality problems, and are summarized below.

Temperature:

The current water temperature management approach using the SWW tower has several serious limitations:

1) The stated goal in the WQMMP of managing water temperature downstream from the Project, “as if the dams did not exist,” may sound like a laudable idea. However, the concept of “natural conditions” in ODEQ’s most recent temperature standard was invalidated in court because it was not based on protecting aquatic life as required in the Clean Water Act. In addition, the equation being used to set the temperature targets in the lower Deschutes River is calculated using the 7-day **maximum** temperatures of the three tributaries entering LBC. *Targeting only the maximum temperatures from the three tributaries does not create the true and natural thermal conditions in the lower river that would exist if the Project did not exist*.

2) Releasing 100% surface water from LBC from November through early June each year raises the temperature in the lower Deschutes River throughout the late winter, spring, and early summer above pre-SWW tower temperatures

(Figure 10). This increase has altered aquatic insect life cycles and likely contributes to earlier growth of nuisance algae that has further impacted aquatic invertebrate populations in ways yet to be fully understood.

One example is the disturbing increase in abundance of the polychaete worm, *Manayunkia speciosa*. The number of individuals per square meter of stream substrate of this species increased from zero before tower operation (Nightengale et al. 2016) to over 8,000 in 2016 at RM 99 (Edwards 2017). This very small polychaete worm is the intermediate host of the salmonid parasite *Ceratanova shasta.* Recent studies discussed at a Round Butte Coordination meeting in February 2017, reported high infection rates of *C. shasta* in spring Chinook salmon juveniles, with subsequent high mortality rates. These high infection and mortality rates coincide with a sudden and unexplained decrease in smolt to adult survival of both wild and hatchery origin spring Chinook to the Deschutes River. The overall impacts *C. shasta* might be having on salmonid populations in the lower Deschutes River are presently unknown. The dramatic increase in the host worm for *C. shasta* is likely the result of increased nutrient load and warmer temperature in the lower Deschutes River as a result of SWW tower operation.

3) "Interim measures" signed off by ODEQ consistently allowed the Joint Applicants to ignore lawfully-derived temperature management requirements and release more warm surface water into the lower Deschutes River.

4) The capture of smallmouth bass (*Micopterus dolumieu*) by steelhead anglers in the lower 40 miles of the Deschutes River during the summer of 2016 exceeded anything in recent memory (S. Pribyl pers. comm.). Subsequent investigations by ODFW confirmed smallmouth bass presence in numbers never previously observed by them (R. French pers. comm. to S. Pribyl). The conditions that changed in the lower Deschutes River to trigger this increase is not clear at this time. However, Figure 10 shows a graphic increase in water temperature in the lower Deschutes River from April to July compared to pre-SWW tower temperatures. This early increase in water temperature may have resulted in water temperatures in the Deschutes River near the Columbia River reaching 60°F earlier than in previous years. The warmer water, earlier in the year, may

have encouraged smallmouth bass to migrate up the Deschutes River from the Columbia River, where they are abundant, in search of the warm water they prefer. Most of the smallmouth bass appeared to leave the Deschutes River in September and October, likely from a downstream migration back to the now-warmer Columbia River. The impact of increased smallmouth bass numbers in the lower Deschutes River is currently unknown, but increased predation on native fishes is a definite possibility.

5) Finally, increasing water temperature in the Deschutes, a large river that previously contributed important cold water to the Columbia River during summer months when fish managers throughout the Columbia River basin are looking for ways to keep the Columbia cooler, is counter-productive to these larger management goals, and eliminates one of the more important cold-water refuges for upstream migrating adult salmonids in the mid-Columbia region.

pH:

Oregon's water quality standards for pH (6.5-8.5 for the Deschutes Basin) are set for one reason; **to protect aquatic life**. It is also well established that pH provides a useful indicator of nutrient enrichment problems, since high nutrient loads stimulate excessive algae and aquatic plant growth, which in turn causes pH levels to increase. The pH levels measured at the DRA study site in the lower Deschutes River in 2016 showed significant water quality violations of pH:

1) 234 days out of 279 days sampled (84%) had some pH measurements that exceeded the 8.5 pH standard for the Deschutes Basin.

2) 120 days (43%) had pH measurements recorded above 9.0.

3) pH first exceeded the 8.5 standard in the early spring (March 27th).

4) The daily minimum values of pH did not drop below 8.5 throughout April, May, and June, and the daily maximum values consistently exceeded 9.0 during this time period (Figure 7).

5) Daily maximum pH values continued to exceed the 8.5 standard until the monitoring equipment was removed from the river in late November.

6) No management plan for lowering pH has been developed by the Joint Applicants, as required in the WQMMP when pH measurements in Project discharge exceed the weighted average pH of inflows into LBC.

7) Based on ODEQ data, pH showed an immediate and sustained increase when SWW tower operations began (Figure 12).

The above results describe a river severely impacted by high pH caused by excessive algae and aquatic plant growth stimulated by an increased nutrient load and warmer temperature water released from the SWW tower operation. Data collected by ODEQ show that this change in pH began immediately after the SWW tower began operation.

Dissolved Oxygen:

Water with adequate dissolved oxygen is critical for the survival of aquatic life. Incubating salmon and trout eggs and developing fry are the most sensitive life stage to inadequate DO concentrations. For this reason, water quality standards for DO are higher during salmonid egg incubation and fry development (Table 3). Like pH, DO is also affected by algae and plant growth. Dense growth of aquatic plants and algae produce high DO concentrations during the day and low levels late at night and in early morning, resulting in large diel swings in DO, which was recorded at RM 99 (Figure 8). The results of hourly DO measurements collected at that site and changes in DO requirements are summarized below:

1) The IAs purported to significantly reduce requirements for dissolved oxygen.

   - Salmonid spawning and incubation period was changed from year-round to October 15-June 15.

- The DO requirement during spawning season was lowered from 11.0 mg/L to 9.0 mg/L based on the interpretation of an intergravel dissolved oxygen (IGDO) study that concluded IGDO remained above 8.0 mg/L.
- The DO requirements during non-spawning season were lowered from an absolute minimum of 8.0 mg/L to the lowest cold-water aquatic life standard of 8.0 mg/L (30-day mean minimum), 6.5 mg/L (7-day minimum mean), and 6.0 mg/L (absolute minimum).

2) The spawning season set in the IAs (Oct 15-June15), does not adequately protect resident trout eggs and fry from low DO levels as required by OARs. Direct observation of trout spawning at RM 99 shows trout spawning continuing until late July. An absolute minimum DO concentration of 9.0 mg/L should be applied throughout resident trout spawning/incubation, which continues at least until late August.

3) Based on the lowest requirements in the final IA, there were no DO violations at the RM 99 site in 2016. However, if the original requirements in the WQMMP are used, then DO was lower than the required 11.0 mg/L throughout the entire sample period from February 18 - November 22. Even if the lower standard for spawning/incubation of 9.0 mg/L is accepted because IGDO was above 8.0 mg/L, DO dropped below 9.0 mg/L from June 29 - September 22.

4) Dissolved oxygen dropped below an absolute minimum of 8.0 mg/L from August 2 - September 22.

With the exception of the dates set for spawning, the changes purportedly made in the IAs fall within current Oregon standards for dissolved oxygen in the Deschutes Basin. The DRA's concern is the rationale for making the changes in the IAs. Information obtained through a public records request to ODEQ indicate that the changes in DO requirements were made at the specific request of the Joint Applicants to avoid the lost power revenue caused by spilling water at the Reregulating Dam necessary to meet DO requirements at the time, and thus not being able to run the water through the turbines at the Reregulating Dam. This is not consistent with the goal for adaptive management described in the WQMMP, namely **“to ensure compliance with water quality standards.”** (Bold added for emphasis)

Water Quality Standards and the Antidegradation Rule:

Besides setting specific numeric criteria for parameters such as temperature, pH, and dissolved oxygen, Oregon’s administrative rules include an “antidegradation” component. This rule includes numerous provisions for implementation and a complete description can be found at: http://arcweb.sos.state.or.us/pages/rules/oars_300/oar_340/340_041.html

The purpose of the antidegradation policy is clearly defined as follows:

Antidegradation (OAR 340-041-0004)
(1) Purpose. The purpose of the Antidegradation Policy is to guide decisions that affect water quality such that unnecessary further degradation from new or increased point and nonpoint sources of pollution is prevented, and to protect, maintain, and enhance existing surface water quality to ensure the full protection of all existing beneficial uses. The standards and policies set forth in OAR 340-041-0007 through 340-041-0350 are intended to supplement the Antidegradation Policy.

With regard to waters that have been identified as “water quality limited,” such as the lower Deschutes River, the antidegradation rule states simply that *Water quality limited waters may not be further degraded,* except in accordance with the following exceptions:

(9) Exceptions. The Commission or Department may grant exceptions to this rule so long as the following procedures are met:

(A) The new or increased discharged load will not cause water quality standards to be violated;

(C) The new or increased discharged load will not unacceptably threaten or impair any recognized beneficial uses or adversely affect threatened or endangered species.

(D) The new or increased discharged load may not be granted if the receiving stream is classified as being water quality limited under sub-section (a) of the definition of “Water Quality Limited” in OAR 340-041-0002.

We believe the water quality data and other information collected to date clearly demonstrate that surface water released from LBC by the SWW tower operations has:

1) caused water quality standards to be violated,
2) has unacceptably threatened or impaired beneficial uses (specifically cold-water aquatic life) and threatened or endangered species, and
3) has taken place in a stream that is already classified as water quality limited by being placed on Oregon's 303d list of water quality limited streams for the same parameters that are being degraded by the Project.

Because none of the identified exceptions to the antidegradation rule are present in this situation, current SWW tower operations are in violation of Oregon's antidegradation policy, as these operations have clearly "further degraded" water quality in the lower Deschutes River.

Further, Project operations are regularly resulting in violations of Oregon's water quality standards for pH and DO, and are violating the water quality requirements laid out in the Project's § 401 Certification.

It is important to remember that water quality standards are set at levels deemed necessary to protect the beneficial uses of the waters in question. In the lower Deschutes River the most sensitive beneficial uses are salmon and trout spawning and egg incubation through fry emergence, and cold-water aquatic life such as juvenile salmon and trout rearing and aquatic invertebrates. Years of research, based on both laboratory and field studies, have been evaluated to determine safe levels for a wide range of parameters (EPA 1986). These levels are further evaluated by state water quality agencies before being adopted as state standards. As a result, Oregon's water quality standards have been set based on years of research and public process to ensure aquatic life is adequately protected.

While water quality standards are set for each parameter separately, interactions between parameters can increase their level of impact on aquatic life. For example, as water temperature increases the concentration of dissolved oxygen in water declines, while at the same time salmonid metabolism increases, thus elevating their oxygen demand. Changes in pH also affect the toxicity of other potentially toxic constituents in water. For example, the toxicity of ammonia is 10 times greater at a pH of 8.0 compared to a pH of 7.0. Therefore, whenever water quality standards are violated the potential for negative impacts from other parameters also increases. When multiple standards are exceeded at the same time over long periods of time - days and weeks - as we have seen in this study, the negative effects on aquatic life increase substantially.

What this means is that water quality standards are vitally important in protecting the health of aquatic life in our rivers and streams. Lowering water quality requirements in standards or permits without adequate research, assessment, and due process is careless at best, and legally indefensible.

The water quality data collected by this study clearly demonstrates extensive violations of Oregon's water quality standards and the requirements of the Project's CWA § 401 Certification for multiple parameters throughout most of the study period sampled. Nearly as alarming, this study highlights that ODEQ and the Joint Applicants repeatedly attempted, under the guise of "adaptive management," to define-away systematic violations of critical water quality standards through the promulgation of "interim agreements" that fail to protect the environmental integrity of the lower Deschutes River.

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Appendix A - FIELD AUDIT RESULTS

[redacted] [redacted]

[redacted]

[redacted]	SITENAME	FILENAME	CASE #
	Deschutes River at Disney Riffle Property		

NOTE: GRADE F is a manual grade for "exceptional event" level data only(See DQM for further explanation). GRADE D is a manual grade for "missing" data. Grade E is data of an unknown quality or of known poor quality. GRADES D, E AND F REQUIRE AN EXPLAINATION IN THE RUN COMMENTS SECTION.

ELEVATION (ft)

TEMPERATURE AUDIT RESULTS

#	Audit	DS Value	Diff	Status
1	8.7	8.4	0.30	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±1.5	=<±1.51 - 2.00	=>±2.01

pH AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	8.2	8.0	0.20	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±0.3	=<±0.31 -0.5	=>±0.5

CONDUCTIVITY AUDIT RESULTS

#	Audit	DS Value	Abs % Difference	Status
1		135		
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	Grade D or E
=<±10%	=<±10.1% - 15%	=>±15%

DO AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	10.9	10.5	0.40	B
2				
3				
4				
5				
6				
7				

Criteria: units in mg/L

GRADE A	GRADE B	GRADE E	GRADE C
(<+ 0.3)	(<± 0.31-1.0)	(<±1.01-2.0)	(≥± 2.01)

RUN COMMENTS:

AUDIT RESULTS:

AUDIT # [redacted] #	DATE (mm/dd/yyyy)	TIME (hh:mm)	TEMP (deg C)	pH (SU)	CONDUCTIVITY (umhos/cm)	DO (mg/L)	DO SAT %	COMMENTS
1	2/18/16	16:00	8.7	8.2		10.9		
2								
3								
4								
5								
6								
7								

[redacted] Multiparameter Logger REPORT 12/29/16 FILENAME

[redacted]

[redacted]

[redacted]

[redacted]	SITENAME	FILENAME	CASE #
	Deschutes River at Disney Riffle Property		

NOTE: GRADE F is a manual grade for "exceptional event" level data only(See DQM for further explanation). GRADE D is a manual grade for "missing" data. Grade E is data of an unknown quality or of known poor quality. GRADES D, E AND F REQUIRE AN EXPLAINATION IN THE RUN COMMENTS SECTION.

ELEVATION (ft)

TEMPERATURE AUDIT RESULTS

#	Audit	DS Value	Diff.	Status
1	8.2	8.1	0.10	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±1.5	=<±1.51 - 2.00	=>±2.01

pH AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	8.2	8.3	0.10	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±0.3	=<±0.31 -0.5	=>±0.5

CONDUCTIVITY AUDIT RESULTS

#	Audit	DS Value	Abs % Difference	Status
1		139		
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	Grade D or E
=<±10%	=<±10.1% - 15%	=>±15%

DO AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	11.0	11.0	0.00	A
2				
3				
4				
5				
6				
7				

Criteria: units in mg/L

GRADE A	GRADE B	GRADE E	GRADE C
(<± 0.3)	(≤± 0.31-1.0)	(≤±1.01-2.0)	(≥±2.01)

RUN COMMENTS:

AUDIT RESULTS:

AUDIT #	[redacted] #	DATE (mm/dd/yyyy)	TIME (hh:mm)	TEMP (deg C)	pH (SU)	CONDUCTIVITY (umhos/cm)	DO (mg/L)	DO SAT %	COMMENTS
1		3/4/16	10:20	8.2	8.2		11		
2									
3									
4									
5									
6									
7									

Multiparameter Logger REPORT
12/29/16

[redacted]

FILENAME

[redacted]

[redacted]

[redacted]

[redacted]	SITENAME	FILENAME	CASE #
	Deschutes River at Disney Riffle Property		

NOTE: GRADE F is a manual grade for "exceptional event" level data only(See DQM for further explanation). GRADE D is a manual grade for "missing" data. Grade E is data of an unknown quality or of known poor quality. GRADES D, E AND F REQUIRE AN EXPLAINATION IN THE RUN COMMENTS SECTION.

ELEVATION (ft)

TEMPERATURE AUDIT RESULTS

#	Audit	DS Value	Diff	Status
1	10.5	9.3	1.20	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±1.5	=<±1.51 - 2.00	=>±2.01

pH AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	8.3	8.4	0.10	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±0.3	=<±0.31 -0.5	=>±0.5

CONDUCTIVITY AUDIT RESULTS

#	Audit	DS Value	Abs % Difference	Status
1		134		
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	Grade D or E
=<±10%	=<±10.1% - 15%	=>±15%

DO AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	11.8	11.4	0.40	B
2				
3				
4				
5				
6				
7				

Criteria: units in mg/L

GRADE A	GRADE B	GRADE E	GRADE C
(<± 0.3)	(<± 0.31-1.0)	(<±1.01-2.0)	(≥± 2.01)

RUN COMMENTS:

AUDIT #

AUDIT RESULTS:

	[redacted] #	DATE (mm/dd/yyyy)	TIME (hh:mm)	TEMP (deg C)	pH (SU)	CONDUCTIVITY (umhos/cm)	DO (mg/L)	DO SAT %	COMMENTS
1		4/1/16	14:40	9.2	8.3		11.8		
2									
3									
4									
5									
6									
7									

[redacted] Multiparameter Logger REPORT 12/29/16 FILENAME

[redacted] [redacted]

[redacted]

[redacted]	SITENAME	FILENAME	CASE #
	Deschutes River at Disney Riffle Property		

NOTE: GRADE F is a manual grade for "exceptional event" level data only(See DQM for further explanation). GRADE D is a manual grade for "missing" data. Grade E is data of an unknown quality or of known poor quality. GRADES D, E AND F REQUIRE AN EXPLAINATION IN THE RUN COMMENTS SECTION.

ELEVATION (ft)

TEMPERATURE AUDIT RESULTS

#	Audit	DS Value	Diff.	Status
1	11.4	12.4	1.00	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±1.5	=<±1.51 - 2.00	=>±2.01

pH AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	8.8	9.1	0.30	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±0.3	=<±0.31 -0.5	=>±0.5

CONDUCTIVITY AUDIT RESULTS

#	Audit	DS Value	Abs % Difference	Status
1		139		
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	Grade D or E
=<±10%	=<±10.1% - 15%	=>±15%

DO AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	11.5	11.6	0.10	A
2				
3				
4				
5				
6				
7				

Criteria: units in mg/L

GRADE A	GRADE B	GRADE E	GRADE C
(<+ 0.3)	(≤±0.31-1.0)	(≤±1.01-2.0)	(≥±2.01)

RUN COMMENTS:

AUDIT RESULTS:

AUDIT #	[redacted] #	DATE (mm/dd/yyyy)	TIME (hh:mm)	TEMP (deg C)	pH (SU)	CONDUCTIVITY (umhos/cm)	DO (mg/L)	DO SAT %	COMMENTS
1		5/2/16	12:35	11.4	8.8		11.5		
2									
3									
4									
5									
6									
7									

[redacted]

Multiparameter Logger REPORT
12/29/16

FILENAME

[redacted] [redacted]

[redacted]

[redacted]	SITENAME	FILENAME	CASE #
	Deschutes River at Disney Riffle Property		

NOTE: GRADE F is a manual grade for "exceptional event" level data only(See DQM for further explanation). GRADE D is a manual grade for "missing" data. Grade E is data of an unknown quality or of known poor quality. GRADES D, E AND F REQUIRE AN EXPLAINATION IN THE RUN COMMENTS SECTION.

ELEVATION (ft)

TEMPERATURE AUDIT RESULTS

#	Audit	DS Value	Diff.	Status
1	13.1	13.8	0.70	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±1.5	=<±1.51 - 2.00	=>±2.01

pH AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	8.8	9.2	0.40	B
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±0.3	=<±0.31 -0.5	=>±0.5

CONDUCTIVITY AUDIT RESULTS

#	Audit	DS Value	Abs % Difference	Status
1		128		
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	Grade D or E
=<±10%	=<±10.1% - 15%	=>±15%

DO AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	10.9	11.2	0.30	A
2				
3				
4				
5				
6				
7				

Criteria: units in mg/L

GRADE A	GRADE B	GRADE E	GRADE C
(<+ 0.3)	(≤± 0.31-1.0)	(≤±1.01-2.0)	(≥±2.01)

AUDIT #

RUN COMMENTS:

AUDIT RESULTS:

#	[redacted] #	DATE (mm/dd/yyyy)	TIME (hh:mm)	TEMP (deg C)	pH (SU)	CONDUCTIVITY (umhos/cm)	DO (mg/L)	DO SAT %	COMMENTS
1		6/8/16	12:30	13.1	8.8		10.9		
2									
3									
4									
5									
6									
7									

[redacted]

Multiparameter Logger REPORT
12/29/16

FILENAME

[redacted] [redacted]

[redacted]

[redacted]

[redacted]#	SITENAME	FILENAME	CASE #
	Deschutes River at Disney Riffle Property		

NOTE: GRADE F is a manual grade for "exceptional event" level data only(See DQM for further explanation). GRADE D is a manual grade for "missing" data. Grade E is data of an unknown quality or of known poor quality. GRADES D, E AND F REQUIRE AN EXPLAINATION IN THE RUN COMMENTS SECTION.

ELEVATION (ft)

TEMPERATURE AUDIT RESULTS

#	Audit	DS Value	Diff	Status
1	13.1	13.6	0.50	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±1.5	=<±1.51 - 2.00	=>±2.01

pH AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	8.6	9.1	0.50	B
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±0.3	=<±0.31 -0.5	=>±0.5

CONDUCTIVITY AUDIT RESULTS

#	Audit	DS Value	Abs % Difference	Status
1		126		
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	Grade D or E
=<±10%	=<±10.1% - 15%	=>±15%

DO AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	9.8	9.8	0.00	A
2				
3				
4				
5				
6				
7				

Criteria: units in mg/L

GRADE A	GRADE B	GRADE E	GRADE C
(<± 0.3)	(<± 0.31-1.0)	(<±1.01-2.0)	(≥± 2.01)

RUN COMMENTS:

AUDIT RESULTS:

AUDIT #	[redacted] #	DATE (mm/dd/yyyy)	TIME (hh:mm)	TEMP (deg C)	pH (SU)	CONDUCTIVITY (umhos/cm)	DO (mg/L)	DO SAT %	COMMENTS
1		7/22/16	11:30	13.1	8.6		9.8		
2									
3									
4									
5									
6									
7									

[redacted]

Multiparameter Logger REPORT
12/29/16

FILENAME

[redacted]

[redacted]

[redacted]

[redacted]	SITENAME	FILENAME	CASE #
	Deschutes River at Disney Riffle Property		

NOTE: GRADE F is a manual grade for "exceptional event" level data only(See DQM for further explanation). GRADE D is a manual grade for "missing" data. Grade E is data of an unknown quality or of known poor quality. GRADES D, E AND F REQUIRE AN EXPLAINATION IN THE RUN COMMENTS SECTION.

ELEVATION (ft)

TEMPERATURE AUDIT RESULTS

#	Audit	DS Value	Diff.	Status
1	16.2	13.7	2.50	E
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±1.5	=<±1.51 - 2.00	=>±2.01

pH AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	8.5	9	0.50	B
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±0.3	=<±0.31 -0.5	=>±0.5

CONDUCTIVITY AUDIT RESULTS

#	Audit	DS Value	Abs % Difference	Status
1		121		
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	Grade D or E
=<±10%	=<±10.1% - 15%	=>±15%

DO AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	8.9	9.2	0.30	A
2				
3				
4				
5				
6				
7				

Criteria: units in mg/L

GRADE A	GRADE B	GRADE E	GRADE C
(<± 0.3)	(<± 0.31-1.0)	(<±1.01-2.0)	(>± 2.01)

AUDIT

RUN COMMENTS:

AUDIT RESULTS:

#	[redacted] #	DATE (mm/dd/yyyy)	TIME (hh:mm)	TEMP (deg C)	pH (SU)	CONDUCTIVITY (umhos/cm)	DO (mg/L)	DO SAT %	COMMENTS
1		8/26/16	11:10	16.2	8.5		8.9		
2									
3									
4									
5									
6									
7									

[redacted] Multiparameter Logger REPORT 12/29/16 FILENAME

[redacted] [redacted]

[redacted]

[redacted]	SITENAME	FILENAME	CASE #
	Deschutes River at Disney Riffle Property		

NOTE: GRADE F is a manual grade for "exceptional event" level data only(See DQM for further explanation). GRADE D is a manual grade for "missing" data. Grade E is data of an unknown quality or of known poor quality. GRADES D, E AND F REQUIRE AN EXPLAINATION IN THE RUN COMMENTS SECTION.

ELEVATION (ft)

TEMPERATURE AUDIT RESULTS

#	Audit	DS Value	Diff	Status
1	12.7	12.1	0.60	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±1.5	=<±1.51 - 2.00	=>±2.01

pH AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	8.6	8.9	0.30	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±0.3	=<±0.31 -0.5	=>±0.5

CONDUCTIVITY AUDIT RESULTS

#	Audit	DS Value	Abs % Difference	Status
1		121		
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	Grade D or E
=<±10%	=<±10.1% - 15%	=>±15%

DO AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	9.4	9.7	0.30	A
2				
3				
4				
5				
6				
7				

Criteria: units in mg/L

GRADE A	GRADE B	GRADE E	GRADE C
(<+ 0.3)	(<+ 0.31-1.0)	(<±1.01-2.0)	(≥+ 2.01)

RUN COMMENTS:

AUDIT RESULTS:

AUDIT #	[redacted] #	DATE (mm/dd/yyyy)	TIME (hh:mm)	TEMP (deg C)	pH (SU)	CONDUCTIVITY (umhos/cm)	DO (mg/L)	DO SAT %	COMMENTS
1		10/20/16	11:10	12.7	8.6		9.4		
2									
3									
4									
5									
6									
7									

[redacted] Multiparameter Logger REPORT 12/29/16 FILENAME

[redacted] [redacted]

[redacted]

[redacted]	SITENAME	FILENAME	CASE #
	Deschutes River at Disney Riffle Property		

NOTE: GRADE F is a manual grade for "exceptional event" level data only(See DQM for further explanation). GRADE D is a manual grade for "missing" data. Grade E is data of an unknown quality or of known poor quality. GRADES D, E AND F REQUIRE AN EXPLAINATION IN THE RUN COMMENTS SECTION.

ELEVATION (ft)

TEMPERATURE AUDIT RESULTS

#	Audit	DS Value	Diff	Status
1	10.2	10.9	0.70	A
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±1.5	=<±1.51 - 2.00	=>±2.01

pH AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	8.8	9.3	0.40	B
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	GRADE C
=<±0.3	=<±0.31 -0.5	=>±0.5

CONDUCTIVITY AUDIT RESULTS

#	Audit	DS Value	Abs % Difference	Status
1		135		
2				
3				
4				
5				
6				
7				

Criteria:

GRADE A	GRADE B	Grade D or E
=<±10%	=<±10.1% - 15%	=>±15%

DO AUDIT RESULTS

#	Audit	DS Value	Abs. Difference	Status
1	10.5	11.4	0.90	B
2				
3				
4				
5				
6				
7				

Criteria: units in mg/L

GRADE A	GRADE B	GRADE E	GRADE C
(<± 0.3)	(≤± 0.31-1.0)	(≤±1.01-2.0)	(≥±2.01)

RUN COMMENTS:

AUDIT RESULTS:

AUDIT #	[redacted] #	DATE (mm/dd/yyyy)	TIME (hh:mm)	TEMP (deg C)	pH (SU)	CONDUCTIVITY (umhos/cm)	DO (mg/L)	DO SAT %	COMMENTS
1		11/22/16	11:30	10.2	8.8		10.5		
2									
3									
4									
5									
6									
7									

[redacted]

Multiparameter Logger REPORT
12/29/16

FILENAME

Appendix B - QUALITY ASSURANCE/QUALITY CONTROL PROGAM & METHODS

Deschutes River Alliance

Water Quality Sampling Quality Assurance/Quality Control

Program and Methods

Instrument Calibration:

All instruments were calibrated per manufacturers instructions. A log of calibrations has been kept on all instruments. Calibration on handheld instruments was done within 24 hours of each use event. Calibration on in-dwelling instruments (YSI data sonde) was done prior to initial placement and again after battery replacement.

Instruments were calibrated using name brand pre-formulated calibration standard solutions.

Instrument Data Audits:

The YSI data sonde was audited monthly using handheld instruments to determine temperature, pH, dissolved oxygen, oxygen saturation and turbidity. The Winkler method of determining dissolved oxygen was utilized as a further confirmatory assay for dissolved oxygen. Use of multiple measures was employed as described below.

Use of Multiple Measures:

To ensure in-field accuracy, redundant multiple instruments were used simultaneously to measure temperature, pH and DO. Excessive variances led to repeat calibration as needed, or probe replacement.

Instrument Storage:

Instruments were stored in a secure and temperature controlled environment when not in use. During seasonal storage, calibrations were done every 30 days.