# Data Summary and Quality Assurance Report: 2014 River Monitoring Data by the South Yuba River Citizens League

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# Introduction

The South Yuba River Citizens League (SYRCL) monitors water quality conditions at up to 38 sites throughout the Yuba River watershed. Monthly site visits by trained volunteers (March – November) follow quality control procedures and standards detailed in a Quality Assurance Project Plan (QAPP) maintained with the State Water Resources Control Board (Yuba Watershed Council 2012). Site visits involve measurement of four parameters (temperature, dissolved oxygen, pH, and conductivity) with field equipment and sampling of water for measurement of turbidity at the SYRCL office. Due to equipment limitations, most pH measurements are taken in the SYRCL office from the turbidity samples.

The QAPP directs volunteers to take a minimum of three replicate measurements for each of the five parameters. Replicate measurements provide a way to assess precision and also increase the likelihood of accuracy by allowing errant values to be averaged. The QAPP specifies a maximum acceptable precision standard for each parameter. Protocol dictates that a fourth measurement is to be taken when previous measurements do not meet precision standards.

This report evaluates compliance with precision standards and data quality procedures for the 2013 data collection effort. In addition, this report identifies measurements for which values exceeded water quality objectives and briefly discusses these issues with regard to hydrology and data from prior years. Previous reports and more information on SYRCL's River Monitoring Program, including a map of monitoring sites, site photos and past data summaries can be found at www.yubashed.org.

# Methods

**Completeness**

Completeness is the fraction of planned data that was actually collected according to protocol. Although there are no statistical criteria that require a certain percentage of data completeness, it is expected that 80% of all planned measurements are taken when anticipated. This accounts for adverse weather conditions, safety concerns, and equipment problems.

Site visit completeness was determined by comparing the number of site visits anticipated in the 2014 monitoring design to the number of successful site visits. Successful site visits were those that had adequate flows for collecting water quality data. The number of successful site visits was divided by the number of planned site visits and multiplied by 100.

Percent completeness for each parameter was determined by comparing the number of measurements planned for collection in 2014 to the number of measurements we collected that were also deemed valid. An invalid measurement does not meet the QAPP sampling methods or precision standards established below. The number of valid samples collected was divided by the number of samples anticipated in 2014 and then multiplied by 100.

A percent valid metric for each parameter was also added to the 2014 data analysis. While it has no basis in the QAPP, it is a useful internal metric for identifying and correcting problems with River Monitors' ability to follow protocols. Percent valid was calculated by dividing the total valid records for each parameter by the actual records collected for each parameter and multiplying by 100.

## QAPP Precision Standards

The precision standards established in the QAPP (Yuba Watershed Council 2012) were used to evaluate data quality. Data not meeting the percent or range precision standards in Table 1 below were flagged and reported as QAPP precision violations. Percent precision was calculated for each parameter by dividing the standard deviation of all the replicates by their average and multiplying by 100. Range precision was calculated by subtracting the minimum value from the maximum value of each data record.

Percent precision exceeding 10% for dissolved oxygen, conductivity values greater than 100 µS, and turbidity values greater than 2 NTU constituted a precision violation. For temperature, pH, conductivity values 100 µS or less, and turbidity values 2 NTU or less, a range of all the replicates from each record was calculated. Ranges exceeding the established precision standard listed in the table below constituted precision violations.

Records with less than three measurements were flagged for not following procedures detailed in the QAPP. Any record not meeting the QAPP precision standard should have included a fourth measurement. Since calculating percent precision in the field is difficult, some volunteers follow the "rule-of-thumb" standards for taking a fourth measurement. Monitors should take a fourth measurement for dissolved oxygen readings with ranges of 0.4 mg/L or greater and conductivity readings with ranges of more than 10 µS**.**

**Table 1. Precision standards established in the Quality Assurance Project Plan.**

| Parameter | Method | Units | Precision Standard |
|---|---|---|---|
| Water Temperature | Thermometer | °C | ± 1 °C |
| Dissolved Oxygen | Micro-Winkler Titration | mg/L | ± 10% |
| pH | pH meter | pH units | ± 0.2 units |
| Conductivity | Conductivity meter | µS | 10% or 5 µS, whichever is greater* |
| Turbidity | Nephelometer | NTU | 10% or 0.2 NTU, whichever is greater |

*The QAPP states the conductivity standard as 10% or 5 µS, or whichever is greater. This analysis used 10 µS as the precision standard for replicates averaging 100 µS or less because our conductivity meters measure only in 10 µS increments.

## Water Quality Exceedances

For analysis of water quality conditions, replicate measurements were averaged from each sampling event to obtain a single value. The average values were compared to the water quality objectives set by the Central Valley Regional Water Quality Control Board Basin Plan (CVRWQCB 2009) found in Table 2 below. Values above or below these objectives are considered exceedences. All exceedances were evaluated to ensure that they did not result from an error in data entry or reporting units, and that they were reasonable given ambient conditions, field notes, and related parameter measurements.

Water quality objectives from the Basin Plan are based on the known effects of these parameters on aquatic life. For instance, prolonged exposure to a pH of less than 6 or greater than 9 can cause death for trout, salmon and frogs, and a pH of less than 5 will cause death for most aquatic life. Enough dissolved oxygen is crucial for aquatic life as low levels can cause reduction in growth for aquatic organisms, failure of fish eggs/larvae to survive, growth of toxic or smothering bacteria, fungi or algae, and changes in species composition. The maximum tolerable temperature for aquatic life depends on the species, but the entire Yuba River watershed is classified with the beneficial use of cold water to support native species such as rainbow trout. Conductivity and turbidity have no water quality objectives because they vary with natural geology and weather.

**Table 2. Water quality objectives from the CVRWQCB Basin Plan.**

| Parameter | Method/Range | Units | Water Quality Objective |
|---|---|---|---|
| Water Temperature | Thermometer | °C | ≤ 20°C |
| Dissolved Oxygen | Micro-Winkler Titration | mg/L | ≥ 7 mg/L |
| pH | pH meter | pH units | 6.5 – 8.5 |
| Conductivity | Conductivity meter | µS | NA |
| Turbidity | Nephelometer | NTU | NA |

**QAPP pH Sampling Method Deviation**

SYRCL lacks the funding capacity to maintain pH probes for simultaneous field visits to all of our sites. Therefore, pH was measured in the field at only 21 of the 38 monitoring sites. pH meters were distributed to maximize in-field pH readings: sites that are paired and farthest away from the SYRCL office received pH meters, as well as sites with evidence of pH problems. pH at all remaining sites was measured in the office from the turbidity samples. This adjustment could be problematic because pH changes with temperature and as carbon dioxide dissolves into the sample.

In order to minimize the potential for change in pH, river monitors were asked to collect their turbidity sample last, eliminate as much headspace in the bottle as possible, keep it shaded and return it to the SYRCL office as quickly as possible. A two hour hold time was placed on pH measurements; measurements taken after this two hour window were discarded for quality control purposes. Because the QAPP lists a preferred or maximum hold time of 15 minutes for measuring pH, data analysis is needed to evaluate the effect of two hour hold time on pH deviation.

# Results

## Completeness

The 2014 River Monitoring Program had 330 planned site visits and 309 possible site visits, for a site visit completeness of 93.64%. In addition of the 2014 data meeting the site visit completeness objective, all of the parameters met the completeness objective for the year.

**Table 3. Percent completeness and percent valid records for each parameter compared to 309 site visits.**

| Parameter | Possible Records | Actual Records | Valid Records | % Valid Records | % Completeness |
|---|---|---|---|---|---|
| Water Temp. | 309 | 306 | 302 | 98.69% | 99.03% |
| Dissolved Oxygen | 309 | 305 | 303 | 99.34% | 98.71% |
| pH | 309 | 298 | 281 | 94.30% | 96.44% |
| Conductivity | 309 | 304 | 301 | 99.01% | 98.38% |
| Turbidity | 309 | 293 | 253 | 86.35% | 94.82% |

Precision violations and water quality exceedances were calculated from the 309 site visits in 2014. Table 4 below summarizes the total number of records, QAPP violations, and water quality exceedances for each parameter. Total QAPP precision violations include failures both to meet the precision standards noted in Table 1 and to take a minimum of three replicate samples. Less than 307 actual records exist for each parameter because of monitoring mistakes in the field, equipment malfunctioning, or samples that had surpassed QAPP designated hold times for turbidity or pH.

**Table 4. Summary of QAPP precision violations and water quality exceedances for the five parameters recorded for SYRCL River Monitoring 2014.**

| Parameter | Actual Records | Precision Violations | % Precision Violations | Less than 3 measurements | % Total QAPP Violations | WQ Exceedances | % WQ Exceedances |
|---|---|---|---|---|---|---|---|
| Water Temperature | 306 | 3 | 0.98% | 1 | 1.31% | 57 | 18.63% |
| Dissolved Oxygen | 305 | 0 | 0.00% | 2 | 0.66% | 22 | 7.21% |
| pH | 298 | 15 | 5.03% | 2 | 5.70% | 6 | 5.03% |
| Conductivity | 304 | 0 | 0.00% | 3 | 0.99% | NA | NA |
| Turbidity | 293 | 36 | 12.29% | 0 | 12.29% | NA | NA |

## Water Temperature

***Water Temperature Precision***

Three (0.98%) of the 306 water temperature records violated QAPP precision standards with a range for replicates exceeding 1°C. Volunteers were trained to take a fourth measurement when previous replicates yield a range greater than 1°C, and two of these records did include a fourth measurement.

One (0.33%) water temperature record contained less than three measurements. This record was double checked to ensure it was not a result of a data entry error. Since the QAPP requires at least three water temperature measurements for each visit, this record violated sampling protocol. Therefore 4 out of 306 records, or 1.31%, of 2014 water temperature records violate QAPP precision standards and monitoring protocol.

The percentage of total QAPP violations for water temperature had increased steadily from 2010 (3.04%), 2011 (5.5%), and 2012 (8.10%). The instances of less than three measurements in 2011 were due largely to volunteer confusion accompanying a change in monitoring equipment from Hanna pH meters to Supco Digital Thermometers. The instances in 2012 were not explainable by a similar protocol change. The total QAPP violations for water temperature is now decreasing and has gone from 2.76% in 2013 to 1.31% in 2014.

***Water Temperature Exceedances***

In 2014, there were 57 recorded water temperature exceedances of 20°C throughout the watershed, representing 18.63% of the total water temperature records. The number of exceedances in April, June, July, August, and September are listed in Table 5 below.

**Table 5. 2014 water temperature exceedances by month.**

| Month | Records | Percent |
|---|---|---|
| April | 1 | 1.75% |
| June | 9 | 15.79% |
| July | 22 | 38.60% |
| August | 19 | 33.33% |
| September | 6 | 10.53% |

The highest average water temperature in 2014 was recorded at 27.35°C at Bridgeport State Park (site 33) on the South Yuba River on 7/15/2014 at 13:55. Table 6 shows water temperature exceedances by site.

**Table 6. 2014 water temperature exceedances by site, including recorded maximum average temperature and summer average (July – September).**

| Site | Exceedances | Total Visits | Percent of Visits | Maximum Average (°C) | Summer Average (°C) |
|---|---|---|---|---|---|
| 5 | 1 | 9 | 11.11% | 20.03 | 15.3 |
| 10 | 1 | 9 | 11.11% | 21.53 | 20.01 |
| 13 | 2 | 6 | 33.33% | 22.7 | 22.7 |
| 14 | 1 | 6 | 16.67% | 23.1 | 23.1 |
| 15 | 6 | 12 | 50.00% | 24.17 | 22.82 |
| 19 | 4 | 9 | 44.44% | 26.7 | 23.8 |
| 20 | 1 | 7 | 14.29% | 20.23 | 18.25 |
| 22 | 3 | 8 | 37.50% | 24.87 | 22.69 |
| 23 | 1 | 9 | 11.11% | 20.57 | 19.16 |
| 30 | 4 | 11 | 36.36% | 24.9 | 22.95 |
| 31 | 3 | 3 | 100.00% | 26.37 | 24 |
| 33 | 6 | 11 | 54.55% | 27.35 | 25.06 |
| 35 | 1 | 9 | 11.11% | 24.17 | 21.99 |
| 39 | 1 | 6 | 16.67% | 25.03 | 25.03 |

| | | | | | |
|---|---|---|---|---|---|
| 42 | 2 | 9 | 22.22% | 20.93 | 19.53 |
| 44 | 1 | 6 | 16.67% | 21.93 | 21.93 |
| 46 | 3 | 8 | 37.50% | 23.08 | 21.73 |
| 47 | 5 | 9 | 55.56% | 26.45 | 24.01 |
| 49 | 2 | 9 | 22.22% | 23.6 | 22.23 |
| 55 | 3 | 9 | 33.33% | 25.2 | 21.54 |
| 56 | 3 | 9 | 33.33% | 24.03 | 22.57 |
| 65 | 1 | 3 | 33.33% | 20.33 | 19.82 |
| 69 | 2 | 2 | 100.00% | 25.03 | 22.97 |

The majority (33 records or 57.89%) of water temperature exceedances occurred on the main stem of the South Yuba River, with values recorded over 20°C from near the headwaters below Van Norden Meadows downstream to Bridgeport Crossing. Six records (10.53%) occurred on main stem of the Middle Yuba at Our House Dam and above Oregon Creek. Tributaries to the South Yuba and Lower Yuba accounted for 18 records (31.58%) exceeding water quality objectives. No water temperature exceedances were recorded on the North Yuba River or its tributaries.

## Dissolved Oxygen

***Dissolved Oxygen Precision***

Of the 305 records of dissolved oxygen in 2014, there was zero records (0.00%) violating QAPP precision standard of a maximum range of 10% for replicates. There were two records with less than three replicates, one of which resulted from a broken DO sample bottle and the other from a sampling error. Therefore, there were two out of 305 records (0.66%) that violated QAPP precision standards and/or monitoring protocol.

The "rule-of-thumb" standard for taking a fourth measurement was effective for obtaining a fourth measurement when the range of readings equaled or exceeded 0.4 mg/L. Of the 89 records with ranges of 0.4 mg/L or greater, 46 (51.69%) included a fourth measurement.

***Dissolved Oxygen Exceedances***

Dissolved oxygen levels were below the water quality objective of at least 7 mg/L for 22 site visits (7.21%). Exceedances of DO occurred throughout the majority of the monitoring season from June to November, with 63.64% occurring in June and July (Table 7). All of the exceedances occurred on the South Yuba, Lower Yuba, and their tributaries.

**Table 7. Dissolved oxygen exceedances by month.**

| Month | Number | Percent |
|---|---|---|
| June | 4 | 18.18% |
| July | 10 | 45.45% |
| August | 3 | 13.64% |
| September | 3 | 13.64% |
| November | 2 | 9.09% |

Low dissolved oxygen values were associated with 5 of the 9 monitoring months (55.56%) this year. Last year, low dissolved oxygen values were associated with 8 of the 9 monitoring months (88.89%). Exceedances have gone down from 26 occurrences to 22, which could be due river monitors doing better DO titrations, the use of new chemicals, or inabilities to sample from sites. This is further enforced by the record of dissolved oxygen parameter completeness rising from 90% to 99% and shows us no lack of record for 2014. A couple things playing against this includes increasing water temperatures and salinity in 2014. Typically, dissolved oxygen decreases with increasing water temperatures and salinity. The lowest DO value of the year was at Van Norden Dam (site 39) at 3.9 mg/L in November. DO exceedances by site are listed in Table 8 below.

**Table 8. Dissolved oxygen exceedances by site.**

| Site | Exceedances | % of Total Exceedances | Site Visits | % Site Visits |
|---|---|---|---|---|
| 10 | 3 | 11.54% | 9 | 33.33% |
| 22 | 4 | 15.38% | 8 | 50.00% |
| 25 | 2 | 7.69% | 6 | 33.33% |
| 33 | 1 | 3.85% | 11 | 9.09% |
| 38 | 1 | 3.85% | 9 | 11.11% |
| 39 | 3 | 11.54% | 6 | 50.00% |
| 40 | 2 | 7.69% | 9 | 22.22% |
| 42 | 1 | 3.85% | 9 | 11.11% |
| 44 | 1 | 3.85% | 6 | 16.67% |
| 47 | 2 | 7.69% | 9 | 22.22% |
| 58 | 1 | 3.85% | 5 | 20.00% |
| 69 | 1 | 3.85% | 2 | 50.00% |

In 2013, Scotchman Creek (site 25) had 4 instances of DO values falling below 7 mg/L in June, July, September, and November. None of these exceedances were associated with high water temperatures or low flow conditions. In the 124 site visits since 2001, Scotchman Creek has had four other cases of DO values below 7 mg/L in the months of July, August, and September. The measurements recorded in September and November did include comments such as “strange organic odor” and “stringy brown/black algae.”

Scotchman Creek’s River Monitor has lived along the creek for several years and thoroughly explored the area, but has never observed that occurrence before. In June of 2013, she learned a marijuana grow was established upstream of the monitoring site on Forest Service land. She alerted Forest Service officials to the situation and it was eradicated by September. Marijuana cultivation adjacent to creeks have been widely cited for impacts to watersheds such as low flows from stream diversions, unpermitted soil grading, clear cutting of trees, and heavy fertilizer and pesticide usage. After the marijuana eradication, Scotchman Creek’s DO’s exceedances have gone down by half. Currently, more studies being done on Scotchman Creek to determine ways to increase stream health.

Lower Rock Creek (site 22) was flagged four times (50% of site visits) during the months of June, July, August, and September for DO exceedances and experienced water temperature exceedances June through August.

For 10 (45.45%) of the records with DO values below 7 mg/L, water temperature also exceeded the water quality objective of 20°C. An inverse relationship between dissolved oxygen and temperature is expected because gasses become less soluble in water with a higher temperature.

## pH

***pH Precision***

In 2013 there were 298 pH records of 309 total site visits. The remaining 11 records were discarded because samples had surpassed the two hour hold time or pH meters malfunctioned in the field.

Fifteen out of the 298 (5.03%) of the pH records had a range of greater than 0.2 pH units and therefore constitute QAPP precision violations. Monitors are trained to take a fourth measurement with ranges exceeding 0.2 units, but only 11 of these records (73.33%) included a fourth measurement. Additionally, two out of 298 records (0.67%) had less than three measurements. Both of these were from forgetting to take three replicates in the office from their turbidity sample. Consequently, pH had 17 instances of QAPP violations for precision and/or monitoring protocol. Taken in total with the missing or discarded measurements, quality approved pH data was collected for 94.30% of pH records.

***pH Exceedances***

In 2014, there were 15 records (5.03%) that had pH values outside the 6.5-8.5 suitable range for aquatic life. Twelve of these records had pH values less than 6.5, while three records had pH values above 8.5. Twelve of the fifteen exceedances (80.00%) occurred on the South Yuba River and its tributaries. The highest recorded pH value of 9.63 occurred at the Lower Rock Creek (site 22) tributary of the South Yuba in November. Bubbles were observed at the site visit. The lowest recorded pH value of 6.07 occurred at Lower Castle Creek (site 60), a tributary to the South Yuba River, in March. Foam was observed at this site visit, and the stream bed was reported to be gradually sloping and shallow revealing the understory. Specific site information for the pH exceedences is contained in Appendix Table 2.

## Conductivity

***Conductivity Precision***

Of the 309 total site visits in 2014, 304 conductivity records were captured. The remaining 5 records were either not taken correctly or due to a broken meter. No records violated the QAPP precision standard of 10% or 10 µS, whichever is greater. Three records violated QAPP monitoring protocol by having less than three measurements. All of these violations were all from a lapse in monitoring protocol. Therefore, only 0.99% of conductivity records broke QAPP precision standards or monitoring protocol.

Because precision is difficult to calculate in the field, the river monitors are trained to take a fourth measurement when ranges exceed 10 µS. Three records had ranges exceeding this standard, and two of them included a fourth sample as instructed.

***Conductivity Exceedances***

There are no water quality standards for conductivity; the highest conductivity reading was 406.67 µS, which occurred on September 13$^{th}$ at Upper Castle Creek (site 40) on a tributary to the South Yuba. The lowest conductivity reading was 0 µS, which occurred on March 8$^{th}$ at Lower Castle Creek (site 60) on a tributary to the South Yuba.

# Turbidity

***Turbidity Protocol***

SYRCL measures turbidity from grab samples brought back from the field with a 2020 La Motte Turbidimeter. The QAPP gives a maximum holding time of 24 hours if samples are kept in the dark. Of the 309 site visits, there were only 293 records of turbidity after 16 were discarded because they surpassed the 24 hour hold time.

***Turbidity Precision***

For turbidity averages of 2 NTU and below, precision was greater than 0.2 NTU for 36 of 293 (12.29%) turbidity records. Thirty-four of these (94.44%) included a fourth sample. For turbidity averages greater than 2 NTU, precision was greater than 10% for 4 of 293 turbidity records. These records did include a fourth measurement. Precision violations were thus recorded for 40 records (13.65%).

Turbidity had 36 instances of QAPP violations for precision and/or monitoring protocol. Taken in total with the missing or discarded measurements, turbidity data was collected for 86.35% of turbidity records.

***Turbidity Exceedances***

Although there are no water quality standards for turbidity, the highest turbidity reading of 14 NTU occurred at Van Norden (site 39) on November 18$^{th}$. This location additionally had the second highest reading on July 12$^{th}$ at 8.44 NTU. Turbidity has been an issue at this site with low flows and reddish brown algae.

## Summary and Conclusions

SYRCL's River Monitoring in 2014 produced high quality data from the standpoint of compliance with the state approved QAPP. Out of 1506 total records collected, only 4.38% violated QA precision standards or monitoring protocol. Total percent violations of both the 2012 and 2013 River Monitoring season were reduced. This season of river monitoring produced noticeably higher site visit completeness, parameter completeness, and percentage of valid records for all parameters besides turbidity than the year prior. Overall percent completeness was an acceptable 97.48% and the objective of 80% completeness was met for all parameters this year. This percent completeness was 12.89% higher than last year. Higher percentages of completeness and percent valid might be due to strong feedback and communication between the coordinator and the volunteers in 2014. After each monitoring event, the River Monitoring Coordinator contacted River Monitors that collected data not meeting precision standards or monitoring protocol, and gently communicated what could be improved for future site visits.

Despite these successes, there are several ways the frequency of lapse in precision or protocol can be reduced. Precision violations most commonly resulted from failure to adhere to protocols, such as working within sample hold time limits, recording a minimum of measurements, and following guidelines for taking a fourth measurement. Although new program volunteers receive an extensive field training prior to service, most were trained more than two years prior to 2014 and some up to seven years prior. Continued regular trainings or refreshers for all River Monitors would lead to improved precision and an increase in the percent completeness for the program. Integrating newly trained River Monitors with current River Monitors was an effective way to reinforce QA goals.

Data collected in 2014 showed more water quality exceedances than in the past year. Of the 909 records in 2014 for water temperature, dissolved oxygen, and pH, 94 records (10.34%) surpassed state objectives for maintaining aquatic life. By comparison, the rate of exceedance of water quality objectives was less in 2013 when 74 out of 848 (8.73%) records failed to meet water quality objectives. This year's water quality exceedances still were better than exceedances in years before 2013.

It is important to note that water quality exceedances recorded in 2013 have a large variability in sampling time, from 7:00 to 19:00. Temperature depends on time of day, and dissolved oxygen and pH also have diurnal variation. SYRCL has been using automatically recording thermistors to monitor water temperature at approximately 12 sites annually since 2007, with 21 sites monitored in 2014. This data (available on yubashed.org) shows that sites located lower on the South Yuba River, such as Bridgeport (Site 33) have higher water temperatures than upper sites on the South Yuba River. The data from thermistors shows diurnal temperature range fluctuating for some of these lower sites, and peak temperature occurs in the late afternoon or early evening. Time of day monitoring should be kept consistent with the noon sampling time specified in the QAPP for accurate comparisons throughout the watershed.

Accuracy of pH meters is also a concern because pH meters show more deviations than others. While some pH meters are up to 9 years old, the pH electrodes are replaced every year per the manufacturer's suggestion for maintaining accuracy. pH meters should be occasionally tested and always tested when pH exceedances are detected by using calibration solution upon their return to the office during monitoring days. After monitoring weekend, post-calibration data could help evaluate how much each meter drifts with time since calibration.

## Acknowledgements

Marianne Pott has been a wonderful River Monitoring Coordinator for SYRCL, completing two years of service. She has remained at SYRCL after her term of service to train the new coordinator Karl Ronning who will take on the 2015 year. Terry Armstrong continues to be an exceptional volunteer, entering data from field sheets year after year. SYRCL is grateful to all the volunteer River Monitors for their time to be trained, conduct field monitoring, and attend to their own data with care and diligence. The preparation of this report was supervised and edited by Gary Reedy and Rachel Hutchinson. A draft of this report was provided to the Technical Advisory Committee of the Yuba-Bear Watershed Council including a representative of the State Water Resources Control Board.

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# Appendix

**Appendix Table 1**: Sites with QAPP violations of precision standards and/or monitoring protocol during 2013 monitoring season. Turbidity values are measured by a volunteer in the office and so are not reflective of River Monitor behaviors in the field.

| Site | Water Temp | DO | pH | Conductivity | Turbidity | Total |
|---|---|---|---|---|---|---|
| 2 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 1 | 0 | 1 | 2 |
| 7 | 1 | 0 | 0 | 0 | 0 | 1 |
| 10 | 0 | 0 | 1 | 0 | 1 | 2 |
| 11 | 0 | 0 | 3 | 0 | 1 | 4 |
| 12 | 0 | 0 | 0 | 0 | 1 | 1 |
| 13 | 0 | 0 | 1 | 0 | 0 | 1 |
| 14 | 0 | 0 | 0 | 0 | 1 | 1 |
| 15 | 0 | 1 | 1 | 1 | 1 | 4 |
| 16 | 0 | 0 | 0 | 0 | 3 | 3 |
| 19 | 0 | 0 | 0 | 0 | 2 | 2 |
| 20 | 0 | 0 | 1 | 0 | 3 | 4 |
| 21 | 2 | 0 | 2 | 0 | 1 | 5 |
| 22 | 0 | 0 | 0 | 0 | 1 | 1 |
| 23 | 0 | 0 | 0 | 0 | 1 | 1 |
| 25 | 0 | 0 | 0 | 1 | 4 | 5 |
| 26 | 1 | 0 | 1 | 1 | 0 | 3 |
| 33 | 0 | 0 | 1 | 0 | 0 | 1 |
| 34 | 0 | 0 | 1 | 0 | 2 | 3 |
| 35 | 0 | 1 | 0 | 0 | 0 | 1 |
| 38 | 0 | 0 | 0 | 0 | 1 | 1 |
| 39 | 0 | 0 | 0 | 0 | 1 | 1 |
| 44 | 0 | 0 | 0 | 0 | 3 | 3 |
| 46 | 0 | 0 | 1 | 0 | 4 | 5 |
| 47 | 0 | 0 | 0 | 0 | 1 | 1 |
| 49 | 0 | 0 | 0 | 0 | 1 | 1 |
| 54 | 0 | 0 | 1 | 0 | 3 | 4 |
| 55 | 0 | 0 | 0 | 0 | 1 | 1 |
| 56 | 0 | 0 | 1 | 0 | 0 | 1 |
| 60 | 0 | 0 | 1 | 0 | 0 | 1 |
| 68 | 0 | 0 | 0 | 0 | 1 | 1 |
| Total | 4 | 2 | 17 | 3 | 40 | 66 |

**Appendix Table 2**: Sites with measurements exceeding water quality objectives (highlighted cells) from 2014 SYRCL monitoring. Averages and standard deviations were calculated from 3 to 4 replicate measurements for each parameter at each site visit. Site Name ends with reference to sub-basin (SY = South Yuba, MY = Middle Yuba, NY = North Yuba, LY = Lower Yuba) and "T" if a tributary. Blank cells indicate no data record.

| Site | Site Name | Date | Time | Air Temp | H2O Temp Avg | H2O Temp StdDev | H2O DO Avg | H2O DO StdDev | H2O pH Avg | H2O pH StdDev |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | Oregon Creek, MYT | 7/11/2014 | 10:40 | 26.1 | 20.03 | 0.19 | 8.32 | 0.16 | 8.3 | 0 |
| 7 | Jackson Meadows, MY | 9/13/2014 | 10:20 | 24.9 | 8.77 | 0.05 | 9.6 | 9.5 | 0.2 | 6.1 |
| 7 | Jackson Meadows, MY | 11/15/2014 | 10:20 | 7.8 | 8.6 | 0 | 9.7 | 9.7 | 0.6 | 6.2 |
| 10 | Indian Springs, SY | 7/12/2014 | 12:25 | 26.3 | 21.53 | 0.05 | 6.38 | 0.22 | 7.4 | 0 |
| 10 | Indian Springs, SY | 7/12/2014 | 12:25 | 26.3 | 21.53 | 0.05 | 6.38 | 0.22 | 7.4 | 0 |
| 10 | Indian Springs, SY | 6/14/2014 | 13:50 | 17.8 | 16.03 | 0.05 | 6.47 | 0.05 | 7.67 | 0.05 |
| 10 | Indian Springs, SY | 8/9/2014 | 12:45 | 26.7 | 19.77 | 0.09 | 6.63 | 0.05 | 7.77 | 0.09 |
| 10 | Indian Springs, SY | 11/18/2014 | 13:40 | 10.8 | 4.03 | 0.11 | 11.2 | 11.1 | 0.2 | 6.5 |
| 11 | Langs Crossing, SY | 4/19/2014 | | 18.8 | 10.37 | 0.17 | 9 | 8.8 | 0.4 | 6.2 |
| 12 | Upper Humbug Creek, SYT | 6/14/2014 | | 16.4 | 14 | 0 | 9.2 | 9 | 0.4 | 6.3 |
| 13 | Above Humbug Creek, SY | 8/8/2014 | 10:10 | 25.2 | 22.7 | 0 | 7.57 | 0.05 | 7.67 | 0.05 |
| 13 | Above Humbug Creek, SY | 6/14/2014 | 11:33 | 26.1 | 20.63 | 0.05 | 8.13 | 0.09 | 7.67 | 0.19 |
| 14 | Below Humbug Creek, SY | 8/8/2014 | 10:55 | 30.8 | 23.1 | 0 | 7.43 | 0.05 | 8 | 0 |
| 15 | Purdon Crossing, SY | 7/12/2014 | 10:15 | 27.5 | 24.17 | 0.05 | 7.15 | 0.32 | 8.4 | 0 |
| 15 | Purdon Crossing, SY | 7/17/2014 | 8:15 | 23 | 23.83 | 0.05 | 7.6 | 0.2 | 7.57 | 0.05 |
| 15 | Purdon Crossing, SY | 8/9/2014 | | 30.5 | 23.77 | 0.05 | 7.1 | 0.22 | 7.48 | 0.37 |
| 15 | Purdon Crossing, SY | 6/19/2014 | 17:10 | 35.5 | 23.52 | 0.04 | 7.93 | 0.09 | 8.38 | 0.04 |
| 15 | Purdon Crossing, SY | 8/21/2014 | 12:30 | 28.4 | 22.93 | 0.05 | 7.83 | 0.21 | 8.2 | 0 |
| 15 | Purdon Crossing, SY | 6/14/2014 | 10:10 | 24.3 | 20.02 | 0.04 | 7.75 | 0.41 | 7.88 | 0.04 |
| 19 | Jones Bar, SY | 7/12/2014 | 13:12 | 31.7 | 26.7 | 0 | 8.32 | 0.19 | 8 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 19 | Jones Bar, SY | 8/9/2014 | 11:40 | 33.3 | 24.2 | 0 | 7.7 | 0.08 | | |
| 19 | Jones Bar, SY | 6/15/2014 | 14:06 | 29.1 | 21.6 | 0 | 8.6 | 0.14 | 7.83 | 0.09 |
| 19 | Jones Bar, SY | 9/13/2014 | 11:40 | 31.5 | 20.5 | 0 | 8.62 | 0.27 | 7.52 | 0.08 |
| 20 | Simpson Street Bridge, LYT | 9/15/2014 | 13:30 | 41.2 | 20.23 | 0.16 | 10.13 | 0.09 | 7.38 | 0.04 |
| 21 | Spring Creek, SYT | 3/8/2014 | | 10.9 | 7.8 | 0 | 9.6 | 9.8 | 0.4 | 6.3 |
| 21 | Spring Creek, SYT | 6/19/2014 | | 19 | 12.4 | 0.65 | 10 | 9.8 | 0.2 | 6.6 |
| 22 | Lower Rock Creek, SYT | 7/12/2014 | 9:15 | 24 | 24.87 | 0.05 | 6.4 | 0 | 7.4 | 0 |
| 22 | Lower Rock Creek, SYT | 8/9/2014 | 9:25 | 24.6 | 23.4 | 0 | 6.7 | 0.3 | 7.1 | 0 |
| 22 | Lower Rock Creek, SYT | 6/14/2014 | 10:10 | 22.8 | 22.5 | 0 | 6.87 | 0.19 | 7.3 | 0 |
| 22 | Lower Rock Creek, SYT | 7/12/2014 | 9:15 | 24 | 24.87 | 0.05 | 6.4 | 0 | 7.4 | 0 |
| 22 | Lower Rock Creek, SYT | 9/13/2014 | 9:30 | 22.4 | 19.8 | 0 | 6.67 | 0.19 | 7.27 | 0.05 |
| 22 | Lower Rock Creek, SYT | 8/9/2014 | 9:25 | 24.6 | 23.4 | 0 | 6.7 | 0.3 | 7.1 | 0 |
| 22 | Lower Rock Creek, SYT | 6/14/2014 | 10:10 | 22.8 | 22.5 | 0 | 6.87 | 0.19 | 7.3 | 0 |
| 22 | Lower Rock Creek, SYT | 11/15/2014 | 10:25 | 15.3 | 6.9 | 0 | 8.8 | 8.9 | 0.2 | 9.6 |
| 23 | Poorman Creek, SYT | 7/14/2014 | 11:45 | 33.8 | 20.57 | 0.05 | 7.8 | 0 | 8.07 | 0.05 |
| 25 | Scotchman Creek, SYT | 9/12/2014 | 12:44 | 30.8 | 15.23 | 0.05 | 5.03 | 0.05 | 6.8 | 0 |
| 25 | Scotchman Creek, SYT | 7/11/2014 | 11:42 | 28 | 15.77 | 0.09 | 6.08 | 0.54 | 6.9 | 0 |
| 30 | Edwards Crossing | 8/8/2014 | 13:00 | 29.6 | 24.9 | 0.07 | 7.7 | 0.36 | 8 | 0.07 |
| 30 | Edwards Crossing | 7/17/2014 | | 29 | 24.73 | 0.05 | 7.6 | 0.16 | 8.3 | 0.08 |
| 30 | Edwards Crossing | 8/21/2014 | 14:00 | 32.1 | 23.17 | 0.05 | 7.63 | 0.19 | 8 | 0 |
| 30 | Edwards Crossing | 7/12/2014 | 10:55 | 30.3 | 23 | 0 | 8.53 | 0.09 | 8.37 | 0.05 |
| 31 | Highway 49 Bridge, SY | 7/17/2014 | 13:55 | 29.5 | 26.37 | 0.05 | 7 | 0.14 | 8.3 | 0 |
| 31 | Highway 49 Bridge, SY | 6/19/2014 | 15:10 | 30 | 21.8 | 0 | 7.37 | 0.05 | 7.95 | 0.05 |
| 31 | Highway 49 Bridge, SY | 8/21/2014 | 11:00 | 28.9 | 21.63 | 0.04 | 7.93 | 0.05 | 7.88 | 0.04 |
| 33 | Bridgeport, SY | 7/15/2014 | 13:55 | 34.6 | 27.35 | 0.09 | 8.4 | 0 | 8.78 | 0.04 |

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|---|---|---|---|---|---|---|---|---|---|---|
| 33 | Bridgeport, SY | 8/21/2014 | 15:15 | 32.4 | 25.35 | 0.09 | 7.67 | 0.09 | 8.22 | 0.04 |
| 33 | Bridgeport, SY | 7/17/2014 | 10:17 | 29 | 24.9 | 0 | 6.8 | 0.24 | 7.52 | 0.19 |
| 33 | Bridgeport, SY | 8/9/2014 | 10:12 | 29.8 | 24.72 | 0.22 | 9.03 | 0.17 | 7.45 | 0.05 |
| 33 | Bridgeport, SY | 9/15/2014 | 14:45 | 34.9 | 23 | 0.07 | 8.77 | 0.05 | 7.65 | 0.05 |
| 33 | Bridgeport, SY | 6/19/2014 | 10:20 | 28.5 | 20.83 | 0.05 | 8.4 | 0 | 8.23 | 0.05 |
| 33 | Bridgeport, SY | 7/17/2014 | 10:17 | 29 | 24.9 | 0 | 6.8 | 0.24 | 7.52 | 0.19 |
| 33 | Bridgeport, SY | 7/15/2014 | 13:55 | 34.6 | 27.35 | 0.09 | 8.4 | 8.4 | 0 | 8.7 |
| 35 | Lower Rush Creek, SYT | 7/12/2014 | 14:15 | 34.3 | 24.17 | 0.05 | 8.17 | 0.12 | 7.63 | 0.05 |
| 38 | Plavada Bridge, SY | 7/12/2014 | 10:15 | 25.3 | 18.9 | 0 | 6.93 | 0.09 | 7.2 | 0 |
| 38 | Plavada Bridge, SY | 10/11/2014 | 9:45 | 12 | 12.8 | 0 | 7.8 | 7.8 | 0.6 | 6.3 |
| 39 | Van Dorden Dam, SY | 7/12/2014 | 12:30 | 25 | 25.03 | 0.05 | 5.8 | 0.08 | 6.9 | 0 |
| 39 | Van Dorden Dam, SY | 11/18/2014 | 11:26 | 2.5 | 3.9 | 0 | 3.9 | 0.22 | 6.4 | 0 |
| 39 | Van Dorden Dam, SY | 7/12/2014 | 12:30 | 25 | 25.03 | 0.05 | 5.8 | 0.08 | 6.9 | 0 |
| 39 | Van Dorden Dam, SY | 6/16/2014 | 11:20 | 14 | 16.9 | 0 | 6.73 | 0.12 | 7.5 | 0 |
| 39 | Van Dorden Dam, SY | 11/18/2014 | 11:26 | 2.5 | 3.9 | 0 | 4.1 | 3.6 | 0.5 | 6.4 |
| 40 | Upper Castle Creek, SYT | 9/13/2014 | 10:08 | 19.2 | 13 | 0 | 5.97 | 0.05 | 7 | 0 |
| 40 | Upper Castle Creek, SYT | 7/12/2014 | 9:45 | 19.9 | 15.13 | 0.05 | 6.97 | 0.17 | 7.03 | 0.05 |
| 42 | Canyon Creek, SYT | 7/12/2014 | | 24 | 20.93 | 0.05 | 7.07 | 0.09 | 7.67 | 0.05 |
| 42 | Canyon Creek, SYT | 8/9/2014 | | 23 | 20.33 | 0.47 | 6.83 | 0.29 | | |
| 42 | Canyon Creek, SYT | 8/9/2014 | | 23 | 20.33 | 0.47 | 6.83 | 0.29 | | |
| 42 | Canyon Creek, SYT | 5/11/2014 | 9:50 | 13 | 9.9 | 0.08 | 8.2 | 9.2 | 1 | 6.3 |
| 42 | Canyon Creek, SYT | 4/18/2014 | 9:50 | 14.5 | 11.1 | 0 | 9.6 | 9.6 | 0.2 | 6.4 |
| 44 | Kingvale, SY | 7/12/2014 | 11:20 | 26.4 | 21.93 | 0.05 | 6.3 | 0.14 | 7.43 | 0.05 |
| 44 | Kingvale, SY | 7/12/2014 | 11:20 | 26.4 | 21.93 | 0.05 | 6.3 | 0.14 | 7.43 | 0.05 |
| 46 | Lower Kentucky Ravine Creek, SYT | 7/15/2014 | 13:17 | 34.5 | 23.08 | 0.13 | 8.1 | 0.08 | 8.3 | 0 |
| 46 | Lower Kentucky Ravine Creek, SYT | 8/9/2014 | 11:45 | 31 | 21.5 | 0.08 | 7.6 | 0 | 7.6 | 0 |
| 46 | Lower Kentucky | 9/15/2014 | 15:20 | 32 | 20.62 | 0.04 | 7.6 | 0 | 7.7 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Ravine Creek, SYT | | | | | | | | | |
| 47 | Dry Creek, LYT | 8/11/2014 | 14:40 | 34.1 | 26.45 | 0.09 | 7.87 | 0.09 | 7.75 | 0.05 |
| 47 | Dry Creek, LYT | 7/12/2014 | 9:40 | 23.5 | 24.5 | 0 | 6.5 | 0.14 | 7.3 | 0 |
| 47 | Dry Creek, LYT | 6/16/2014 | 13:30 | 25.4 | 23.88 | 0.04 | 9.17 | 0.05 | 8.2 | 0 |
| 47 | Dry Creek, LYT | 9/13/2014 | 10:25 | 26.6 | 21.07 | 0.05 | 7.97 | 0.05 | 7.2 | 0 |
| 47 | Dry Creek, LYT | 4/22/2014 | 13:50 | 19.1 | 20.27 | 0.13 | 8.53 | 0.09 | 8.02 | 0.04 |
| 47 | Dry Creek, LYT | 11/14/2014 | 14:05 | 19.2 | 14.07 | 0.05 | 5.2 | 0 | 7.5 | 0 |
| 47 | Dry Creek, LYT | 7/12/2014 | 9:40 | 23.5 | 24.5 | 0 | 6.5 | 0.14 | 7.3 | 0 |
| 49 | Above Poorman Creek, SYT | 7/14/2014 | 10:30 | 35.1 | 23.6 | 0 | 7.13 | 0.25 | 7.8 | 0 |
| 49 | Above Poorman Creek, SYT | 8/9/2014 | 12:00 | 31.2 | 23.6 | 0.08 | 8.17 | 0.05 | 7.97 | 0.05 |
| 55 | Above Oregon Creek, MY | 6/13/2014 | 14:10 | 25.9 | 25.2 | 0.08 | 7.93 | 0.09 | 8.43 | 0.05 |
| 55 | Above Oregon Creek, MY | 7/11/2014 | 11:15 | 26.5 | 24.13 | 0.05 | 8.07 | 0.17 | 8.6 | 0 |
| 55 | Above Oregon Creek, MY | 8/9/2014 | 8:20 | 17.9 | 22.1 | 0 | 8.4 | 0 | 7.97 | 0.05 |
| 55 | Above Oregon Creek, MY | 7/11/2014 | 11:15 | 26.5 | 24.13 | 0.05 | 8 | 7.9 | 0.4 | 8.6 |
| 56 | Our House Dam, MY | 7/11/2014 | 12:00 | 28 | 24.03 | 0.12 | 7.2 | 0 | 7.93 | 0.05 |
| 56 | Our House Dam, MY | 8/10/2014 | 11:30 | | 23.07 | 0.05 | 7.83 | 0.05 | 7.27 | 0.05 |
| 56 | Our House Dam, MY | 9/13/2014 | 13:00 | 30 | 20.6 | 0.07 | 8.73 | 0.09 | 8.33 | 0.04 |
| 58 | Lola Montez Bridge, SY | 6/15/2014 | 18:15 | 15 | 17.5 | 0.14 | 6.97 | 0.12 | 6.87 | 0.05 |
| 60 | Lower Castle Creek, SYT | 3/8/2014 | 12:25 | 12 | 3.43 | 0.05 | 9.6 | 9.8 | 0.2 | 6 |
| 65 | Oregon Creek Swimming Hole, MYT | 8/21/2014 | 16:20 | 27.8 | 20.33 | 0.05 | 7.55 | 0.21 | 7.9 | 0 |
| 69 | Above Hoyt's Crossing, SY | 7/17/2014 | 11:30 | 29 | 25.03 | 0.05 | 6.5 | 0.08 | 8.1 | 0 |
| 69 | Above Hoyt's Crossing, SY | 8/21/2014 | 9:15 | 23 | 20.9 | 0 | 7.6 | 0.16 | 7.68 | 0.04 |
| 69 | Above Hoyt's Crossing, SY | 7/17/2014 | 11:30 | 29 | 25.03 | 0.05 | 6.5 | 0.08 | 8.1 | 0 |