AQ 2 – WATER QUALITY/WATER TEMPERATURE INTERIM TECHNICAL MEMORANDUM

KERN RIVER NO. 1 HYDROELECTRIC PROJECT
FERC PROJECT NO. 1930

PREPARED FOR:

SOUTHERN CALIFORNIA
EDISON®
Energy for What's Ahead℠

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Table of Contents

List of Tables

List of Maps

List of Figures

List of Appendices

List of Acronyms

°C	degrees Celsius
°F	degrees Fahrenheit
µS/cm	microsiemens
AQ 2 TSP	AQ 2 – Water Quality/Water Temperature Technical Study Plan
BASIN	Boulder Area Sustainability Information Network
CCC	Criterion Continuous Concentration
cm	centimeter
CTR	California Toxics Rule
DO	dissolved oxygen
EPA	Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
IRIS	Integrated Risk Information System
KR1	Kern River No. 1
m	meter
MDL	Method Detection Limit
MET	Meteorological Station
mg/L	milligrams per liter
mL	milliliters
NTR	National Toxics Rule
NTU	Nephelometric Turbidity Units
Project	Kern River No. 1 Hydroelectric Project, FERC Project No. 1930
QA/QC	quality assurance/quality control
SCE	Southern California Edison
SPD	Study Plan Determination
TDS	Total dissolved solids
TKN	Total Kjeldahl Nitrogen
TSP	Technical Study Plan
TSS	Total Suspended Solids
USGS	U.S. Geological Survey

1.0 INTRODUCTION

This AQ 2 – Water Quality/Water Temperature Interim Technical Memorandum provides the methods and findings of the AQ 2 – Water Quality/Water Temperature Technical Study Plan (AQ 2 TSP) in support of the Southern California Edison's (SCE) Kern River No. 1 (KR1) Hydroelectric Project (Project) relicensing, Federal Energy Regulatory Commission (FERC) Project No. 1930. The AQ 2 TSP was included in SCE's Revised Study Plan filed on February 13, 2024 (SCE 2024). In its March 14, 2024, Study Plan Determination (SPD), FERC approved the AQ 2 TSP without modifications (FERC 2024).

Data for this memorandum was collected May to October 2024. Field sampling efforts and data analysis completed to date are summarized below. Refer to Section 7, which describes the schedule for completing any outstanding study elements.

2.0 STUDY OBJECTIVES

The objectives of the study, as outlined in AQ 2 TSP (SCE 2024), include the following:

- Collect seasonal water quality (physical, chemical, and bacterial) and water temperature in Democrat Dam Impoundment and bypass reach.[1]

- Compare water quality and water temperature conditions to the objectives/criteria of the Basin Plan (CRWQCB 2019) and other water quality standards.

3.0 STUDY AREA

- The study area for the water quality and water temperature assessment includes the Democrat Dam Impoundment and bypass reach Table 3-1 and Map3-1.

- Studies were not conducted at locations where access was unsafe (e.g., where there is very steep terrain).

4.0 METHODS

Study implementation followed the methods described in the AQ 2 TSP (SCE 2024). The following describes the water quality and water temperature sampling methodology, including seasonal *in-situ* field measurements, seasonal water quality grab sampling, bacterial sampling, water temperature loggers, laboratory analysis, methylmercury fish tissue sampling, and reporting.

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[1] A bypass reach is a segment of a river downstream of a diversion facility where Project operations result in the diversion of a portion of the water from the river.

4.1 STUDY PLAN VARIANCES

There were five minor variances related to the AQ 2 TSP approved in FERC's SPD (FERC 2024) and there are two 2025 additions to the AQ 2 TSP that will be implemented in 2025.

- Minor Variances
    - For some analytical parameters, the laboratories used Standard Methods analyses rather than EPA methods analyses specified in the AQ 2 TSP; however, EPA recognizes the Standard Methods analyses as equivalent.
    - For the two upstream sampling sites (KR 55.6 and KR 55.2) there was confusion with field staff regarding which site to collect grab samples at in 2024. During the spring seasonal water quality sampling, a grab sample was collected at KR 55.6 as specified in AQ 2 TSP Table AQ 2-1 and in the fall sampling grab samples were collected at KR 55.2 to collect surface and mid-depth as specified in AQ 2 TSP text. These sites are very near each other and the water quality is expected to be similar; however, in 2025, grab samples will be collected from both sites.
    - The AQ 2 TSP schedule for bacterial sampling required sampling to occur over five relatively evenly spaced dates in the month of July 2024. Due to the Borel Fire, which began on July 24, 2024, in the immediate vicinity of the study area, the planned fifth sampling was not able to be completed in July. The fifth sampling occurred on August 13, 2024, when the area was reopened and safe for access. Five total samples were taken, the fifth sample, however, exceeded the 30-day sampling window specified in the Basin Plan.
    - The AQ 2 TSP had inconsistencies between sampling parameters in the text and Table AQ 2-2 for the seasonal in-situ field measurement (turbidity, alkalinity, and salinity). This led to turbidity not being recorded in the field. Alkalinity test kits were used in the field to collect alkalinity and salinity was calculated from specific conductance measurements. Turbidity will be collected in 2025 during in-situ measurements.
    - Grab samples were analyzed for total mercury in 2024; however, samples were not analyzed for methylmercury. Methylmercury will be analyzed in 2025.
- 2025 Additions
    - The AQ 2 TSP specified total and fecal coliform analyses and did not require bacterial analysis for *Escherichia coli* (*E. coli*), however, the State Water Resources Control Board (SWRCB 2019) requires *E. coli* sampling for recreation contact bacterial analysis. In 2025, *E. coli* will be included in the analysis.

  - The AQ 2 TSP did not require Hardness (as Ca CO3) as a seasonal water quality grab sample parameter. Criteria for several water quality parameters are, however, Hardness dependent (Cadmium, Copper, Lead, Nickel), (non-detect in 2024). Hardness analysis of water quality grab samples will be performed in 2025.

4.2 WATER QUALITY SAMPLING LOCATIONS

- Water quality and water temperature sampling locations are identified in Table 3-1 and depicted on Map 3-1.

- Exact sampling locations were determined in the field based on sampling suitability (i.e., well-mixed and deep enough for representative sampling) and accessibility.

- Sampling locations were documented using hand-held global positioning system (GPS) units.

- Sediment management related issues and their potential effects on water quality are addressed in the Land 2 – Erosion and Sedimentation Technical Study Plan.

4.3 SEASONAL *IN-SITU* FIELD MEASUREMENTS

- *In-situ* water quality measurements, dissolved oxygen (DO) (mg/L and percent saturation), pH, specific conductance (microsiemens [µS/cm]), salinity (ppt), alkalinity (mg/L), turbidity (NTU)[2], and water temperature (degrees Celsius [°C]) were collected in the impoundment and bypass reach (Table 4-1).

- Samples were collected once during the spring runoff (June, access permitting), and once during the late summer/early fall base-flow period (October) in 2024. Samples will be collected again in 2025 following the same general timeline, access permitting.

- At stream locations, measurements were made approximately 0.1 meter (m) beneath the surface in flowing, well-mixed riffle or run areas.

- Samples were collected using a YSI Pro Digital Sampling System multi-parameter water quality meter.

- Pre- and post-sampling calibration of the *in-situ* instrumentation was conducted following the manufacturer's instructions.

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[2] Turbidity is specified here but was not included in table

4.4 SEASONAL WATER QUALITY GRAB SAMPLES

- Water quality grab samples were collected at the Democrat Dam Impoundment and in the bypass reach.
    - Samples were collected once during the spring runoff (high flow) and once during the late summer/early fall base-flow period (low flow) period in 2024 in coordination with the in-situ water quality measurements to screen for potential water quality issues (Table 4-1). Samples will be collected again in 2025 following the same general timeline.
    - At stream locations, measurements were made approximately 0.1 m beneath the surface in flowing, well-mixed riffle or run areas.
    - At the impoundment location, grab samples were collected from near the surface (1 m depth) and at mid-column depth.
- Samples were collected consistent with EPA protocols for each analyte (see Section 4.6, Laboratory Analysis) and consistent with general water quality sampling methods (National Field Manual for the Collection of Water-Quality Data; https://www.usgs.gov/mission-areas/water-resources/science/national-fieldmanual-collection-water-quality-data-nfm?qt-science_center_objects=0#qtscience_center_objects).
    - The sampling team employed a strict quality assurance/quality control (QA/QC) program. Equipment (bottles/samplers) were clean and thoroughly rinsed in the field with the water being sampled prior to sampling at each sampling location. The Kemmer sampler used for impoundment mid-column samples was filled and rinsed three times before sampling. Sampling bottles were obtained clean and sterile from the laboratory and remained sealed until sample collection. Specific collection of equipment blanks was not necessary for these samples. Laboratory blanks were performed for all samples. Field replicates and additional sampling were not collected unless exceedances were reported.
    - Water quality samples were decanted into laboratory-supplied sample containers and analyzed at a State-certified water quality laboratory.
    - The sample containers were labeled with the date and time that the samples were collected along with the sampling site or identification label.
    - The sample containers were preserved (as appropriate), stored on ice, and delivered to a State-certified water quality laboratory for analyses in accordance with maximum holding periods.
    - A chain-of-custody record was maintained with the samples at all times.

4.5 BACTERIAL SAMPLING

- Surface water bacteria samples for total and fecal coliform were collected downstream of day-use recreation areas (Table 3-1). Samples were collected at four relatively evenly spaced times in the month of July 2024. The final sampling was disrupted due to the Borel Fire but occurred as soon as practicable in August following containment of the Borel Fire. The bacterial sampling will be repeated in July 2025 and the analysis will include *E. coli* (Table 4-1).

- Sampling avoided collecting surface "scum" by plunging the open bottle (sterilized) mouth quickly downward below the water surface and sampling avoided contact with or disturbance of the streambed. Bottles were filled with the opening pointed slightly upward into the current and the bottles were removed with the opening pointed upward toward the water surface and tightly capped, allowing about 2.5 to 5 centimeters (cm) of headspace for proper mixing.

- Samples did not exceed Basin Plan objectives in 2024 thus there was no need to coordinate with the Water Board and Forest Service (within 10 business days). In 2025, if samples exceed Basin Plan objectives SCE will coordinate with the Water Board and Forest Service (within 10 business days) to discuss the issue, as appropriate.

4.6 WATER TEMPERATURE

- Water temperatures and meteorological conditions were collected for locations identified in Table 3-1 from May 15 to October 15, 2024. This data collection will be repeated in 2025 from May 15 to October 15.
    - Water temperatures were collected by installing and maintaining redundant water temperature loggers at seven locations, including upstream of the Democrat Dam Impoundment and in the bypass reach. Each water temperature monitoring station (Table 3-1, Map 3-1) was equipped with two HOBO Tidbit MX TEMP 5000 temperature loggers set to record data at 15-minute intervals.

- Meteorological station data[3] (relative humidity, windspeed, solar radiation, air temperature) was collected from nearby existing weather stations[4]: Kern Canyon PH; KPH and Isabella Dam; ISB[5] and Arvin-Edison – San Joaquin Valley – Station 125.[6]
    - The water temperature monitoring sites were visited, and data downloaded at least once every two months between June and October except for sites

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[3] Relative humidity, windspeed, and solar radiation were not available from existing weather stations

[4] Kern Canyon PH; KPH: CA Dept of Water Resources https://cdec.water.ca.gov/dynamicapp/staMeta?station_id=KPH

[5] Isabella Dam; ISB: CA Dept of Water Resources https://cdec.water.ca.gov/dynamicapp/staMeta?station_id=ISB

[6] Arvin-Edison – San Joaquin Valley – Station 125 California Irrigation Management Information System (CIMIS)

that were inaccessible during the Borel Fire and associated National Forest closure.

  - Temperature and meteorological data, including depiction of seasonal patterns and daily averages, minimums, and maximums, as a function of time and location in the study area were summarized. Aquatic species requirements (e.g., Moyle 2002) will be summarized in the final technical memo to be issued in early 2026 when the temperature study is complete

4.7 LABORATORY ANALYSIS

- Water quality samples collected during the field program were processed by several State-certified laboratories approved by the State Water Resources Control Board for chemical and bacterial analysis.
  - Zalco Laboratories completed the water quality grab sample analysis.
  - BSK Associates was subcontracted by Zalco for several tests.
  - Pace Analytical Labs completed the bacterial analysis.
- The parameters analyzed by the analytical laboratory are provided in Table 4-1 and described in Appendix A.
- The laboratories reported each parameter analyzed with the laboratory method detection limit and reporting limit. The laboratories attempted to attain reporting detection limits that are at or below the applicable regulatory criteria.
- Results from the water quality sampling were compared with the water quality objectives/criteria identified in the Tulare Lake Basin Plan (CRWQCB 2018) and with other relevant water quality standards, including the Environmental Protection Agency (EPA) numeric aquatic life and human health criteria (65 FR 31682, EPA 2023), the National Toxics Rule (NTR) (Federal Register FR 57 60848, EPA 1992), and the California Toxics Rule (CTR) (Federal Register, 65 FR 31682, EPA 2000).

4.8 METHYLMERCURY FISH TISSUE SAMPLING

- Edible-sized sport fish were captured in the Democrat Dam Impoundment as part of the AQ 3 – Fish Population Technical Study Plan and are being tested for concentrations of both total and methylmercury.
- Sampling was conducted to try to capture up to 10 each of largemouth bass, smallmouth bass, white crappie, and catfish as identified in the AQ 2 TSP to sample for total and methylmercury concentrations.
  - Three days of sampling were conducted in an effort to meet target capture numbers during the fish population study because numbers of edible sized fish of some species were low (e.g., <5 fish per species). See AQ 3 – Fish

Population Interim Technical Memorandum for details on collection procedures.

- Fish samples were submitted to Marine Pollution Studies Laboratory in Moss Landing, California, for individual fish muscle tissue analysis. In the final technical memo, the results of the fish muscle tissue analyses will be summarized in a table and will include the fish identification number, date and time collected, total and fork length, weight, and total/methylmercury concentrations. Average total and methylmercury concentrations by species will be calculated. The mercury concentrations will also be presented relative to fish weight in graphical format and compared to appropriate Office of Environmental Health Hazard Assessment and/or EPA screening value guidelines.

4.9 REPORTING

- This memorandum includes summary tables and maps, as appropriate. The stakeholder review and comment period includes 90 days for the first year memorandum (2024) and 60 days for the second year (2025).

- Upon request, data will be provided to resource agencies and interested stakeholders in an Excel spreadsheet (electronic format).

- If water quality issues are identified during the first-year sampling, they will be discussed at the Initial Study Report Meeting scheduled for March 19, 2025.

- The water quality criteria used in the analysis are shown in Table 4-1.

5.0 RESULTS SUMMARY

Results for the water quality studies are provided below. The Basin Plan (CRWQCB 2018) includes water quality objectives/criteria (Table 4-1) for the protection of beneficial uses in the study area (Table 5-1), including: (1) power generation; (2) water contact recreation; (3) water non-contact recreation; (4) warm freshwater habitat; (5) cold freshwater habitat; (6) wildlife habitat; and (7) rare, threatened, or endangered species.

5.1 SEASONAL *IN-SITU* FIELD MEASUREMENTS

Seasonal *in-situ* field measurement results are presented in Table 5-2 for the spring runoff sampling June 26–27, 2024, and the late summer/early fall base flow period October 9–10, 2024. Each parameter is discussed below.

5.1.1 Water Temperature

The Basin Plan water quality objective for water temperature states that elevated temperature wastes shall not cause the temperature of waters designated COLD or WARM to increase by more than 5 degrees Fahrenheit (°F) (2.78°C]) above natural receiving water temperature (CRWQCB 2018). Water temperatures ranged from 18.9 to

20.5°C in the spring sampling and from 19.8 to 20.5°C in the fall sampling exhibiting very little seasonal fluctuation. Section 5.4 shows that seasonally (May to October) water temperature ranged from 15.7°C and 24.4°C. These temperatures are greater than COLD water temperatures (e.g., ≤20°C) for fish species and in the range occupied by WARM water fish species. The continuous water temperature data that were collected are presented in more detail in Section 5.4.

5.1.2 Dissolved Oxygen

The Basin Plan water quality objectives for DO are a minimum of 5.0 mg/L for water designated WARM and a minimum of 7.0 mg/L for waters designated COLD (CRWQCB 2018). The specific dissolved oxygen water quality objectives for the Kern River from Lake Isabella to the KR1 Powerhouse is a minimum of 8.0 mg/L, which is consistent with EPA criterion (CRWQCB 208, EPA 1986). DO ranged from 8.58 to 9.12 mg/L during the spring and fall sampling periods, which is consistent with Basin Plan criteria. Percent saturation was greater than 90% for all measurements.

5.1.3 Specific Conductance

The Basin Plan water quality objectives for conductivity is a maximum of 300 µS/cm for the Kern River from Lake Isabella to the KR1 Powerhouse. Conductivity ranged from 92 to 93 µS/cm in the spring sampling and 140 to 143 µS/cm in the fall sampling, well below the Basin Plan criterion.

5.1.4 pH

The Basin Plan water quality objective for pH states that "the pH of water shall not be depressed below 6.5, raised above 8.3, or changed at any time more than 0.3 units from normal ambient pH" (CRWQCB 2018). The national EPA pH criterion is 6.5 to 9 for chronic exposure in fresh water (EPA 2019). pH ranged from 7.96 to 8.17 during both sampling periods, which is within the range specified in the Basin Plan.

5.1.5 Alkalinity

There are no alkalinity criteria in the Basin Plan and the NTR identifies that a total alkalinity continuous concentration "of 20 mg/l is a minimum value except where alkalinity is naturally lower, in which case the criterion cannot be lower than 25 percent of the natural level" (EPA 2023). Alkalinity was >20mg/L in the Study Area, ranging from 40 to 44 mg/L.

5.1.6 Salinity

Salinity is normally estimated indirectly by measuring specific conductivity (see Section 5.1.3). There are no salinity criteria in the Basin Plan water quality objectives. We converted the electrical conductivity samples to salinity using the following equation: salinity ppt = 0.4665 (conductivity µS/cm)1.0878 (Dohrman 2023). Salinity values during the spring runoff and fall sampling period ranged from 0.003 to 0.05 ppt (Table 5-2). Freshwater usually has a salinity value of <0.5 ppt (Wetzel 2001).

5.2 SEASONAL WATER QUALITY GRAB SAMPLES

Results of the general water quality sampling are presented in Table 5-4 for the spring sampling and Table 5-5 for the fall sampling in 2024. Sampling occurred concurrent with the *in-situ* field measurements. Table 5-6 contains the calculated criteria and results for ammonia, which has criteria based on temperature and pH and was calculated on a location-by-location basis. All general water quality sampling parameters were within the Basin Plan water quality objectives and the CTR and EPA national water quality criteria.

5.3 BACTERIAL SAMPLING

The Basin Plan water quality objective for bacteria states that, “in water designated REC-1, the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not exceed a geometric mean of 200/100 milliliters (mL), nor shall more than ten percent of the total number of samples taken during any 30-day period exceed 400/100 mL” (CRWQCB 2018). Bacterial sampling occurred in the month of July and August 2024 over a 42-day period. Due to the Borel Fire, the final sampling was delayed until the area was safe for access, which surpassed the 30-day sampling window. The results of the total coliform and fecal coliform sampling are detailed in Table 5-7. The threshold for fecal coliform was not exceeded during the sampling period. Neither the Basin Plan nor the EPA have criteria for total coliform.

The Water Board updated water quality control plan for inland surface waters (SWRCB 2019) includes *E. coli* sampling for recreation contact bacterial analysis. In 2025, *E. coli* will be included in the analysis.

5.4 WATER TEMPERATURE

Water temperature loggers (Table 3-1, Map 3-1) were installed prior to May 15 and were maintained through October 15, 2024. The water temperature monitoring sites were visited, and data downloaded at least once every two months between June and October except for sites that were inaccessible during the Borel Fire and associated National Forest closure. Between October 12, 2024, and October 15, 2024, temperature loggers KR 50.28 and KR 54.2 were dewatered during a decrease in flow that occurred to facilitate the fish population study (i.e., lower flows required for fish sampling).

The 15-minute data was summarized into daily averages, minimums, and maximums and are tabulated in Table 5-8 and shown in Figures 5-1 through 5-9 with corresponding flows. Average daily temperatures ranged between 15.7°C and 24.4°C during the monitoring period. Generally, the highest water temperatures occurred from late July / August to mid-September when flows began lowering following spring runoff and air temperatures were highest. The maximum water temperature (24.9°C) was recorded on August 6, 2024, and the minimum water temperature (14.4°C) was recorded on May 25, 2024. In the bypass reach, water temperature increased slightly (<1°C) due to the lower flows and associated downstream warming; however, below the powerhouse water temperature was nearly the same as inflow water temperature to Democrat Dam Impoundment.

Air temperatures for the study date range (May 15 to October 15) retrieved from the KPH meteorological station are shown in Figure 5-9. The KPH location showed a range of temperatures from 72°F (22°C) to 106°F (41°C) with mean annual air temperature around 92°F (33°C) for the monitoring period.

5.5 LABORATORY ANALYSIS

A detailed summary of the QA/QC review of the seasonal water quality grab sampling reports received from the various labs can be found in Appendix B. The QA/QC review of the reports indicated that all samples were acceptable (i.e., hold times, preservation, containers, etc.) were appropriate.

5.6 METHYLMERCURY FISH TISSUE SAMPLING

A total of 29 edible-sized sport fish were collected for total mercury and methylmercury fish tissue sampling, including 10 largemouth bass three black crappie, five bluegill sunfish, one channel catfish, one white catfish, and nine brown bullhead. Fish ranged in size from 15.5 to 247-centimeter fork length (cm FL) (see the AQ 3 TM). The fish are currently being analyzed at the Marine Pollution Studies Laboratory in Moss Landing, California. Results will be included in the final technical memo to be issued later in 2025.

6.0 STUDY SPECIFIC CONSULTATION

No study specific consultation is required for this study, and no consultation has been conducted to date.

7.0 OUTSTANDING STUDY PLAN ELEMENTS

The water quality/water temperature study is a two-year study with results of data collected from May to October 2024 reported herein. Water temperature monitoring, seasonal *in-situ* field measurements, seasonal water quality grabs samples, and bacterial sampling will be conducted again in 2025. The methylmercury fish tissue sampling for the TSP has been completed, however, analysis of results is pending laboratory analysis. The anticipated schedule to complete the outstanding study plan elements is outlined in the table below.

Schedule for Completion of Outstanding Study Plan Elements

Date	Activity
Year 1	
March 2025	Distribute draft Interim Technical Memorandum to stakeholders (Year 1)
April–June 2025	Stakeholders review and provide comments on draft technical memo (90 days)
July–August 2025	Resolve comments and prepare final technical memorandum (Year 1)
December 2025	Distribute final technical memorandum (Year 1) in Draft License Application.

Date	Activity
Year 2	
May–June 2025	Install water temperature probes and conduct spring water quality in-situ and grab sampling
May–October 2025	Maintain water temperature probes
July 2025	Conduct bacteria sampling at the four day-use recreation areas
September/October 2025	Conduct summer/fall water quality in-situ and grab sampling
October 2025 – January 2026 (Year 2)	Analyze data and prepare draft technical memo
January 2026	Distribute draft Technical Memorandum to stakeholders (Year 2)
February–March 2026	Stakeholders review and provide comments on draft technical memo (60 days)
April 2026	Resolve comments and prepare final technical memorandum (Year 2)
May 2026	Distribute final comprehensive technical memorandum (Year 1 and Year 2) in Final License Application

8.0 REFERENCES

CRWQCB (California Regional Water Quality Control Board). 2018. Water Quality Control Plan for the Tulare Lake Basin Third Edition. Revised May 2018 (with approved amendments). Available at: https://www.waterboards.ca.gov/centralvalley/water_issues/basin_plans/tularelakebp_201805.pdf

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TABLES

Table 3-1. Water Quality and Water Temperature Sampling Locations

Site Name/ID and Description	Sampling Location River Mile (RM)	Coordinates	Seasonal In-situ Field Measurements	Seasonal Water Quality Grab Samples / Temperature Monitoring Locations	Bacterial Sampling
KR 55.6 (Kern River above Democrat Dam)	RM 55.6	35.531954, -118.658381	X	X[1]	--
KR 55.2 (Kern River below rafting take-out)	RM 55.2	35.531481, -118.664900	X	--[1]	X
KR 54.36 (Kern River between Democrat Dam and Instream Flow Release)	RM 54.36	35.523707, -188.675464	X	X	--
KR 54.2 (Kern River below Instream Flow Release)	RM 54.2	35.22709, -118.675759	X	X	--
KR 50.84 (Kern River near USGS gage 1192500; below Democrat Dam)	RM 53.84	35.20211, -118.680249	X	X	--
KR 50.3 (Kern River near Lucas Creek)	RM 50.3	35.483765, -118.711885	X	X	--
KR 48.7 (Kern River below Upper Richbar Day Use Area)	RM 48.7	35.476250, -118.724036	X	--	X
KR 48.4 (Kern River below Lower Richbar Day Use Area)	RM 48.4	35.475149, -118.728459	X	--	X
KR 47.78 (Kern River below Live Oak Day Use Area)	RM 47.78	34.479729, -118.733570	X	--	X
KRTR 43.94 (Kern River No. 1 Powerhouse Tailrace)	RM 43.94	34.460697, -118.779644	X	X	--
KR 44.0 (Kern River upstream of Kern River No. 1 Powerhouse)	RM 44.0	35.461124, -118.778816	X	X	--

[1] Grab samples during the fall were taken at KR 55.2 (within impoundment) not at KR 55.6 as indicated in AQ 2 TSP. Water temperature monitoring occurred at KR 55.6 as indicated in AQ 2 TSP. In 2025, grab samples will be collected at both KR 55.6 and KR 55.2.

Table 4-1. Summary of Water Quality Analytical Tests, Including Laboratory Methods and Detection Limits, and Chemical Water Quality Objectives.

Analyte	Units[1]	Analysis Method[2]	Method Detection Limit (MDL)	Reporting Limit (RL)	Water Quality Criteria			Sample Container	Hold Time	Preservative/ Comment
					Basin Plan[3]	CA Toxics Rule (CTR)[4]	EPA Criteria[5]			
***In-Situ* Measurements**										
Water Temperature	Celsius (°C)	Water Quality Meter	Not Applicable	Not Applicable	≤ +5°F[6]	NS	NS	Not Applicable	Not Applicable	None
Dissolved Oxygen (DO)	mg/L	Water Quality Meter	Not Applicable	Not Applicable	5.0–7.0[7]	NS	3.0 - 8.0[8]	Not Applicable	Not Applicable	None
Conductivity	µS/cm at 25°C	Water Quality Meter	Not Applicable	Not Applicable	300	NS	NS	Not Applicable	Not Applicable	None
pH	unitless	Water Quality Meter	Not Applicable	Not Applicable	6.5–8.3[9]	NS	6.5 – 9.0	Not Applicable	Not Applicable	None
Alkalinity	mg/L	Alkalinity Test Kit	Not Applicable	10	NS	NS	>20[12]	Not Applicable	Not Applicable	None
Salinity	PPT	Calculated	Not Applicable	Not Applicable	NS	NS	NS	Not Applicable	Not Applicable	None
Turbidity	NTU	Water Quality Meter	Not Applicable	Not Applicable	Depends on Turbidity Baseline	NS	NS	Not Applicable	Not Applicable	None
General Parameters										
Nitrate	mg/L	EPA 300.0	0.01	0.1	10	NS	NS	500mL plastic	48 hours	H_2SO_4, maintain at ≤6°C
Nitrite	mg/L	EPA 300.0	6.7	150	1	NS	NS	500mL plastic	48 hours	H_2SO_4, maintain at ≤6°C
Ammonia as N	mg/L	SM 4500 / EPA 350.1	0.33	0.8	0.025	NS	Depends on pH & temperature	500mL plastic	28 days	H_2SO_4, maintain at ≤6°C
Total Kjeldahl Nitrogen (TKN)	mg/L	SM 4500 / EPA 351.2	0.30	0.1	NS	NS	NS	500mL plastic	28 days	H_2SO_4, maintain at ≤6°C
Total Phosphorus	µg/L	SM 4500	0.0022	0.1	NS	NS	NS	500mL plastic	28 days	H_2SO_4, maintain at ≤6°C
Ortho-phosphate	mg/L	SM 4500-P E	0.016	0.3	NS	NS	NS	500mL amber glass	48 hours	Maintain at ≤6°C
Total Dissolved Solids	mg/L	SM 2540C	5.0	10	500[10]	NS	NS	500mL plastic	7 days	Maintain at ≤6°C
Total Suspended Solids	mg/L	SM 2540D	2.0	2.5	NS	NS	NS	500mL plastic	7 days	Maintain at ≤6°C
Total Alkalinity	mg/L	SM 2320B	10.0	10	NS	NS	>20[12]	250mL plastic	14 days	Maintain at ≤6°C
Metals-Dissolved										
Arsenic	µg/L	EPA 200.7	0.005	0.02	10[11]	150/340[13]	150/340[13], 0.018[14], 0.14[15]	125mL plastic	48 hours	Maintain at ≤6°C
Cadmium	µg/L	EPA 200.7	7	10	5[11]	2.2/4.3[13, 16]	0.72/1.8[13, 16]	125mL plastic	48 hours	Maintain at ≤6°C
Copper	µg/L	EPA 200.7	16	50	1,300[11]	9.0/13[13, 16], 1,300[14]	9.0/13[13, 16, 17]	125mL plastic	48 hours	Maintain at ≤6°C
Iron	µg/L	EPA 200.7	0.031	0.1	300[11]	NS	1,000[18], 300[19]	125mL plastic	48 hours	Maintain at ≤6°C

Analyte	Units[1]	Analysis Method[2]	Method Detection Limit (MDL)	Reporting Limit (RL)	Water Quality Criteria			Sample Container	Hold Time	Preservative/ Comment
					Basin Plan[3]	CA Toxics Rule (CTR)[4]	EPA Criteria[5]			
Lead	µg/L	EPA 200.7	0.01	0.05	15[11]	2.5/65[13, 16]	2.5/65[13, 16]	125mL plastic	48 hours	Maintain at ≤6°C
Manganese	µg/L	EPA 200.7	0.003	0.03	50[11]	NS	50[20]	125mL plastic	48 hours	Maintain at ≤6°C
Nickel	µg/L	EPA 200.7	0.001	0.01	100[11]	52/470[13, 16], 610[14], 4,600[15]	52/470[13, 16], 610[14], 4,600[15]	125mL plastic	48 hours	Maintain at ≤6°C
Chromium-Total	µg/L	EPA 200.7	2	10	50[11]	NS	100[10]	125mL plastic	48 hours	Maintain at ≤6°C
Metals-Total										
Total Mercury	ng/L	EPA 245.1	0.13	0.40	2,000	50[14], 51[15]	770/1,400[13]	125mL plastic	48 hours	Maintain at ≤6°C
Methyl Mercury	ng/L	EPA 1630	--	--	NS	NS	NS	125mL plastic	48 hours	Maintain at ≤6°C
Bacteria										
Total Coliform	MPN/100 mL	EPA SM9223B	Not Applicable	1	NS	NS	NS	100 mL plastic	24 hours	Maintain at ≤6°C
Fecal Coliform	MPN/100 mL	EPA SM9223B	Not Applicable	1	200/100 mL[21]	NS	126	100 mL plastic	24 hours	Maintain at ≤6°C
E. coli	MPN/100 mL	SM 9223B	Not Applicable	1	100/100 mL[22]	NS	NS	100 mL plastic	8 Hours	8 hours

[1] Units follow listed criterion standards. If standards were not available, laboratory supplied units were used. (Note: µg/L-ppb and mg/L=ppm)

[2] Analysis methods are periodically updated by the EPA. The most recent methods available were used for the water quality analysis.

[3] The Water Quality Control Plan for the Tulare Lake Basin Second Edition relies on California primary and secondary Maximum Concentration Level objectives as criteria for water quality to be used as a municipal and domestic supply for human consumption.

[4] California Toxics Rule (CTR) criteria are based primarily on EPA standards developed under the Clean Water Act for human consumption of water and aquatic organisms with an adult risk for carcinogens estimated to be one in one million as contained in the Integrated Risk Information System (IRIS) as of October 1, 1996.

[5] Federal water quality criteria are from the EPA's website unless otherwise noted in the footnotes.
Aquatic Life Criteria: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table#table
Human Health Criteria: https://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table

[6] Elevated temperature wastes shall not cause the temperature of waters designated COLD or WARM to increase by more than 5°F above natural receiving water temperature.

[7] 5.0 mg/L for waters designated WARM, 7.0 mg/L for waters designated COLD or SPWN.

[8] The 1-day minimum warmwater criteria are 5.0 mg/L for early life stages, which includes all embryonic and larval stages and all juveniles forms to 30 days following hatching, and 3.0 mg/L for other life stages. The 1-day minimum coldwater criteria are 8.0 mg/L to achieve required intergravel DO concentrations for early life stages, 5.0 mg/L for early life stages exposed directly to the water column, and 4.0 mg/L for other life stages (EPA's 1986 'Gold Book').

[9] pH shall not be depressed below 6.5, raised above 8.3, or changed at any time more than 0.3 units from normal ambient pH.

[10] The criteria listed are secondary Maximum Concentration Levels (MCLs) for California drinking water quality objectives that do not necessarily indicate a toxic amount of contaminate. Rather these standards dictate water quality objectives designed to preserve taste, odor, or appearance of drinking water.

[11] The criteria listed are primary MCL^{s} listed to address health concerns· Updated November 2024

[12] The CCC of 20 mg/L is a minimum value except where alkalinity is naturally lower, in which case the criterion cannot be lower than 25 percent of the natural level.

[13] Freshwater aquatic life protection, continuous concentration (4-day average)/maximum concentration (1-hour average).

[14] Human health criterion (30-day average) for drinking water sources (consumption of water and aquatic organisms).

[15] Human health criterion (30-day average) for other waters (consumption of aquatic organisms only).

[16] Criterion is hardness dependent which is expressed as a function of hardness and decreases as hardness decreases. The actual criteria are calculated based on the hardness (as CaCO$_3$) of the sample water. Values displayed above correspond to a total hardness of 100mg/L.

[17] Criteria values are from the EPA's 2004 National Recommended Water Quality Criteria.

[18] Criterion for freshwater aquatic life protection (EPA's 1986 'Gold Book').

[19] Criterion for domestic water supplies (EPA's 1986 'Gold Book').

[20] *E. coli* was not a water quality parameter identified in the AQ-3 TSP; however, the Tulare Basin Plan now included *E. coli*.

[21] Criterion for domestic water supplies (EPA's 1986 'Gold Book').

[22] Six-week rolling geometric mean of 100/100 mL and a statistical threshold value of 320/100 mL not to be exceeded by more than 10 percent of the samples collected in a calendar month.

KEY:
MDL (Method Detection Limit): The minimum measured concentration of a substance that can be reported with 99 percent confidence that the measured concentration is distinguishable from method blank results.
MPN: Most probable number of bacterial colonies per 100 mL of water.
MRL (Method Reporting Limit): The lowest concentration of a substance that can be reliably reported under current laboratory operating conditions.
NS: no standard available

Table 5-1. Water Quality Control Plan for the Tulare Lake Basin Beneficial Uses in the Project Study Area

Beneficial Use	Definition
Hydropower Generation (POW)	Beneficial uses of waters used for hydroelectric power generation.
Water Contact Recreation (REC-1)	Beneficial uses of waters used for recreational activities involving body contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs.
Non-contact Water Recreation (REC-2)	Beneficial uses of waters used for recreational activities involving proximity to water, but not normally involving body contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, and aesthetic enjoyment in conjunction with the above activities.
Warm Freshwater Habitat (WARM)	Beneficial uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
Cold Freshwater Habitat (COLD)	Beneficial uses of waters that support cold water ecosystems including, but not limited to, preservation and enhancement of aquatic habitats, vegetation, fish, and wildlife, including invertebrates.
Wildlife Habitat (WILD)	Beneficial uses of waters that support wildlife habitats including, but not limited to, the preservation and enhancement of vegetation and prey species used by wildlife, such as waterfowl.
Rare, Threatened, or Endangered Species (RARE)	Beneficial uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened or endangered.

Table 5-2. Summary of *In-Situ* Sample Results for the 2024 Sampling Year.

Site ID	Site Description	Date	Time of Day	Water Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen (% saturation)	Specific Conductance (µS/cm at 25°C)	pH	Alkalinity (mg/L)	Salinity (PPT)[1]
Spring Runoff										
KR 55.6	Kern River above Democrat Dam	6/27/2024	0830	18.9	8.68	94	92	7.97	40	0.0348
KR 55.2	Kern River below rafting take-out	6/27/2024	0845	19.0	8.73	94	92	7.97	40	0.0348
KR 54.36	Kern River between Democrat Dam and Instream Flow Release	6/27/2024	940	19.0	9.10	98	92	7.96	40	0.0348
KR 54.2	Kern River below Instream Flow Release	6/27/2024	1000	19.1	9.06	98	92	8.01	40	0.0348
KR 50.84	Kern River near USGS gage 1192500; below Democrat Dam	6/27/2024	1030	19.2	8.99	92	93	8.00	40	0.0352
KR 50.3	Kern River near Lucas Creek	6/27/2024	1110	19.5	8.93	97	92	8.04	40	0.0348
KR 48.7	Kern River below Upper Richbar Day Use Area	6/27/2024	1130	19.6	8.94	98	92	8.12	40	0.0348
KR 48.4	Kern River below Lower Richbar Day Use Area	6/27/2024	1145	19.6	8.96	98	92	8.14	40	0.0348
KR 47.78	Kern River below Live Oak Day Use Area	6/27/2024	1200	19.7	8.93	98	92	8.12	40	0.0348
KRTR 43.94	Kern River No. 1 Powerhouse Tailrace	6/26/2024	1220	20.5	9.06	100	93	8.17	40	0.0352
KR 44.0	Kern River upstream of Kern River No. 1 Powerhouse	6/26/2024	1300	19.3	8.84	97	93	8.00	40	0.0352
Late Summer/Early Fall Base-Flow Period										
KR 55.6	Kern River above Democrat Dam	10/10/2024	1030	20.0	8.72	95	143	7.95	43	0.0562
KR 55.2	Kern River below rafting take-out	10/10/2024	1110	20.1	8.89	98	142	7.99	43	0.0558
KR 54.36	Kern River between Democrat Dam and Instream Flow Release	10/9/2024	1200	20.1	8.63	95	141	7.95	43	0.0554
KR 54.2	Kern River below Instream Flow Release	10/9/2024	1215	20.2	8.58	95	141	7.95	44	0.0554
KR 50.84	Kern River near USGS gage 1192500; below Democrat Dam	10/9/2024	1300	20.3	8.67	96	142	7.99	44	0.0558
KR 50.3	Kern River near Lucas Creek	10/10/2024	0935	19.8	8.90	97	141	7.97	43	0.0554
KR 48.7	Kern River below Upper Richbar Day Use Area	10/10/2024	1150	20.2	8.79	97	140	7.98	44	0.0550
KR 48.4	Kern River below Lower Richbar Day Use Area	10/10/2024	1200	20.4	8.95	99	142	8.00	44	0.0558
KR 47.78	Kern River below Live Oak Day Use Area	10/10/2024	1215	20.4	8.89	99	142	8.10	43	0.0558
KRTR 43.94	Kern River No. 1 Powerhouse Tailrace	10/9/2024	1030	20.3	8.95	99	142	7.89	43	0.0558
KR 44.0	Kern River upstream of Kern River No. 1 Powerhouse	10/9/2024	1015	20.1	9.12	100	140	8.00	43	0.0550

[1] Salinity was calculated by converting conductivity measurements (Dohrman 2023)

Table 5-3. Summary of Seasonal Grab Sample Results Collected During the Spring 2024 Sampling Event

Water Quality Parameters	Units	MDL	RL	WQ Criteria	Site ID, Lab Sample ID, Date, Time and Analytical Results							
					KR 55.6 Kern River above Democrat Dam (surface)	**KR 55.2 Kern River above Democrat Dam (mid-column)**	**KR 54.36 Kern River between Democrat Dam and Instream Flow Release**	**KR 54.2 Kern River below Instream Flow Release**	**KR 50.84 Kern River near USGS Gage 1192500**	**KR 50.3 Kern River near Lucas Creek**	**KRTR 43.94 Kern River No. 1 Powerhouse Tailrace**	**KR 44.0 Kern River upstream of Kern No. 1 Powerhouse**
					2406585-02	**-**	**2406585-01**	**2406585-05**	**2406585-03**	**2406585-04**	**2406558-01**	**2406558-02**
					6/27/2024	**-**	**6/27/2024**	**6/27/2024**	**6/27/2024**	**6/27/2024**	**6/26/2024**	**6/26/2024**
					0830	**-**	**0940**	**1000**	**1030**	**1110**	**1220**	**1300**
General Parameters												
Nitrate as N	mg/L	0.01	0.10	10[2]	0.35	-	0.15	0.30	0.46	0.28	0.15	0.40
Nitrite as N	mg/L	6.7	150	1[2]	ND	-	ND	ND	ND	ND	ND	ND
Ammonia as N	mg/L	0.33	0.80	0.025[3]	ND	-	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen (TKN)	mg/L	0.30	0.80	NS	0.39	-	ND	ND	ND	0.35	0.32	0.61
Total Phosphorus	ug/L	0.0022	0.10	NS	ND	-	ND	ND	ND	ND	ND	ND
Ortho-phosphate	mg/L	0.016	0.30	NS	ND	-	ND	ND	ND	ND	ND	ND
Total Dissolved Solids	mg/L	5.0	10.0	500[2]	94.0	-	80.0	69.0	89.0	86.0	ND	49.0
Total Suspended Solids	mg/L	2.0	2.5	NS	56.0	-	6.7	6.2	7.9	8.7	9.1	7.4
Total Alkalinity (as CaCO3)	mg/L	10.0	10.0	>20[4]	38.0	-	38.0	38.0	37.0	38.0	36.0	36.0
Metals - Dissolved												
Arsenic	µg/L	0.005	0.020	10[2]	ND	-	ND	ND	ND	ND	ND	ND
Cadmium	µg/L	7.0	10.0	Hardness dependent[5]	ND	-	ND	ND	ND	ND	ND	ND
Copper	µg/L	16	50.0	Hardness dependent[5]	ND	-	ND	ND	ND	ND	ND	ND
Iron	µg/L	0.031	0.10	300[2]	0.10	-	0.10	ND	0.10	ND	ND	0.10
Lead	µg/L	0.01	0.05	Hardness dependent[5]	ND	-	ND	ND	ND	ND	ND	ND
Manganese	µg/L	0.0030	0.030	50[2]	0.056	-	0.056	0.055	0.054	0.057	0.061	0.069
Nickel	µg/L	0.0010	0.010	Hardness dependent[5]	ND	-	ND	ND	ND	ND	ND	ND
Chromium-Total	µg/L	2.00	10.0	50[2]	ND	-	ND	ND	ND	ND	ND	ND
Metals-Total												
Total Mercury	ng/L	0.08	0.20	1,400[6]	ND	-	ND	ND	ND	ND	ND	ND

[1] KR 55.2 was not sampled in the spring.

[2] Water quality objective from the 2015 Water Quality Control Plan for the Tulare Lake Basin Second Edition.

[3] Basin Plan water quality objective is 0.025 mg/L. EPA criterion is pH, temperature, and life cycle dependent. See Table AQ 6-9 for EPA criteria and results.

[4] EPA criterion. The CCC of 20 mg/L is a minimum value except where alkalinity is naturally lower, in which case the criterion cannot be lower than 25 percent of the natural level.

[5] Criterion is hardness dependent which is expressed as a function of hardness and decreases as hardness decreases. Actual criterion is calculated based on the hardness (as $CaCO_3$) of the sample water. Hardness was not directly analyzed but all values were ND.

[6] EPA maximum concentration (1-hour average) criterion for freshwater aquatic life protection. Basin Plan water quality objective is less stringent (2,000 ng/L).

Note: Bold results do not meet the listed criteria

KEY: ND: Analyte was not detected above the method detection limit and is therefore considered a non-detect.
NS: No standard
PQL (Practical Quantitation Limit): The concentration that can be reliably measured within specified limits and accuracy during routine laboratory operating conditions.
RL (Reporting Limit): The lowest concentration of a substance that can be reliably reported under current laboratory operating conditions.

Table 5-4. Summary of Seasonal Grab Sample Results Collected During the Fall 2024 Sampling Event

					Site ID, Lab Sample ID, Date, Time and Analytical Results							
					KR 55.2 Kern River above Democrat Dam (surface)	**KR 55.2 Kern River above Democrat Dam (mid-column)**	**KR 54.36 Kern River between Democrat Dam and Instream Flow Release**	**KR 54.2 Kern River below Instream Flow Release**	**KR 50.84 Kern River near USGS Gage 1192500**	**KR 50.3 Kern River near Lucas Creek**	**KRTR 43.94 Kern River No. 1 Powerhouse Tailrace**	**KR 44.0 Kern River upstream of Kern No. 1 Powerhouse**
					2410283-02 AHJ3577	**2410283-03 AHJ3577**	**2410259-03 AHJ3600**	**2410259-02 AHJ3600**	**2410259-05 AHJ3600**	**2410283-01 AHJ3577**	**2410259-01 AHJ3600**	**2410259-04 AHJ3600**
					10/10/2024	**10/10/2024**	**10/9/2024**	**10/9/2024**	**10/9/2024**	**10/10/2024**	**10/9/2024**	**10/9/2024**
Water Quality Parameters	**Units**	**MDL**	**RL**	**WQ Criteria**	**1035**	**1100**	**1200**	**1215**	**1300**	**1000**	**1030**	**1015**
General Parameters												
Nitrate as N	mg/L	0.01	0.10	10[1]	0.15	0.18	0.13	0.26	0.22	0.15	0.12	0.20
Nitrite as N	mg/L	6.7	150	1[1]	ND	ND	ND	ND	ND	ND	ND	ND
Ammonia as N	mg/L	0.33	0.80	0.025[2]	ND	ND	ND	ND	ND	ND	ND	ND
Total Kjeldahl Nitrogen (TKN)	mg/L	0.30	0.10	NS	ND	ND	ND	ND	ND	ND	1.4	ND
Total Phosphorus	ug/L	0.0022	0.10	NS	ND	ND	ND	ND	ND	ND	ND	ND
Ortho-phosphate	mg/L	0.016	0.30	NS	ND	ND	ND	ND	ND	ND	ND	ND
Total Dissolved Solids	mg/L	5.0	10.0	500[1]	88.0	79.0	65.0	70.0	100.0	86.0	74.0	68.0
Total Suspended Solids	mg/L	2.0	2.5	NS	2.8	ND	2.9	2.8	2.8	ND	3.6	2.7
Total Alkalinity	mg/L	10.0	10.0	>20[3]	59.0	56.0	56.0	56.0	54.0	60.0	58.0	57.0
Metals - Dissolved												
Arsenic	µg/L	0.005	0.020	10[1]	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	µg/L	7.0	10.0	Hardness dependent[4]	ND	ND	ND	ND	ND	ND	ND	ND
Copper	µg/L	16	50.0	Hardness dependent[4]	ND	ND	ND	ND	ND	ND	ND	ND
Iron	µg/L	0.031	0.10	300[1]	ND	ND	ND	ND	ND	ND	0.48	ND
Lead	µg/L	0.01	0.05	Hardness dependent[4]	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	µg/L	0.0030	0.030	50[1]	0.069	0.068	0.078	0.075	0.060	0.047	0.080	0.073
Nickel	µg/L	0.0010	0.010	Hardness dependent[4]	ND	ND	ND	ND	ND	ND	ND	ND
Chromium-Total	µg/L	2.00	10.0	50[1]	ND	ND	ND	ND	ND	ND	ND	ND
Metals-Total												
Total Mercury	ng/L	0.08	0.20	1,400[5]	ND	ND	ND	ND	ND	ND	ND	ND

[1] Water quality objective from the 2015 Water Quality Control Plan for the Tulare Lake Basin Second Edition.

[2] Basin Plan water quality objective is 0.025 mg/L. EPA criterion is pH, temperature, and life cycle dependent. See Table AQ 6-9 for EPA criteria and results.

[3] EPA criterion. The CCC of 20 mg/L is a minimum value except where alkalinity is naturally lower, in which case the criterion cannot be lower than 25 percent of the natural level.

[4] Criterion is hardness dependent which is expressed as a function of hardness and decreases as hardness decreases. Actual criterion is calculated based on the hardness (as $CaCO_3$) of the sample water. Hardness was not directly analyzed but all values were ND.

[5] EPA maximum concentration (1-hour average) criterion for freshwater aquatic life protection. Basin Plan water quality objective is less stringent (2,000 ng/L).

Note: Bold results do not meet the listed criteria

KEY:
ND: Analyte was not detected above the method detection limit and is therefore considered a non-detect.
NS: No standard
PQL (Practical Quantitation Limit): The concentration that can be reliably measured within specified limits and accuracy during routine laboratory operating conditions.
RL (Reporting Limit): The lowest concentration of a substance that can be reliably reported under current laboratory operating conditions.

Table 5-5. Calculated Ammonia Concentration Criteria for the Spring and Fall 2024 Sampling Events

Site ID	Date	pH	Temperature (°C)	Basin Plan Waste Discharge Exceedance Criteria (mg/L)	EPA Ammonia Chronic Criteria[1] (mg/L)	EPA Ammonia Acute Criteria[1] (mg/L)	Ammonia Concentration[2] (mg/L)
Spring Sampling							
KR 55.6 Kern River above Democrat Dam (surface)	6/27/2024	7.97	18.9	0.025	0.87	4.53	ND
KR 54.36 Kern River between Democrat Dam and Instream Flow Release	6/27/2024	7.96	19.0	0.025	0.88	4.57	ND
KR 54.2 Kern River below Instream Flow Release	6/27/2024	8.01	19.1	0.025	0.81	4.13	ND
KR 50.84 Kern River near USGS Gage 1192500	6/27/2024	8.00	19.2	0.025	0.82	4.17	ND
KR 50.3 Kern River near Lucas Creek	6/27/2024	8.04	19.5	0.025	0.76	3.77	ND
KRTR 43.94 Kern River No. 1 Powerhouse Tailrace	6/26/2024	8.17	20.5	0.025	0.58	2.70	ND
KR 44.0 Kern River upstream of Kern No. 1 Powerhouse	6/26/2024	8.00	19.3	0.025	0.81	4.14	ND

Site ID	Date	pH	Temperature (°C)	Basin Plan Waste Discharge Exceedance Criteria (mg/L)	EPA Ammonia Chronic Criteria[1] (mg/L)	EPA Ammonia Acute Criteria[1] (mg/L)	Ammonia Concentration[2] (mg/L)
Fall Sampling							
KR 55.6 Kern River above Democrat Dam (surface)	10/10/2024	7.95	20.0	0.025	0.83	4.29	ND
KR 54.36 Kern River between Democrat Dam and Instream Flow Release	10/9/2024	7.95	20.1	0.025	0.83	4.25	ND
KR 54.2 Kern River below Instream Flow Release	10/9/2024	7.95	20.2	0.025	0.82	4.22	ND
KR 50.84 Kern River near USGS Gage 1192500	10/9/2024	7.99	20.3	0.025	0.77	3.88	ND
KR 50.3 Kern River near Lucas Creek	10/10/2024	7.97	19.8	0.025	0.82	4.20	ND
KRTR 43.94 Kern River No. 1 Powerhouse Tailrace	10/9/2024	7.89	20.3	0.025	0.89	4.67	ND
KR 44.0 Kern River upstream of Kern No. 1 Powerhouse	10/9/2024	8.00	20.1	0.025	0.77	3.87	ND

[1] Ammonia criterion calculated using guidelines from the EPA's 2013 Aquatic Life Ambient Water Quality Criteria for Ammonia - Freshwater, which is based on ambient pH and temperature conditions.

[2] ND: Analyte was not detected above the method detection limit (MDL) and is therefore considered a non-detect. The MDL for ammonia is 0.015 mg/L.

Table 5-6. Summary of Analytical Results for Bacterial Sampling in 2024

Sample Location	Test[1, 2]	Sample Dates 2023					
		7/2/2024	7/9/2024	7/18/2024	7/24/2024	8/13/2024[1]	GeoMean
KR 55.2	*Total Coliform (MPN/100mL)*	23.0	33.0	7.8	4.5	<1.8	8.6
	Fecal Coliform (MPN/100mL)	23.0	33.0	2.0	4.5	<1.8	6.6
KR 48.7	*Total Coliform (MPN/100mL)*	23.0	23.0	7.8	2.0	<1.8	6.8
	Fecal Coliform (MPN/100mL)	23.0	23.0	7.8	2.0	<1.8	6.8
KR 48.4	*Total Coliform (MPN/100mL)*	23.0	23.0	7.8	4.5	2.0	8.2
	Fecal Coliform (MPN/100mL)	<1.8	23.0	2.0	4.5	<1.8	3.7
KR 47.78	*Total Coliform (MPN/100mL)*	>1600	33.0	49.0	7.8	<1.8	32.5
	Fecal Coliform (MPN/100mL)	>1600	33.0	22.0	7.8	<1.8	27.7

[1] Sampling delayed until August due to the Borel Fire.

KEY: MPN: Most probable number of bacterial colonies per 100 mL of water.

Table 5-7. Kern River Daily Average, Maximum, and Minimum of Water Temperature (°C) By Site

	Kern River Daily Average, Maximum, and Minimum of Water Temperature (°C)																				
	KR 55.6			KR 54.36			KR 54.2			KR 50.84			KR 50.3			KR 44.0			KR 43.94		
Date	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
5/15/2024	15.7	16.7	14.5	15.9	16.7	14.6	15.9	16.7	14.7	15.9	16.7	14.7	16.4	17.1	15.4	17.3	17.9	16.8	16.0	17.0	14.8
5/16/2024	16.0	17.5	14.6	16.2	17.5	14.7	16.2	17.5	14.7	16.2	17.5	14.7	16.7	17.6	15.4	17.5	18.5	16.7	16.2	17.6	14.9
5/17/2024	16.1	17.5	14.7	16.3	17.6	14.9	16.3	17.5	14.9	16.4	17.5	14.9	16.9	17.6	15.5	17.8	18.4	17.2	16.5	17.6	15.0
5/18/2024	16.2	17.8	14.5	16.3	17.8	14.6	16.3	17.8	14.6	16.4	17.8	14.7	16.8	17.8	15.4	17.7	18.3	17.0	16.6	17.9	15.1
5/19/2024	16.3	17.8	14.8	16.5	17.8	15.0	16.5	17.8	15.0	16.6	17.8	15.0	17.1	17.8	16.0	18.0	18.7	17.5	16.9	17.9	15.6
5/20/2024	16.0	17.4	14.7	16.1	17.4	14.7	16.1	17.4	14.7	16.1	17.4	14.7	16.6	17.7	15.1	17.3	17.8	16.4	16.5	17.6	15.2
5/21/2024	16.1	17.6	14.6	16.1	17.6	14.7	16.1	17.6	14.7	16.1	17.6	14.6	16.4	17.6	14.9	17.0	17.7	16.0	16.4	17.6	15.1
5/22/2024	16.3	17.4	15.2	16.4	17.3	15.2	16.4	17.3	15.2	16.5	17.3	15.2	16.8	17.6	15.7	17.5	18.3	16.8	16.9	17.6	16.0
5/23/2024	16.0	17.5	14.6	16.2	17.5	14.6	16.2	17.5	14.6	16.2	17.4	14.6	16.6	17.5	15.0	17.2	17.9	16.5	16.5	17.6	15.1
5/24/2024	16.1	17.6	14.7	16.2	17.6	14.8	16.2	17.6	14.8	16.2	17.5	14.7	16.6	17.4	15.1	17.2	17.7	16.4	16.5	17.6	15.3
5/25/2024	15.9	17.1	14.4	16.0	17.2	14.6	16.0	17.1	14.6	16.0	17.1	14.6	16.3	17.1	15.2	17.1	17.9	16.3	16.4	17.3	15.2
5/26/2024	16.4	18.1	14.7	16.5	18.0	15.0	16.5	18.0	15.0	16.5	17.9	15.1	16.9	17.8	15.9	17.6	19.0	16.6	16.6	18.0	15.3
5/27/2024	17.1	18.5	15.7	17.2	18.4	15.8	17.2	18.4	15.8	17.2	18.4	15.8	17.6	18.4	16.4	18.3	19.2	17.6	17.4	18.5	16.2
5/28/2024	17.1	18.4	15.7	17.3	18.4	15.8	17.3	18.4	15.8	17.3	18.3	15.8	17.7	18.4	16.6	18.5	19.2	18.1	17.7	18.5	16.6
5/29/2024	16.9	18.4	15.3	17.0	18.5	15.4	17.0	18.5	15.4	17.1	18.4	15.4	17.5	18.5	15.8	18.2	18.6	17.5	17.5	18.5	16.2
5/30/2024	17.1	18.9	15.6	17.2	18.9	15.7	17.2	18.9	15.7	17.2	18.8	15.7	17.5	18.9	16.0	18.2	19.0	17.0	17.6	18.9	16.3
5/31/2024	17.5	19.1	16.1	17.6	19.1	16.2	17.6	19.1	16.2	17.6	19.0	16.2	18.0	19.1	16.6	18.6	19.3	17.7	18.1	19.0	17.0
6/1/2024	17.4	18.8	15.9	17.6	18.8	16.1	17.5	18.7	16.1	17.6	18.7	16.1	18.0	18.9	16.8	18.9	19.5	18.2	18.0	18.9	16.9
6/2/2024	17.3	18.6	16.0	17.5	18.7	16.1	17.5	18.7	16.1	17.6	18.6	16.2	18.1	18.7	17.1	18.8	19.6	18.4	17.9	18.8	16.7
6/3/2024	17.3	18.4	16.1	17.4	18.5	16.2	17.4	18.5	16.2	17.4	18.5	16.1	17.7	18.7	16.5	18.4	19.0	17.4	17.9	18.7	16.8
6/4/2024	17.9	19.6	16.4	18.0	19.7	16.4	18.0	19.7	16.4	18.0	19.7	16.4	18.4	19.8	16.8	18.9	20.0	17.9	18.5	19.8	17.3
6/5/2024	18.3	20.1	17.0	18.4	20.1	17.1	18.4	20.1	17.1	18.5	20.1	17.1	18.9	20.3	17.5	19.7	20.4	18.6	19.0	20.2	17.8
6/6/2024	18.4	19.9	17.2	18.6	20.0	17.3	18.6	20.0	17.3	18.6	20.0	17.3	19.1	20.2	17.7	19.9	20.6	18.7	19.1	20.3	17.8
6/7/2024	18.3	19.4	17.3	18.5	19.8	17.4	18.5	19.8	17.4	18.5	19.8	17.4	19.0	19.9	17.8	19.9	20.6	18.9	19.0	20.0	17.9
6/8/2024	18.1	19.2	17.0	18.3	19.6	16.8	18.3	19.6	16.8	18.3	19.5	16.8	18.6	19.7	17.1	19.3	20.2	18.1	18.8	19.8	17.6
6/9/2024	18.0	19.1	16.9	18.3	19.7	16.7	18.3	19.7	16.7	18.3	19.7	16.8	18.7	19.8	17.3	19.5	20.0	18.7	18.6	19.8	17.1
6/10/2024	18.4	20.2	17.2	18.5	20.3	16.9	18.5	20.3	16.9	18.5	20.2	16.9	18.8	20.4	17.1	19.3	20.6	17.8	18.8	20.4	17.2
6/11/2024	18.7	20.7	17.2	18.8	20.7	17.3	18.8	20.7	17.3	18.8	20.6	17.4	19.2	20.8	17.7	19.9	21.0	18.7	19.2	20.7	17.8
6/12/2024	18.7	20.6	17.3	18.9	20.6	17.4	18.9	20.6	17.4	18.9	20.5	17.4	19.3	20.7	17.8	20.1	21.1	18.8	19.3	20.6	17.9
6/13/2024	18.8	20.1	17.4	18.9	20.2	17.5	18.9	20.2	17.5	18.9	20.2	17.5	19.3	20.4	18.0	20.1	20.9	19.1	19.5	20.4	18.3
6/14/2024	18.8	20.5	17.4	18.9	20.6	17.5	18.9	20.6	17.5	18.9	20.5	17.5	19.3	20.7	17.9	19.9	20.8	18.7	19.5	20.6	18.1
6/15/2024	18.4	19.8	17.2	18.6	19.8	17.2	18.6	19.8	17.2	18.6	19.8	17.2	18.9	20.1	17.5	19.6	20.8	18.5	19.0	20.5	17.7
6/16/2024	18.3	19.9	17.0	18.4	19.8	17.0	18.4	19.9	16.9	18.4	19.8	16.9	18.7	19.9	17.2	19.2	19.9	18.2	18.5	19.9	17.2
6/17/2024	18.5	19.9	17.5	18.6	19.9	17.5	18.6	19.9	17.5	18.6	19.9	17.4	18.8	20.0	17.5	19.3	20.0	18.0	18.9	20.0	17.7
6/18/2024	18.7	20.3	17.2	18.8	20.3	17.2	18.8	20.3	17.2	18.7	20.2	17.2	18.9	20.3	17.3	19.3	20.3	18.0	19.1	20.2	17.7
6/19/2024	19.0	20.4	17.9	19.1	20.4	18.0	19.1	20.4	18.0	19.1	20.3	18.0	19.3	20.5	18.2	19.7	20.5	18.6	19.5	20.4	18.4
6/20/2024	19.1	20.7	17.7	19.2	20.8	17.7	19.2	20.7	17.7	19.2	20.7	17.7	19.4	20.8	17.8	19.8	20.8	18.5	19.6	20.7	18.2

	Kern River Daily Average, Maximum, and Minimum of Water Temperature (°C)																				
	KR 55.6			KR 54.36			KR 54.2			KR 50.84			KR 50.3			KR 44.0			KR 43.94		
Date	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**
6/21/2024	19.4	21.0	18.1	19.5	21.1	18.1	19.5	21.1	18.1	19.5	21.0	18.1	19.8	21.2	18.2	20.2	21.3	18.9	19.8	21.1	18.5
6/22/2024	19.7	21.5	18.3	19.8	21.4	18.4	19.8	21.5	18.4	19.8	21.4	18.3	20.1	21.6	18.6	20.6	21.6	19.4	20.1	21.4	18.8
6/23/2024	19.8	21.3	18.7	20.0	21.3	18.8	20.0	21.3	18.8	20.0	21.2	18.8	20.4	21.5	19.2	21.1	21.9	19.9	20.5	21.4	19.5
6/24/2024	19.8	21.1	18.9	20.0	21.2	18.9	19.9	21.1	18.9	20.0	21.1	18.9	20.4	21.4	19.2	21.1	21.9	19.8	20.7	21.6	19.5
6/25/2024	20.1	21.5	19.0	20.2	21.6	19.0	20.2	21.6	19.0	20.2	21.5	19.0	20.6	21.7	19.3	21.2	22.0	20.0	20.8	21.8	19.7
6/26/2024	19.9	21.1	18.9	20.0	21.1	18.9	20.0	21.1	18.9	20.0	21.0	18.9	20.4	21.5	19.2	21.1	22.0	19.9	20.5	21.6	19.6
6/27/2024	19.8	21.2	18.8	19.9	21.3	18.8	19.9	21.4	18.8	19.9	21.4	18.9	20.3	21.5	19.0	20.8	21.7	19.5	20.0	21.4	19.0
6/28/2024	20.0	21.4	18.9	20.1	21.5	18.8	20.1	21.5	18.8	20.1	21.5	18.8	20.3	21.6	19.0	20.8	21.8	19.5	20.1	21.6	19.0
6/29/2024	20.3	22.0	18.8	20.4	22.0	18.8	20.4	22.0	18.8	20.4	22.0	18.8	20.7	22.1	19.2	21.1	22.1	20.0	20.5	22.1	19.0
6/30/2024	20.2	21.7	19.0	20.3	21.7	19.0	20.3	21.7	19.0	20.3	21.7	19.0	20.7	21.8	19.2	21.3	22.1	20.1	20.4	21.7	19.2
7/1/2024	20.4	22.0	19.0	20.5	22.0	19.0	20.5	22.0	19.0	20.5	22.0	19.0	20.8	22.2	19.2	21.4	22.4	19.7	20.6	22.1	19.2
7/2/2024	20.7	22.5	19.3	20.8	22.6	19.3	20.8	22.6	19.3	20.8	22.6	19.2	21.2	22.8	19.4	21.7	23.0	20.2	20.9	22.6	19.4
7/3/2024	20.8	22.2	19.6	20.9	22.2	19.6	20.9	22.2	19.6	20.9	22.2	19.6	21.3	22.4	19.9	21.9	22.9	20.7	21.0	22.3	19.8
7/4/2024	20.7	22.1	19.5	20.9	22.1	19.6	20.9	22.2	19.6	20.9	22.1	19.6	21.2	22.3	19.9	21.9	22.6	20.7	21.0	22.2	19.7
7/5/2024	21.0	22.4	19.7	21.1	22.5	19.7	21.1	22.5	19.7	21.1	22.5	19.7	21.5	22.7	20.0	22.1	23.0	20.9	21.2	22.6	19.8
7/6/2024	21.0	22.9	19.6	21.1	23.1	19.6	21.1	23.1	19.6	21.1	23.1	19.6	21.5	23.3	19.9	22.1	23.4	20.7	21.2	23.1	19.8
7/7/2024	21.1	22.7	19.7	21.2	22.8	19.7	21.2	22.8	19.7	21.2	22.7	19.7	21.6	22.9	20.0	22.3	23.4	21.0	21.3	22.8	19.9
7/8/2024	21.1	22.4	20.0	21.3	22.5	20.1	21.3	22.5	20.1	21.3	22.4	20.1	21.7	22.6	20.4	22.3	23.2	21.1	21.3	22.5	20.2
7/9/2024	21.2	22.9	20.1	21.4	23.0	20.1	21.4	23.0	20.1	21.4	23.0	20.1	21.7	23.1	20.3	22.3	23.3	20.9	21.5	23.0	20.2
7/10/2024	21.1	22.8	19.8	21.2	23.0	19.8	21.2	23.0	19.8	21.2	23.0	19.8	21.6	23.1	20.0	22.2	23.3	20.7	21.3	23.0	20.0
7/11/2024	21.3	22.9	20.1	21.4	23.1	20.1	21.4	23.1	20.1	21.4	23.1	20.1	21.7	23.2	20.2	22.3	23.3	20.9	21.5	23.1	20.2
7/12/2024	21.2	22.6	20.1	21.3	22.8	20.1	21.3	22.8	20.1	21.3	22.7	20.1	21.6	22.9	20.3	22.1	23.3	20.9	21.4	22.8	20.2
7/13/2024	21.4	22.7	20.3	21.5	22.9	20.3	21.5	22.9	20.3	21.5	22.9	20.2	21.8	23.0	20.5	22.4	23.2	21.3	21.6	22.9	20.4
7/14/2024	21.3	22.5	20.6	21.4	22.6	20.6	21.5	22.6	20.6	21.5	22.6	20.6	21.9	22.8	20.8	22.6	23.4	21.3	21.6	22.6	20.7
7/15/2024	21.6	22.8	20.6	21.7	22.9	20.7	21.7	22.9	20.7	21.7	22.9	20.7	22.0	23.1	20.9	22.5	23.4	21.4	21.7	22.9	20.8
7/16/2024	21.8	23.6	20.6	21.9	23.7	20.6	21.9	23.7	20.6	21.9	23.7	20.6	22.2	23.8	20.8	22.7	23.9	21.4	22.0	23.7	20.7
7/17/2024	21.7	23.3	20.4	21.7	23.3	20.4	21.7	23.3	20.4	21.7	23.3	20.4	22.1	23.4	20.7	22.6	23.9	21.2	21.9	23.4	20.6
7/18/2024	21.8	23.4	20.5	21.9	23.5	20.5	21.9	23.5	20.5	21.9	23.4	20.5	22.2	23.5	20.7	22.7	23.6	21.2	21.9	23.5	20.6
7/19/2024	21.8	23.7	20.5	21.9	23.7	20.5	21.9	23.7	20.5	21.9	23.7	20.4	22.2	23.8	20.5	22.6	23.9	21.1	22.0	23.7	20.6
7/20/2024	21.9	23.6	20.7	22.0	23.7	20.7	22.1	23.7	20.7	22.0	23.6	20.6	22.4	23.8	20.8	23.0	23.9	21.5	22.1	23.7	20.8
7/21/2024	22.0	23.7	20.7	22.1	23.7	20.7	22.1	23.7	20.7	22.1	23.6	20.7	22.4	23.8	21.0	23.0	23.9	21.8	22.2	23.7	20.9
7/22/2024	22.3	24.3	20.9	22.4	24.3	20.9	22.4	24.3	20.9	22.4	24.3	20.9	22.7	24.4	21.1	23.2	24.5	21.8	22.5	24.4	21.0
7/23/2024	22.3	23.8	21.1	22.4	23.8	21.2	22.4	23.8	21.2	22.4	23.8	21.2	22.8	24.0	21.4	23.5	24.5	22.2	22.5	23.9	21.3
7/24/2024	22.5	23.8	21.5	22.6	23.9	21.5	22.7	23.9	21.5	22.7	23.9	21.5	23.1	24.1	21.8	23.8	24.5	22.6	22.8	23.9	21.7
7/25/2024	22.6	24.2	21.3	22.7	24.2	21.3	22.7	24.2	21.3	22.7	24.2	21.3	22.9	24.3	21.5	23.5	24.4	22.2	22.7	24.2	21.4
7/26/2024	22.5	23.9	21.4	22.7	23.9	21.4	22.7	23.9	21.4	22.7	23.8	21.4	23.1	24.2	21.7	23.7	24.5	22.8	22.8	24.0	21.5
7/27/2024	22.1	23.3	20.8	22.2	23.2	20.8	22.2	23.2	20.7	22.2	23.2	20.7	22.4	23.5	20.9	22.9	23.8	21.8	22.3	23.5	20.9
7/28/2024	22.0	23.1	20.8	22.1	23.1	20.7	22.1	23.1	20.7	22.1	23.1	20.7	22.3	23.3	20.9	22.7	23.4	21.8	22.2	23.2	20.9

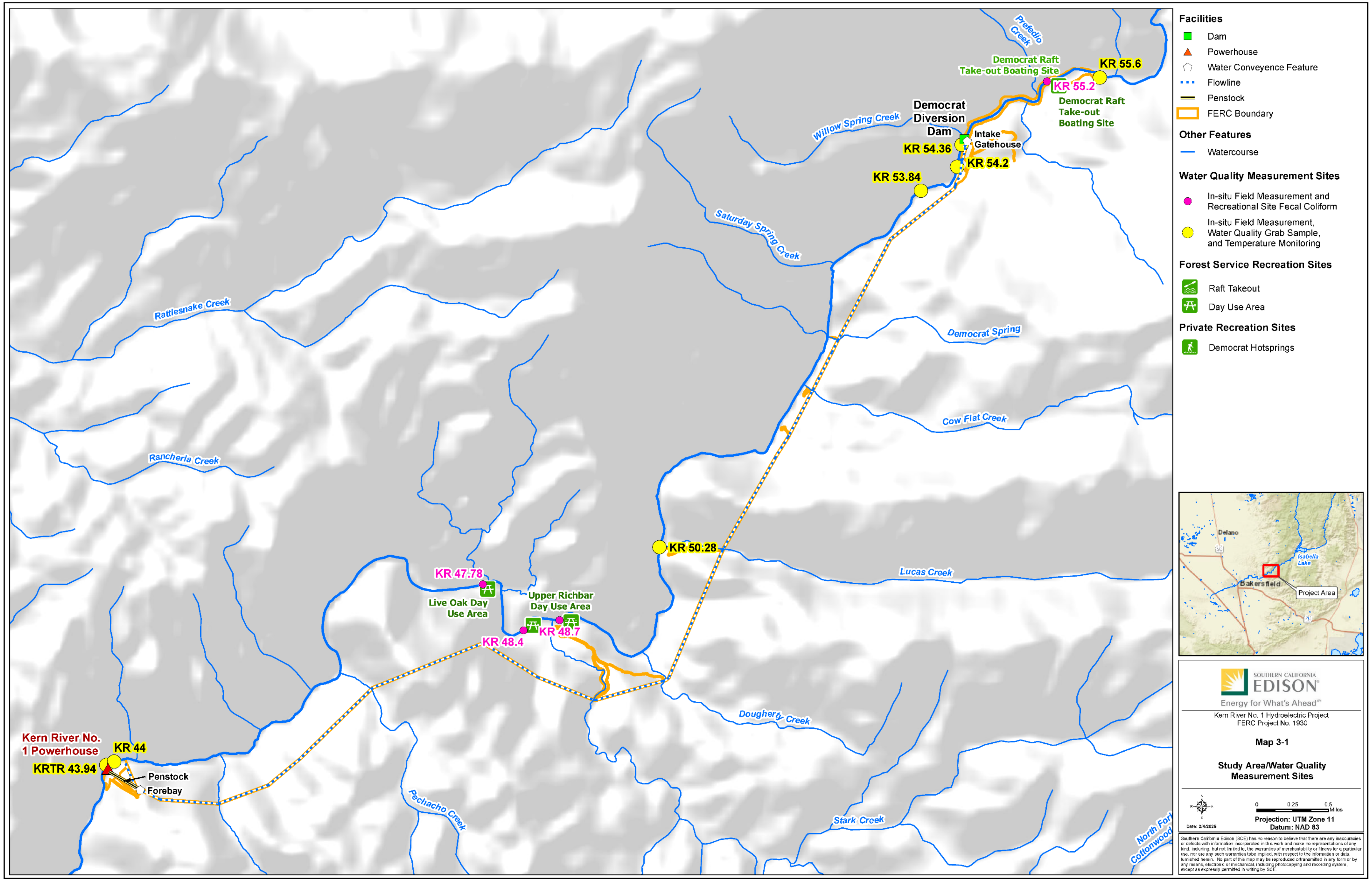
	Kern River Daily Average, Maximum, and Minimum of Water Temperature (°C)																				
	KR 55.6			**KR 54.36**			**KR 54.2**			**KR 50.84**			**KR 50.3**			**KR 44.0**			**KR 43.94**		
Date	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**	**Avg**	**Max**	**Min**
7/29/2024	22.4	24.0	20.9	22.4	23.9	20.8	22.4	23.9	20.8	22.4	23.8	20.8	22.5	23.8	21.0	22.8	23.7	21.9	22.4	23.9	21.0
7/30/2024	22.5	24.2	21.1	22.6	24.2	21.0	22.6	24.2	21.0	22.6	24.1	21.0	22.8	24.1	21.1	23.2	23.7	22.2	22.7	24.2	21.2
7/31/2024	22.8	24.6	21.1	22.8	24.6	21.1	22.8	24.6	21.1	22.8	24.5	21.1	23.0	24.5	21.1	23.3	24.3	21.8	22.9	24.6	21.2
8/1/2024	22.9	24.3	21.6	22.9	24.3	21.6	22.9	24.3	21.6	22.9	24.2	21.6	23.2	24.3	21.8	23.6	24.3	22.6	23.0	24.3	21.8
8/2/2024	22.8	23.7	22.1	22.9	23.6	22.1	22.9	23.6	22.1	22.8	23.6	22.1	23.1	24.1	22.4	23.6	24.3	22.9	23.0	23.9	22.3
8/3/2024	23.2	24.8	21.8	23.3	24.7	21.9	23.3	24.7	21.9	23.3	24.6	22.0	23.5	24.7	22.4	23.9	24.5	23.3	23.3	24.8	22.0
8/4/2024	23.3	24.7	21.8	23.4	24.6	21.9	23.4	24.7	21.8	23.4	24.6	21.9	23.7	24.7	22.3	24.2	24.6	23.6	23.5	24.7	22.0
8/5/2024	23.5	24.8	22.3	23.6	24.8	22.3	23.6	24.8	22.3	23.5	24.7	22.3	23.9	24.8	22.5	24.3	24.9	23.5	23.6	24.8	22.4
8/6/2024	23.5	24.9	22.3	23.6	24.9	22.2	23.6	24.9	22.2	23.6	24.8	22.3	23.9	24.9	22.5	24.4	24.9	23.6	23.7	24.9	22.4
8/7/2024	23.5	24.7	22.3	23.6	24.7	22.4	23.6	24.7	22.3	23.6	24.7	22.3	23.9	24.8	22.7	24.3	24.7	23.6	23.7	24.8	22.5
8/8/2024	23.4	24.6	22.4	23.5	24.6	22.3	23.5	24.6	22.3	23.5	24.6	22.3	23.8	24.6	22.6	24.2	24.7	23.5	23.6	24.7	22.5
8/9/2024	23.4	24.7	22.2	23.4	24.6	22.1	23.4	24.6	22.1	23.4	24.6	22.1	23.6	24.5	22.3	24.0	24.5	23.2	23.5	24.7	22.3
8/10/2024	23.5	24.9	22.2	23.6	24.8	22.2	23.6	24.8	22.2	23.5	24.8	22.2	23.8	24.7	22.6	24.1	24.6	23.5	23.6	24.9	22.4
8/11/2024	23.5	24.7	22.1	23.5	24.6	22.1	23.5	24.6	22.1	23.5	24.6	22.1	23.8	24.5	22.5	24.1	24.5	23.6	23.6	24.7	22.3
8/12/2024	23.5	24.7	22.4	23.6	24.7	22.3	23.6	24.7	22.3	23.6	24.6	22.3	23.8	24.6	22.6	24.1	24.6	23.5	23.7	24.7	22.5
8/13/2024	23.5	24.6	22.5	23.5	24.6	22.4	23.5	24.6	22.4	23.5	24.5	22.4	23.7	24.5	22.5	24.0	24.4	23.2	23.6	24.7	22.6
8/14/2024	23.3	24.4	22.2	23.3	24.4	22.2	23.3	24.3	22.2	23.3	24.3	22.2	23.5	24.2	22.3	23.7	24.2	23.0	23.4	24.4	22.3
8/15/2024	23.2	24.4	22.3	23.3	24.4	22.2	23.3	24.4	22.2	23.3	24.3	22.1	23.4	24.2	22.2	23.6	24.2	22.9	23.4	24.4	22.3
8/16/2024	23.3	24.6	22.2	23.3	24.5	22.1	23.3	24.5	22.1	23.3	24.5	22.1	23.5	24.3	22.1	23.7	24.3	22.9	23.4	24.6	22.2
8/17/2024	23.3	24.5	22.1	23.4	24.4	22.1	23.4	24.4	22.1	23.3	24.3	22.1	23.5	24.2	22.3	23.7	24.2	23.2	23.5	24.4	22.3
8/18/2024	23.4	24.6	22.3	23.5	24.5	22.3	23.5	24.5	22.3	23.5	24.4	22.3	23.6	24.3	22.6	23.9	24.6	23.3	23.6	24.5	22.5
8/19/2024	23.4	24.6	22.3	23.5	24.5	22.2	23.5	24.5	22.2	23.5	24.4	22.3	23.6	24.3	22.4	23.9	24.4	23.3	23.6	24.6	22.4
8/20/2024	23.4	24.5	22.3	23.5	24.4	22.2	23.5	24.4	22.2	23.4	24.3	22.2	23.6	24.3	22.4	23.9	24.3	23.3	23.6	24.5	22.4
8/21/2024	23.3	24.3	22.2	23.3	24.2	22.2	23.3	24.2	22.2	23.3	24.1	22.1	23.4	24.2	22.3	23.7	24.1	23.3	23.4	24.4	22.3
8/22/2024	23.1	24.2	22.1	23.1	24.1	22.0	23.1	24.1	22.0	23.1	24.0	22.0	23.2	23.8	22.0	23.4	23.9	22.8	23.2	24.2	22.2
8/23/2024	22.8	23.6	21.9	22.7	23.5	21.8	22.7	23.5	21.8	22.7	23.5	21.8	22.8	23.6	21.8	23.0	23.5	22.4	22.9	23.9	22.0
8/24/2024	22.5	23.3	21.7	22.5	23.3	21.6	22.5	23.2	21.6	22.5	23.2	21.6	22.6	23.1	21.6	22.7	23.1	22.3	22.7	23.4	21.7
8/25/2024	22.4	23.5	21.4	22.4	23.3	21.3	22.4	23.3	21.3	22.4	23.2	21.3	22.4	23.1	21.4	22.6	23.1	22.1	22.5	23.4	21.4
8/26/2024	22.6	23.7	21.5	22.6	23.6	21.4	22.6	23.6	21.4	22.6	23.5	21.5	22.7	23.4	21.5	22.8	23.4	22.2	22.7	23.7	21.6
8/27/2024	22.5	23.7	21.4	22.6	23.6	21.4	22.6	23.6	21.4	22.6	23.5	21.4	22.8	23.5	21.5	23.0	23.6	22.5	22.7	23.6	21.6
8/28/2024	22.6	23.6	21.5	22.6	23.6	21.4	22.6	23.6	21.4	22.6	23.5	21.4	22.8	23.5	21.5	23.1	23.6	22.5	22.7	23.6	21.6
8/29/2024	22.5	23.5	21.3	22.5	23.4	21.3	22.5	23.4	21.3	22.5	23.3	21.3	22.7	23.4	21.6	23.1	23.6	22.6	22.6	23.6	21.5
8/30/2024	22.5	23.6	21.2	22.5	23.5	21.2	22.5	23.5	21.2	22.5	23.4	21.2	22.6	23.3	21.5	22.9	23.5	22.4	22.6	23.5	21.4
8/31/2024	22.6	23.6	21.5	22.7	23.6	21.5	22.7	23.5	21.5	22.6	23.5	21.5	22.9	23.5	21.9	23.3	24.0	22.7	22.8	23.6	21.6
9/1/2024	22.7	23.7	21.5	22.8	23.6	21.6	22.8	23.6	21.6	22.7	23.5	21.6	23.0	23.6	22.1	23.5	24.2	22.8	22.9	23.7	21.7
9/2/2024	22.9	23.7	21.7	23.0	23.7	21.8	23.0	23.7	21.8	22.9	23.6	21.9	23.2	23.7	22.6	23.6	24.4	23.1	23.1	23.8	21.9
9/3/2024	22.9	23.7	21.6	23.0	23.7	21.8	23.0	23.7	21.8	22.9	23.5	22.0	23.3	23.8	22.6	23.7	24.6	23.0	23.0	23.8	22.0
9/4/2024	23.0	23.7	21.8	23.1	23.6	22.0	23.1	23.6	22.0	23.0	23.5	22.1	23.4	23.9	22.7	23.8	24.9	23.1	23.2	23.7	22.1

Date	Kern River Daily Average, Maximum, and Minimum of Water Temperature (°C)																				
	KR 55.6			KR 54.36			KR 54.2			KR 50.84			KR 50.3			KR 44.0			KR 43.94		
	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
9/5/2024	22.9	23.7	21.7	23.0	23.7	21.8	23.0	23.7	21.8	22.9	23.5	21.9	23.2	23.7	22.5	23.6	24.5	22.9	23.1	23.7	22.0
9/6/2024	23.0	23.6	22.0	23.1	23.6	22.1	23.1	23.6	22.1	23.1	23.5	22.3	23.4	23.9	22.9	23.8	24.7	23.2	23.2	23.7	22.2
9/7/2024	22.8	23.4	21.8	22.9	23.4	21.9	22.9	23.4	22.0	22.8	23.2	22.1	23.1	23.7	22.6	23.6	24.5	22.8	23.0	23.5	22.1
9/8/2024	22.8	23.5	21.7	22.9	23.5	21.9	22.9	23.5	21.9	22.8	23.3	22.0	23.1	23.7	22.4	23.5	24.4	22.7	23.0	23.6	22.0
9/9/2024	22.9	23.5	21.7	22.9	23.5	22.0	22.9	23.5	22.0	22.9	23.3	22.1	23.1	23.9	22.4	23.4	24.3	22.6	23.0	23.6	22.1
9/10/2024	22.7	23.4	21.6	22.8	23.3	21.9	22.8	23.3	21.9	22.7	23.1	22.0	22.9	23.6	22.3	23.3	24.1	22.5	22.9	23.4	22.0
9/11/2024	22.2	23.1	21.2	22.3	23.0	21.5	22.3	22.9	21.5	22.2	22.8	21.5	22.4	23.1	22.0	22.8	23.5	22.1	22.5	23.2	21.6
9/12/2024	21.8	22.4	20.7	21.8	22.3	21.0	21.8	22.3	21.0	21.6	22.1	20.9	21.9	22.8	21.2	22.3	22.9	21.5	21.9	22.5	21.1
9/13/2024	21.9	22.5	20.9	21.8	22.5	21.1	21.8	22.5	21.1	21.6	22.1	21.1	21.9	23.3	20.9	22.1	22.8	21.1	22.0	22.6	21.3
9/14/2024	22.0	22.6	21.1	22.0	22.6	21.4	22.0	22.6	21.4	21.8	22.3	21.3	22.0	23.4	21.1	22.3	23.0	21.4	22.2	22.7	21.5
9/15/2024	22.0	22.6	21.1	22.0	22.6	21.5	22.0	22.5	21.5	21.8	22.3	21.4	22.0	23.2	21.3	22.3	22.9	21.5	22.2	22.7	21.6
9/16/2024	21.1	22.1	20.3	21.2	22.0	20.5	21.1	22.0	20.5	21.0	21.8	20.6	21.1	21.8	20.2	21.5	22.4	20.9	21.4	22.3	20.6
9/17/2024	20.6	21.2	19.7	20.5	21.1	19.8	20.5	21.1	19.8	20.2	20.7	19.5	20.4	21.6	19.6	20.6	21.3	19.8	20.7	21.3	20.0
9/18/2024	20.7	21.4	19.9	20.7	21.2	20.1	20.7	21.2	20.1	20.2	20.7	19.7	20.4	22.0	19.2	20.6	21.3	19.8	20.8	21.4	20.2
9/19/2024	21.0	21.5	20.4	21.0	21.5	20.6	21.0	21.5	20.6	20.7	21.2	20.3	20.9	22.2	20.0	21.0	21.7	20.4	21.1	21.6	20.7
9/20/2024	20.7	21.2	20.0	20.7	21.1	20.1	20.7	21.1	20.1	20.6	20.9	20.0	20.8	21.1	20.7	21.3	21.8	20.8	20.9	21.2	20.2
9/21/2024	20.6	21.4	19.6	20.7	21.4	19.8	20.7	21.4	19.8	20.5	21.2	19.8	20.8	21.8	19.9	21.0	22.1	20.1	20.8	21.5	20.0
9/22/2024	20.8	21.3	19.8	20.8	21.4	20.1	20.8	21.4	20.1	20.7	21.2	20.1	21.0	22.2	20.0	21.3	22.1	20.4	21.0	21.5	20.3
9/23/2024	21.0	21.5	20.1	21.1	21.6	20.4	21.1	21.6	20.4	20.9	21.4	20.5	21.3	22.5	20.3	21.7	22.5	20.8	21.2	21.7	20.6
9/24/2024	21.0	21.5	20.1	21.0	21.4	20.5	21.0	21.4	20.5	20.9	21.3	20.5	21.2	22.5	20.2	21.8	22.4	21.0	21.2	21.5	20.6
9/25/2024	20.9	21.5	19.8	21.0	21.4	20.1	21.0	21.4	20.1	20.9	21.2	20.1	21.1	21.9	20.5	21.7	22.4	20.8	21.1	21.5	20.2
9/26/2024	20.7	21.4	19.7	20.8	21.3	19.9	20.8	21.3	20.0	20.7	21.1	20.0	21.0	21.7	20.5	21.5	22.2	20.6	20.9	21.4	20.1
9/27/2024	20.6	21.1	19.5	20.6	21.1	19.9	20.6	21.1	19.9	20.5	20.9	19.9	20.7	21.8	19.9	21.1	21.9	20.3	20.7	21.2	20.0
9/28/2024	20.8	21.2	20.0	20.9	21.3	20.4	20.8	21.3	20.4	20.7	21.1	20.3	20.9	22.3	19.8	21.2	22.0	20.4	21.0	21.4	20.5
9/29/2024	20.8	21.3	19.9	20.8	21.3	20.2	20.8	21.3	20.2	20.6	21.1	20.1	20.9	22.0	20.0	21.3	22.0	20.5	20.9	21.4	20.3
9/30/2024	20.7	21.2	19.7	20.7	21.1	20.0	20.7	21.1	20.0	20.5	21.0	20.0	20.8	21.7	20.0	21.2	21.9	20.3	20.8	21.2	20.1
10/1/2024	21.0	21.6	20.2	21.0	21.4	20.5	21.0	21.4	20.5	20.8	21.3	20.4	21.0	22.2	20.1	21.3	22.1	20.5	21.1	21.5	20.6
10/2/2024	21.2	21.6	20.3	21.3	21.7	20.7	21.3	21.7	20.7	21.2	21.6	20.7	21.5	22.5	20.7	21.8	22.6	21.0	21.4	21.8	20.8
10/3/2024	21.2	21.6	20.2	21.2	21.7	20.5	21.3	21.7	20.5	21.2	21.6	20.6	21.5	22.3	20.9	22.0	22.6	21.1	21.4	21.8	20.7
10/4/2024	21.0	21.4	20.3	21.1	21.5	20.6	21.1	21.5	20.6	21.0	21.4	20.6	21.3	22.3	20.5	21.7	22.3	21.0	21.2	21.6	20.7
10/5/2024	21.2	21.6	20.7	21.3	21.7	20.9	21.3	21.7	20.9	21.1	21.6	20.7	21.3	22.6	20.2	21.7	22.2	21.0	21.4	21.8	21.0
10/6/2024	21.0	21.4	20.4	21.1	21.5	20.7	21.1	21.5	20.7	20.9	21.4	20.5	21.2	22.3	20.2	21.7	22.2	21.0	21.2	21.6	20.8
10/7/2024	21.1	21.5	20.4	21.1	21.5	20.7	21.1	21.5	20.7	21.0	21.4	20.7	21.2	22.2	20.4	21.6	22.1	20.9	21.2	21.6	20.8
10/8/2024	21.0	21.5	20.1	21.1	21.4	20.4	21.0	21.4	20.5	20.9	21.3	20.4	21.1	22.0	20.5	21.6	22.2	20.9	21.2	21.5	20.6
10/9/2024	20.8	21.2	19.9	20.8	21.2	20.2	20.8	21.2	20.2	20.7	21.1	20.2	20.9	21.6	20.3	21.3	21.8	20.6	20.9	21.3	20.3
10/10/2024	20.7	21.1	20.0	20.7	21.1	20.2	20.7	21.1	20.2	20.6	21.0	20.2	20.7	21.8	20.0	21.0	21.6	20.3	20.8	21.2	20.4
10/11/2024	20.6	21.0	20.0	20.7	21.0	20.3	20.6	21.0	20.3	20.5	20.8	20.2	20.5	21.6	19.5	21.0	21.5	20.4	20.8	21.1	20.4
10/12/2024	20.2	20.5	19.7	20.2	20.5	19.8	**19.4**	**20.7**	**13.3**	**20.0**	**20.4**	**19.5**	**19.0**	**23.2**	**16.4**	20.2	20.9	19.4	20.4	20.7	19.9

	Kern River Daily Average, Maximum, and Minimum of Water Temperature (°C)																				
	KR 55.6			KR 54.36			KR 54.2			KR 50.84			KR 50.3			KR 44.0			KR 43.94		
Date	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
10/13/2024	20.0	20.5	19.5	19.8	20.5	19.3	**16.9**	**28.6**	**11.4**	**19.7**	**20.4**	**19.1**	**18.3**	**26.5**	**14.5**	20.0	20.7	19.2	20.1	20.7	19.5
10/14/2024	20.1	20.9	19.4	19.8	20.6	19.2	**17.8**	**30.4**	**11.4**	**19.7**	**20.3**	**19.0**	**18.8**	**27.3**	**14.5**	20.0	20.7	19.2	20.1	21.0	19.5
10/15/2024	20.1	21.1	19.3	19.9	20.5	19.3	**18.7**	**31.3**	**11.9**	**19.8**	**20.4**	**19.0**	**19.4**	**28.9**	**15.1**	20.2	20.9	19.4	20.2	21.1	19.4

Note: Bolded dates on sites KR 54.2 and KR 50.3 dewatered due to flow decrease from fish populations study.

MAPS



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Map 3-1. Study Area/Water Quality Measurement Sites

FIGURES

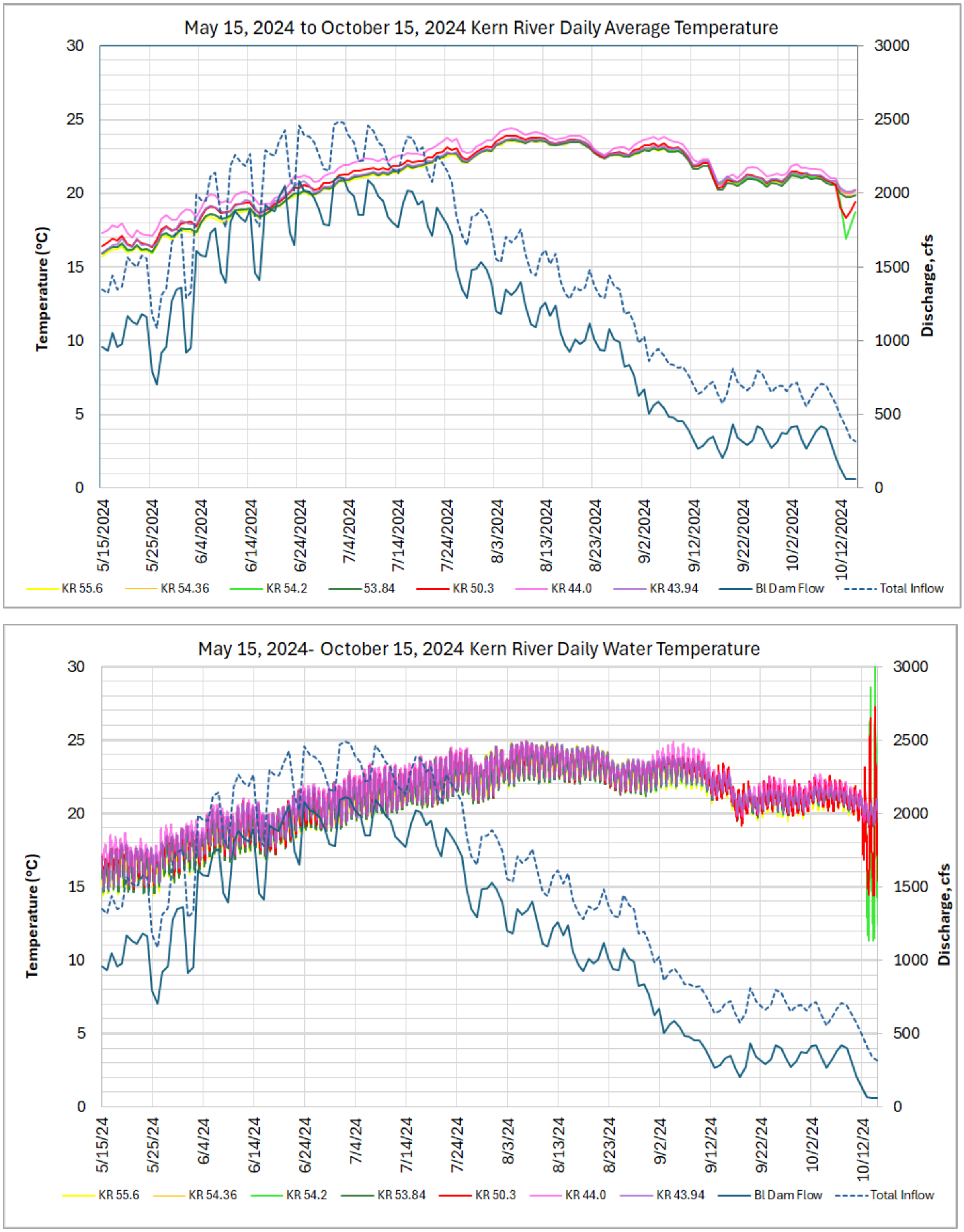

Figure 5-1. Kern River Daily Average Water Temperature (bottom) and 15-minute Temperature (top) with Daily Mean Discharge

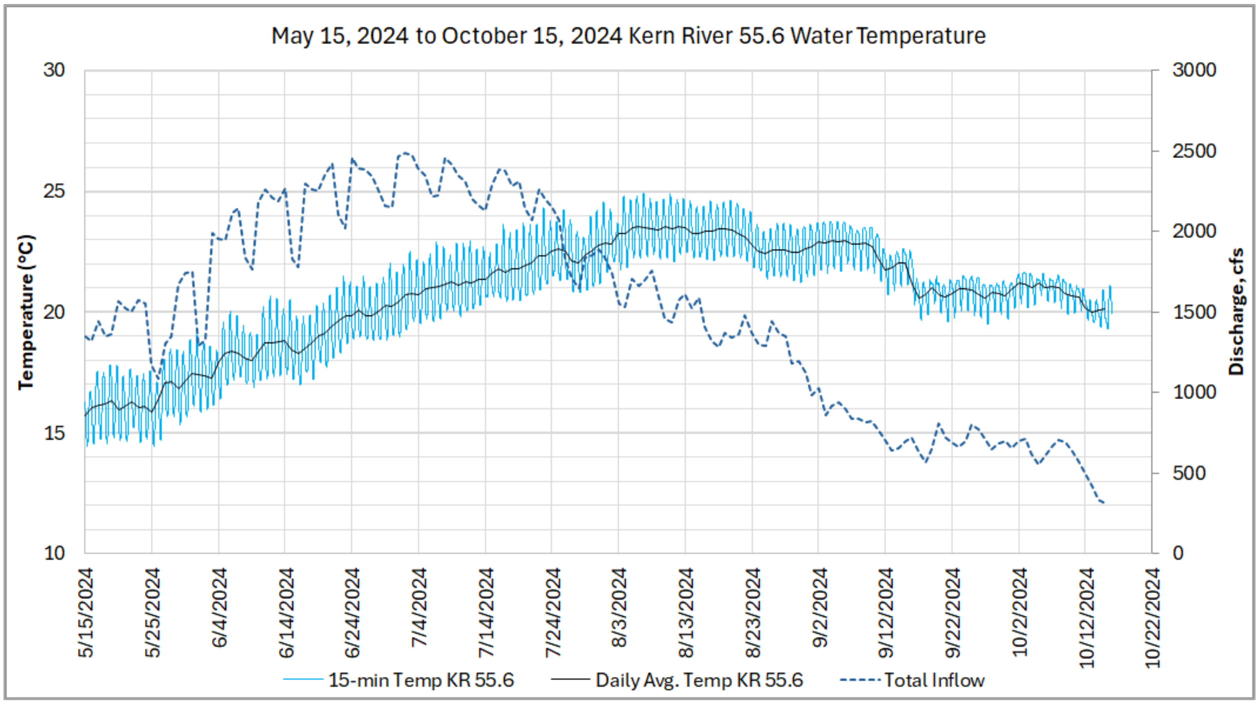

Figure 5-2. Kern River above Democrat Dam, Site KR 55.6, Water Temperature and Daily Mean Discharge

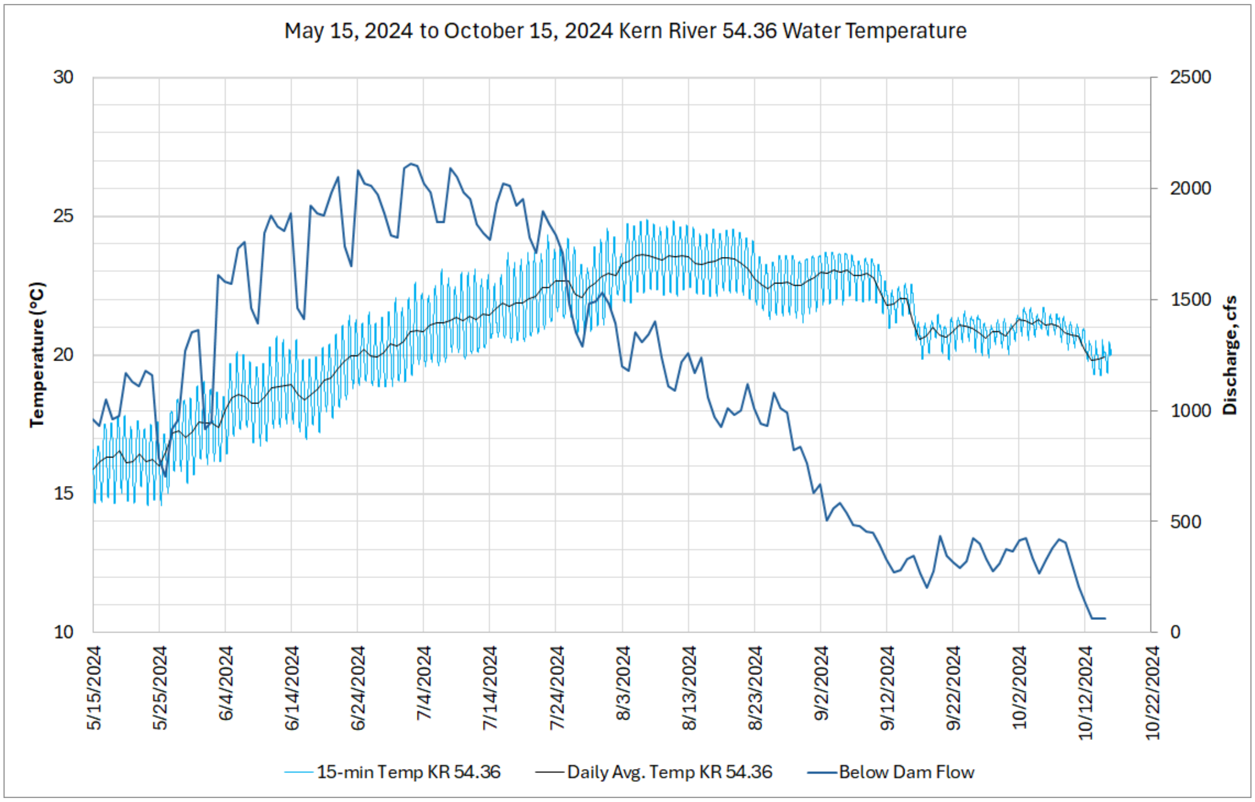

Figure 5-3. Kern River between Democrat Dam and Instream Flow Release, Site KR 54.36 Water Temperature and Daily Mean Discharge

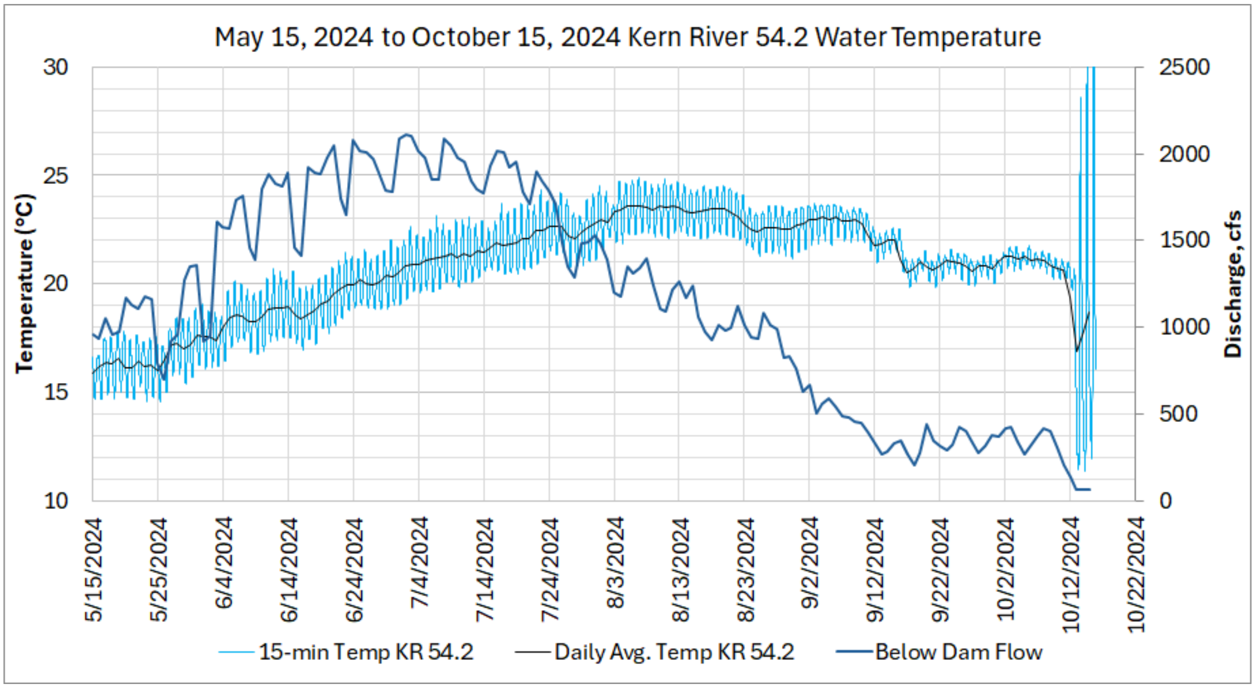

Figure 5-4. Kern River below Instream Flow Release, KR 54.2 Water Temperature and Daily Mean Discharge

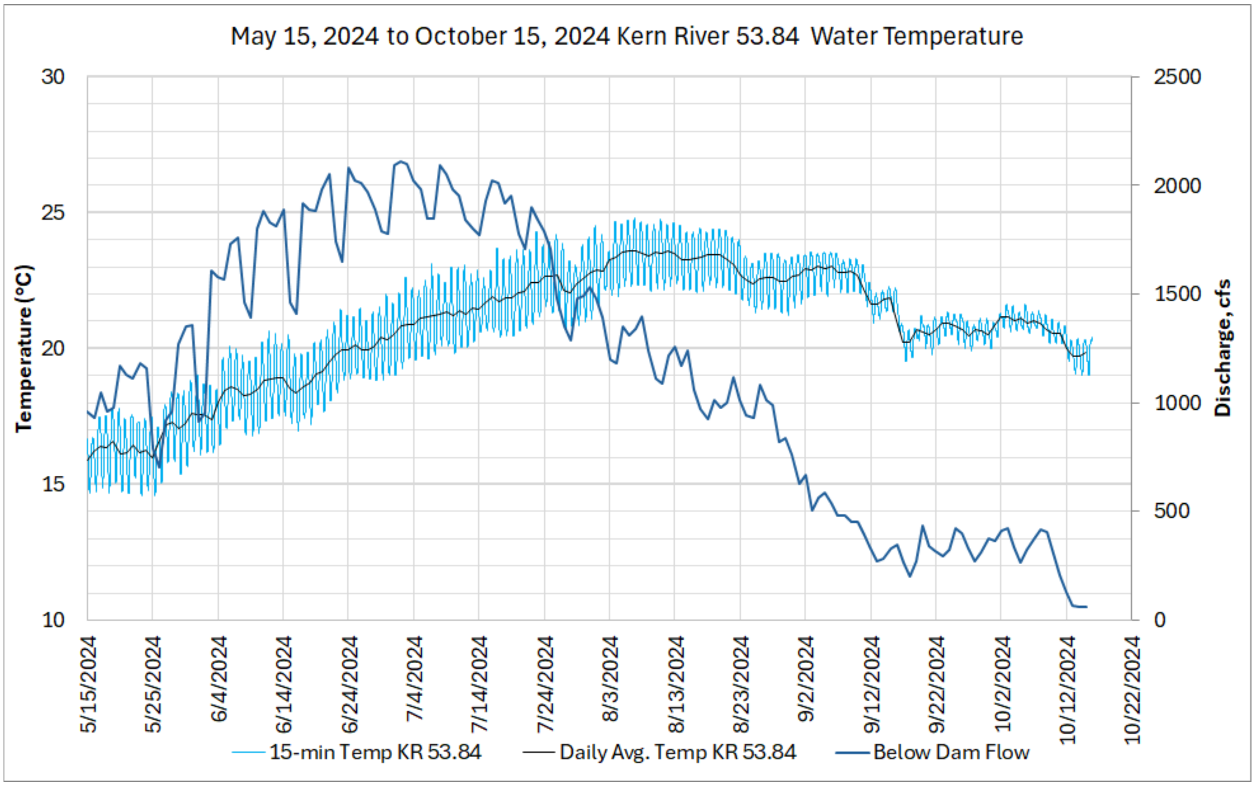

Figure 5-5. Kern River near USGS gage 1192500; below Democrat Dam, KR 53.84 Water Temperature and Daily Mean Discharge

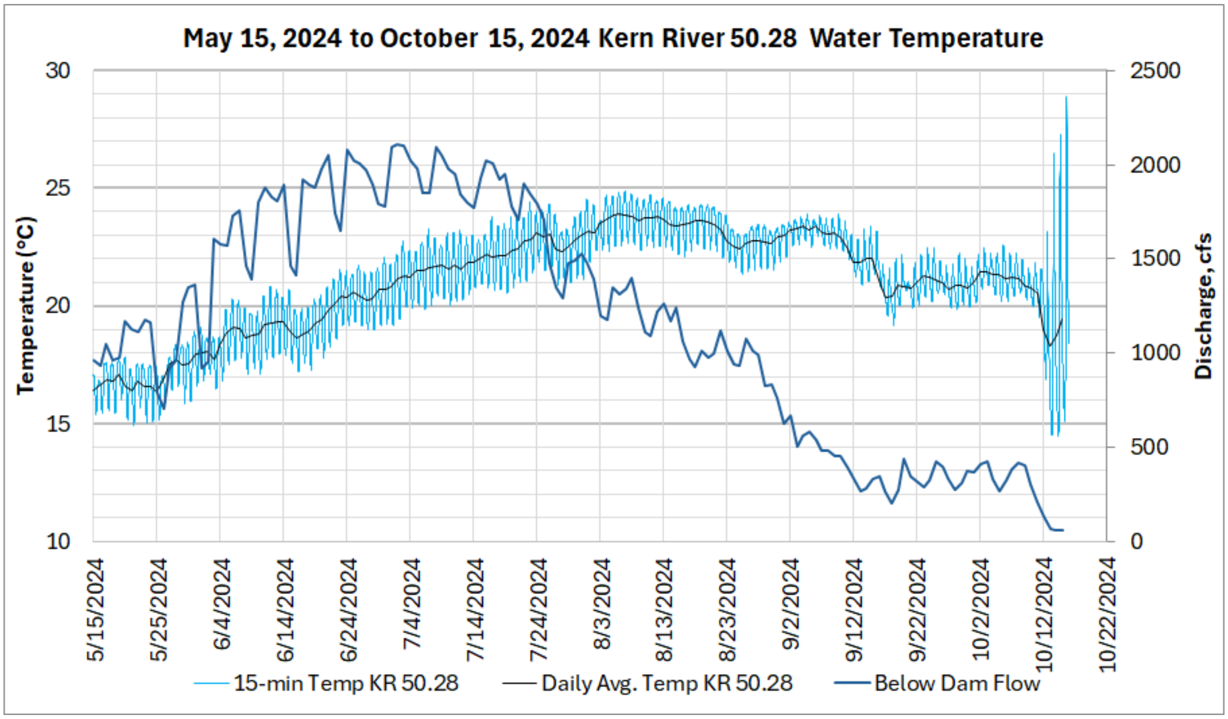

Figure 5-6. Kern River near Lucas Creek, KR 50.28 Water Temperature and Daily Mean Discharge

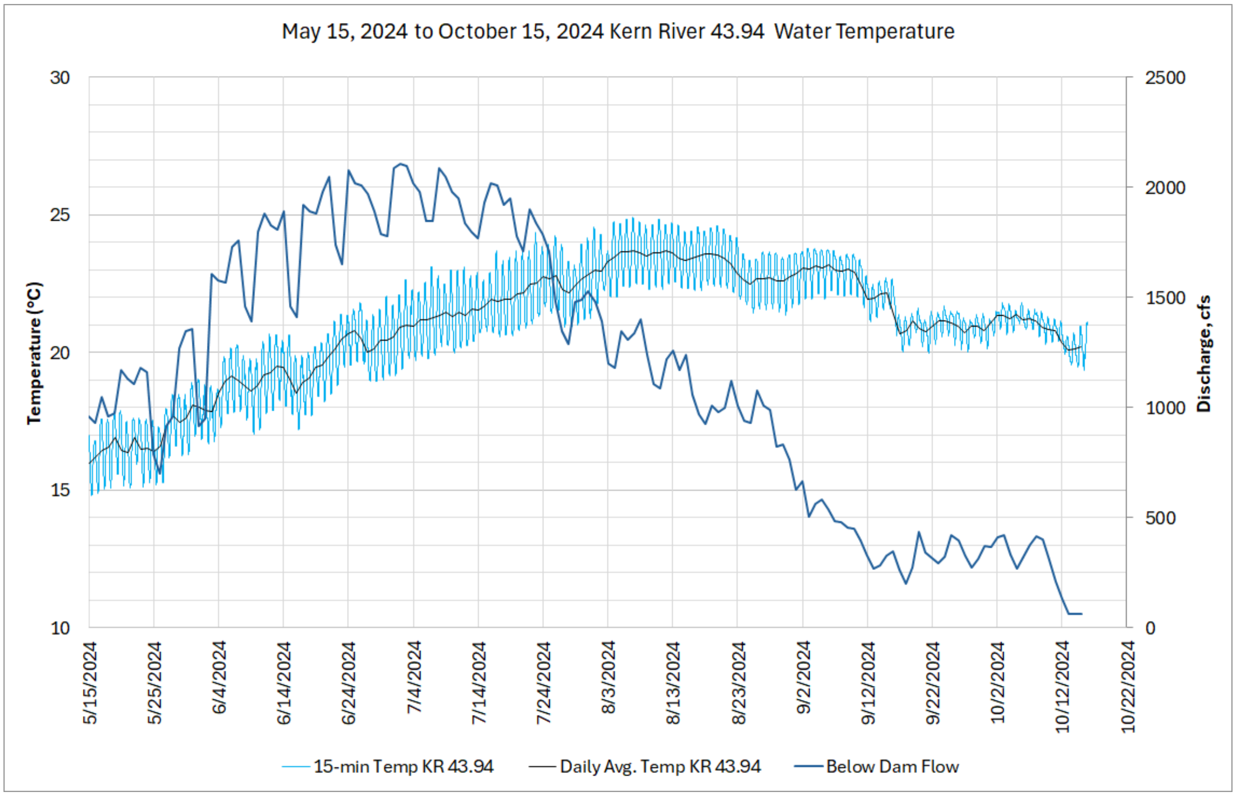

Figure 5-7. Kern River No. 1 Powerhouse Tailrace, KR 43.94 Water Temperature and Daily Mean Discharge

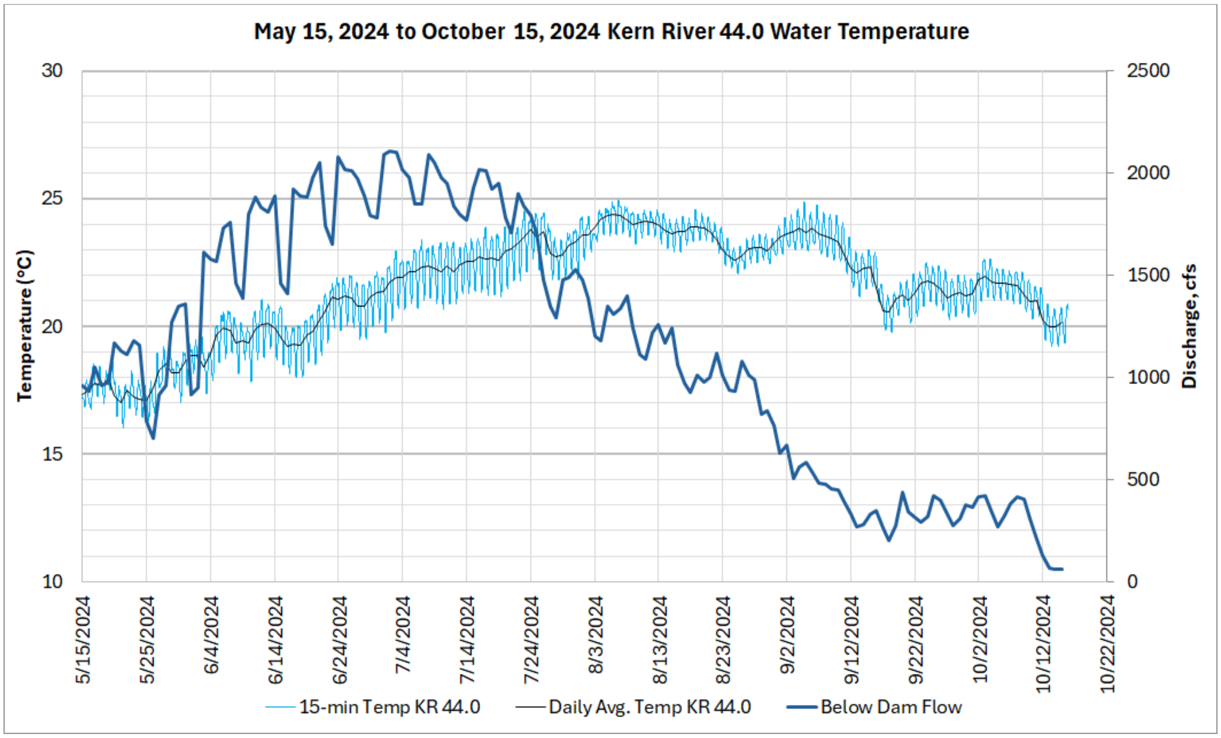

Figure 5-8. **Kern River upstream of Kern River No. 1 Powerhouse, Site KR 44.0 Water Temperature and Daily Mean Discharge**

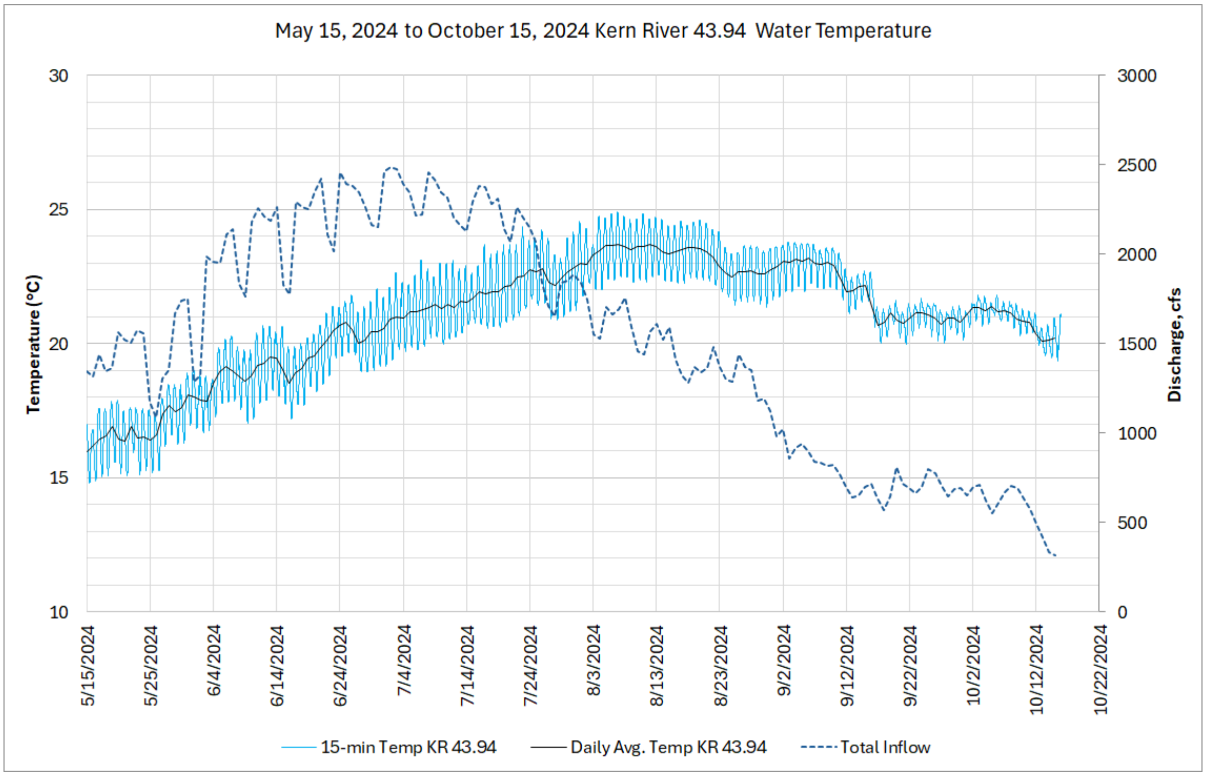

Figure 5-9. **Kern River downwnstream of Kern River No. 1 Powerhouse, Site KR 43.94 Water Temperature and Daily Mean Discharge**

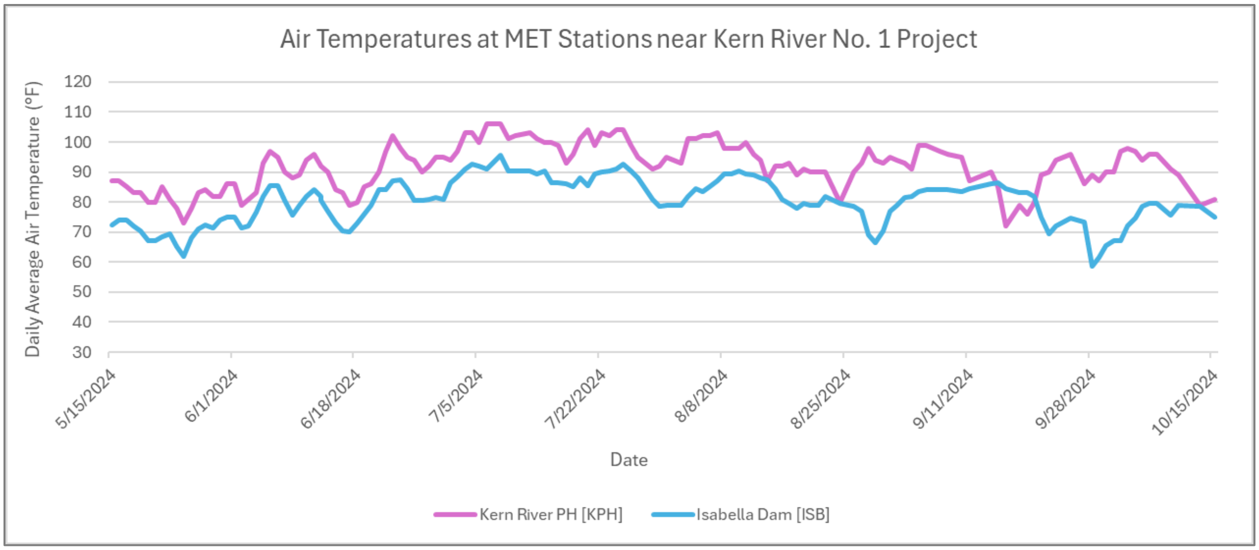

Figure 5-10. Meteorological Station (MET) Data (Daily Average Air Temperature) in the Project Area (Kern River [KPH], Isabella Dam [ISB])

APPENDIX A

Description Water Quality Parameters

TABLE OF CONTENTS

Page

1.0 WATER QUALITY MONITORING PARAMETER

1.1 IN-SITU MEASUREMENTS

1.1.1 TEMPERATURE

Ambient water temperature is a measurement of the intensity of heat stored in a volume of water and is generally reported in degrees Celsius (°C) or Fahrenheit (°F). Natural heat sources include solar radiation, air transfer, condensation of water vapor at the water surface, sediments, precipitation, surface runoff, and groundwater. Anthropogenic sources of heat include industrial effluents, agriculture, forest harvesting, decreases in streamside vegetation coverage, urban development, and mining.

Water temperature has important effects on aquatic biota. Increased water temperature reduces oxygen solubility while elevating metabolic oxygen demand. This causes lower oxygen concentrations that may be detrimental to some aquatic organisms. Reproductive and other biological activities, such as migration, spawning, egg incubation, and fry rearing, are often triggered by water temperature. A rise in water temperature can also provide conditions for the growth of disease-causing organisms. Temperature also influences the solubility of many chemical compounds, thus affecting their toxicity to aquatic life (EPA 1986, MELP 1998).

1.1.2 DISSOLVED OXYGEN (DO)

Dissolved oxygen (DO) is a measure of the amount of oxygen dissolved in water. Values for DO in water analyses are commonly provided in mg/L, although a percentage of saturation may also be used. The concentration of DO in surface water is usually less than 10 mg/L (MELP 1998). The actual concentration will vary with other parameters such as temperature, elevation, photosynthetic activity, biotic activity, stream discharge, and the concentration of other solutes (Hem 1989, Michaud 1994). The maximum solubility of oxygen (fully saturated) at sea level is 12.75 mg/L at 5^{o}C and 8 mg/L at 25^{o}C. DO concentrations decrease within increasing temperatures or elevation (MELP 1998).

Dissolved oxygen is derived from the atmosphere and photosynthetic production by aquatic plants. Atmospheric oxygen is changed to dissolved oxygen when it enters the water, with more mixing occurring in turbulent waters. Dissolved oxygen is essential for the respiration of fish and other aquatic organisms (Michaud 1994). As water moves past their breathing apparatus (such as gills in fish), oxygen gas bubbles in the water (DO) are transferred from the water to their blood. The transfusion is efficient only above certain concentrations. Oxygen is also used for the decomposition of organic matter and other biological and chemical processes. Anoxic waters have obvious detrimental effects on aerobic organisms. These conditions can also lead to the accumulation of chemically reduced compounds, such as ammonium and hydrogen sulfide, in the bottom sediments that can be toxic to benthic organisms (Michaud 1994).

Nutrient solubility and availability rely partly on DO levels, and thus DO also affects the productivity of aquatic ecosystems. In streams, DO concentrations tend to be higher in faster moving waters. During the summer, in particular, when discharges and velocities decrease in streams, DO concentrations can be quite low. Pollution can cause decreases in average DO concentrations by contributing organic matter that uses oxygen or nutrients and stimulates the growth of algae.

1.1.3 CONDUCTIVITY

Conductivity is a measurement of the ability of water to conduct an electric current and provides an estimate of the concentration of dissolved solids. This property is related to water temperature and total ion content (e.g. chloride, sulfate, sodium, and calcium), and depends on the concentration of dissolved metals and other dissolved materials. Water carries more current with increased ion content in the water. Conductivity is lower in cooler waters. Conductivity is measured in terms of resistance and reported in microsiemens per centimeter (μm/cm) at 25°C. Water source and geologic composition of the watershed are important controlling factors of conductivity. Streams that flow through granite bedrock, for example, have lower conductivity than those that flow through limestone or clay soils. The conductivity of pure waters is 0.055 μS/cm. The conductivity of freshwater at 25°C varies between 50 and 1,500 μm/cm (Hem 1989, MELP 1998). Conductivity measurements in streams flowing through granitic, siliceous, or other igneous rocks usually range between 10 and 50 μS/cm. In comparison, it generally ranges between 150 and 500 μS/cm in streams that are flowing through limestones. Conductivity itself is not an aquatic health concern, but serves as an indicator of other water quality concerns.

1.1.4 PH

A pH value is a measure of the activity of hydrogen ions in a water sample. Various types of chemical reactions that occur in natural waters produce hydrogen ions, which are then consumed by participating in subsequent chemical reactions in the system. These interrelated chemical reactions that produce and consume hydrogen ions control the pH value of a water body. It is a useful index of the status of equilibrium reactions in which the water participates. A pH of 7 is considered neutral, values less than 7 are acidic, and values greater than 7 are basic. The units of pH are logarithmic; so a difference of one unit represents a 10-fold change in hydrogen ion concentration. The higher the pH, the fewer free hydrogen ions are present in the water. The pH of natural fresh waters ranges from 4.0 to 10.0, with most waters falling between 6.5 and 8.5 (EPA 1986, Hem 1989, MELP 1998).

The pH of water determines the solubility (the amount that can be dissolved in water) and biological availability (the amount that can be used by aquatic biota) of chemical constituents, such as nutrients (e.g. carbon, nitrogen and phosphorus) and heavy metals (e.g. lead, copper). Unusually high or low pH can have adverse effects on aquatic biota. Values above 9.5 and below 4.5 are considered lethal to aquatic organisms (EPA 1996, MELP 1998). For heavy metals, the degree to which they are soluble determines their toxicity. They tend to be more toxic when pH is lower because they are more soluble and bioavailable.

The pH of water is naturally variable, although the amount of change in natural waters tends to be very small due to many chemical reactions. This ability of the water to maintain a stable pH is called buffering capacity. The initial pH of water is influenced by the geology of the watershed and the original source of the water. In particular, alkalinity, which is typically low in granitic drainages, is usually the primary factor that influences pH values. This causes the waters to be more acidic (pH <7.0) in these types of watersheds (Wetzel 2001). The greatest natural cause for variation is the daily and seasonal changes in photosynthesis. Photosynthesis uses up hydrogen molecules and therefore increases the pH. The pH increases during the day (with maximum values up to 9.0) and decreases at night. Respiration and decomposition processes lower pH. The pH also tends to be higher during the growing season when photosynthesis is greater. As a result, most streams that drain coniferous forests tend to be slight acidic (6.5 to 6.8) (Hem 1989, Michaud 1994, Wetzel 2001).

2.0 LABORATORY ANALYSIS PARAMETER

2.1 GENERAL PARAMETERS

2.1.1 NITRATE/NITRITE

Nitrate (NO_3^-) and nitrite (NO_2^-) ions are produced during nitrification of reduced and organic forms of nitrogen. Nitrate and nitrite are typically reported in mg/L or µg/L. Nitrite is usually present in only minute quantities in water (<0.001 mg/L) because it in an intermediate, unstable form of nitrogen within the nitrogen cycle (MELP 1998). It is formed from nitrate or ammonium ions by certain microorganisms found in soil and water (EPA 1986). Nitrate is formed by the complete oxidation of ammonium by microorganism in the soil and water. It is the most oxidized and stable form of nitrogen in water, and therefore is the principle form of combined nitrogen. Most surface waters contain less than 0.01 mg/L of nitrite and less than 0.2 mg/L nitrate (MELP 1998, Wetzel 2001).

Nitrate is the primary form of nitrogen used during plant growth. Excessive amounts of nitrate may cause phytoplankton or macrophyte outbreaks. Nitrite is toxic to aquatic life at relatively low concentrations (MELP 1998). Although it is an essential plant nutrient, excessive nitrogen can cause proliferation of algae and macrophytes, resulting in eutrophic water conditions. Eutrophication causes decreased oxygen levels which may cause stress or mortality of fish and invertebrates (EPA 1986). Sources of elevated nitrate and nitrite come from municipal and industrial wastewaters, agricultural runoff, urban development, and automobile exhausts.

2.1.2 AMMONIA

Ammonia is found in two forms, ammonium (NH_4^+) that is not toxic and NH_3, which is (EPA 1986). Ammonium is readily adsorbed onto mineral surfaces (Hem 1989). It is reported as mg/L or µg/L, with typical surface water values less than 0.1 mg/L (MELP 1998, Wetzel 2001). Ammonia as NH_3 is reported to be toxic to various aquatic organisms over a range of concentrations (0.53 to 22.8 mg/L) (Oram 2007).

Complex nitrogen cycling and processes occur within aquatic systems. Nitrogen is an essential plant nutrient which contributes to the productivity of a water body. However, excessive ammonia over-stimulates the growth of algae and other plants, leading to eutrophication of a water body. The resulting decrease of oxygen levels may cause stress and mortality of fish and invertebrates (EPA 1986). High ammonia concentrations are also toxic to aquatic life. The specific concentration at which ammonia is harmful to organism depends upon the temperature and pH of the water. At higher temperatures and pH, a greater proportion of the total ammonia is present as NH_3, increasing the toxicity of the water (EPA 1986). The distribution of ammonia in surface waters varies spatially and seasonally depending upon productivity and the amount of organic matter. Anthropogenic sources of ammonia include fertilizers, livestock wastes, residential effluents (e.g. cleaning products), mining, sewage treatments plans, and effluent from various types of industries (Oram 2007).

2.1.3 TOTAL KJELDAHL NITROGEN

Total kjeldahl nitrogen (TKN) is a measure of both the ammonia and organic forms of nitrogen. Organic nitrogen includes organic compounds, such as proteins, polypeptides, amino acids, and urea. TKN is reported in mg/L or µg/L (MELP 1998). In Sierra Nevadan rivers and streams, TKN values typically range between 0.025 and 0.65 mg/L (EPA 2000).

High ammonia concentrations can be deleterious to aquatic life, as it contributes to the eutrophication of water bodies. Organic nitrogen is not biologically available. As a result, it does not influence plant growth or water quality condition until it is transformed to the inorganic forms of nitrogen (MELP 1998). Natural sources of TKN include decaying organic material such as plants and animals wastes. Some species of streamside vegetation, such as alders, are nitrogen fixers. Elevated nitrogen concentrations have been measured in waters with decaying alder leaves (Wetzel 2001). Anthropogenic sources of TKN include effluents from sewage treatment plants and industry, agriculture (fertilizers), urban developments, paper plants, recreation, and mining.

2.1.4 TOTAL PHOSPHORUS

Phosphorus (P) is a nutrient that is essential for growth, and is a measure of both organic and inorganic forms of phosphorus. It can be measured as total phosphorus or ortho-phosphate. Total phosphorus is the total amount of phosphorus in the sample. Ortho-phosphate is the portion that is available to organisms for growth. Total phosphorus measurements include phosphorus that is in biological tissue, as well as the insoluble mineral particles (Michaud 1994, MELP 1998). Phosphorus is fairly abundant in sediments, but concentrations are usually less than a few tenths of a milligram per liter in surface waters (Hem 1989). Total phosphorus concentrations in the rivers and streams in the Sierra Nevada typically range between 2.5 and 485 µg/L (EPA 2000). It is usually reported in µg/L or mg/L.

Phosphorus is essential for plant growth and is often the most limiting nutrient for plant growth in surface waters. As a result, inputs of phosphorus into surface waters can cause algal blooms. Anthropogenic sources of phosphorus include effluents from sewage treatment plants and industry, agriculture, and urban developments (EPA 1986, Hem 1989, MELP 1998).

2.1.5 ORTHO-PHOSPHATE

Ortho-phosphate (PO_4) is a measure of the inorganic oxidized form of soluble phosphorus. It is generally reported in mg/L or µg/L. Background concentrations of orthophosphate in surface waters generally average 0.01 mg/L (Hem 1989).

Along with nitrogen, phosphorus is a necessary nutrient for plant growth. Ortho-phosphate is the most readily available form of phosphorus for uptake during photosynthesis. Animals obtain phosphorus through the consumption of plant materials. Excess ortho-phosphate causes prolific algal growth, causing the same detrimental water conditions as described for nitrogen and total phosphorus (MELP 1998). Since phosphorus is typically the most limiting nutrient for plant growth in fresh water, additions of this element are often the primary causes of eutrophication of water bodies. Phosphate ions readily and strongly adsorb onto soils, suspended solids, and streambed sediments. As a result, soil erosion can be a source of ortho-phosphate. Other sources include agricultural, urban, and industrial wastewater effluents.

2.1.6 TOTAL DISSOLVED SOLIDS

Total dissolved solids (TDS) is a measure of the concentration of inorganic salts (e.g. sodium, chloride, potassium, calcium, magnesium, and sulfate), small amounts of organic material, and dissolved materials in the water column and is reported in mg/L. The value of TDS in fresh water naturally ranges from 0 to 1,000 mg/L (EPA 1986, MELP 1998). Concentrations tend to be comparatively low in streams in granitic and sandstone-dominated watersheds than watersheds with abundant limestone.

The effect of elevated TDS levels on aquatic biota depends on the ionic composition of the dissolved material and the extent of the increase in concentration. Under natural conditions, all aquatic life must be able to survive a range of TDS concentrations (EPA 1986). Sources of total dissolved solids include sewage, stormwater and agricultural runoff, salts from roads, and industrial and water treatment plant wastewater discharges. Total dissolved solids can also be derived from natural sources, including carbonate and salt deposits and mineral springs.

2.1.7 TOTAL SUSPENDED SOLIDS

Total suspended solids (TSS) is a measurement of particulate matter suspended in the water column and is typically reported in mg/L (MELP 1998). Nephelometric Turbidity Units (NTUs) correspond approximately to TSS concentrations. Total suspended solids fluctuate with stream flow and may increase significantly during snowmelt and runoff from rain events. Streams in forested watersheds tend to have low TSS concentrations, usually less than 50 mg/L, although concentrations can be naturally much higher in some streams and rivers (Windell 1992). Waters with TSS concentrations less than 20 mg/L are usually considered to be clear. Concentrations between 40 and 80 mg/L are considered to be cloudy. Waters with concentrations greater than 150 mg/L appear dirty.

High TSS concentrations can increase turbidity, resulting in reduced light penetration, reduced primary productivity, damage to fish gills, and impaired fish feeding ability. Once the suspended solids settle on the stream or lake bottom, invertebrate and other benthic organisms and fish spawning can be adversely affected (EPA 1986).

The freshwater aquatic life criterion for TSS set forth in the EPA's *Quality Criteria for Water* (1976) states that 'settable and suspended solids should not reduce the depth of the composition point for photosynthetic activity by more than 10 percent from the seasonally established norm for aquatic life.' In other words, light penetration should not be decreased more than 10 percent.

2.1.8 TOTAL ALKALINITY (AS CACO3)

Alkalinity is a measurement of the ability of water to neutralize acids (buffering capacity). Alkalinity is the concentration of bases in dissolved in water. These bases are usually carbonate and bicarbonate, but can also be hydroxides. These buffers are important because they slow the rate at which the pH changes. The pH can change naturally as a result of photosynthetic activity of the aquatic vegetation. When the pH is very high (greater than 9) hydroxide ions may also be present. In addition, carbonate and bicarbonate reduce the toxicity of some toxic heavy metals (EPA 1986, Hem 1989, Wetzel 2001). Alkalinity is typically expressed as an equivalent amount of calcium carbonate ($CaCO_3$) in mg/L and generally ranges from 0 to 500 mg/L in fresh waters (MELP 1998). Alkalinity levels up to 400 mg/L are not considered to be detrimental to human health (EPA 1986). Alkalinity values less than 10 mg/L are considered very low and the pH of these waters is very susceptible to acid inputs. Alkalinity values are often very low in granitic drainages (Wetzel 2001). Values between 10 and 20 mg/L are considered moderately susceptible to acid inputs.

In general, very low or high alkalinity itself does not cause detrimental effects to aquatic organisms. However, the concentration of the dissolved materials (alkalinity) and their ratio to one another determines the actual pH and buffering capacity in a given water system (EPA 1986, Wetzel 2001). Waters with very low alkalinity values have little capacity to buffer acid inputs and are thus susceptible to acidification (MELP 1998). As previously discussed, extreme pH values can adversely affect aquatic biota, particularly in low pH (acidic) waters. Acidified drainage basins are known to possess increased sulfate and dissolved aluminum concentrations, as well as significant changes in the ion species and ratios (Wetzel 2001). In some inland waters of extremely high salinity, hydroxide, borate, silicate, phosphate, and sulfide may be the major sources of alkalinity (Wetzel 2001). Relatively few aquatic organisms are adapted to these unusual conditions.

2.2 METALS DISSOLVED

2.2.1 ARSENIC

Arsenic (As) is a widely distributed element in the Earth's crust (ATSDR 2007). It is highly volatile and is an important component in many biochemical processes (Hem 1989). In its elemental form, it appears as a metal-like substance but it is usually found in compounds with other elements and appears as white or colorless powder. Inorganic arsenic results from compounds with elements such as oxygen, chlorine, or sulfur. Organic arsenic results from compounds with hydrogen and carbon. Organic arsenic is generally less harmful than inorganic arsenic (ATSDR 2007). Arsenic is measured in µg/L or mg/L. Natural surface water normally contains an arsenic concentration of about 1 µg/L.

Arsenic can be highly toxic to most organisms in excess concentrations. Concentrations above 5 µg/L have been shown to reduce growth and reproduction in aquatic invertebrates and algae (MELP 1998). Concentrations of 550 µg/L have produced mortality in fish (MELP 1998). In addition, organic arsenic can bioaccumulate in fish and shellfish (ATSDR 2007). Concentrations above 25 µg/L can have negative effects on livestock and, therefore, are potentially toxic to wildlife (MELP 1998). Arsenic is used as a preservative for wood, and is used in pesticides, metal alloys (especially in automobile batteries), and semiconductors and light diodes. Anthropogenic sources of arsenic include coal-fired power plants, industrial water discharge, and agricultural runoff (Hem 1989). It occurs naturally in soil and can enter water from wind-blown dust, runoff, and leaching. Volcanoes are another natural source of arsenic (ATSDR 2007).

2.2.2 CADMIUM

Cadmium (Cd) is an element that occurs naturally in the environment. It is usually found combined with other elements, such as zinc and lead rather than occurring as a pure metal (MELP 1998, ATSDR 1999). It can be measured in either the dissolved (as in this study) or in the total state in water. It dissolves in water at varying degrees depending on which other elements it is combined. Cadmium most easily dissolves in water when it is in a compound with chlorides and sulfates. These compounds are usually present only in small amounts in the environment (ATSDR 1999). It is reported in mg/L or µg/L. It usually found in very small concentrations (less than 0.1 µg/L) (Wetzel 2001).

Cadmium has highly toxic effects on aquatic plants and animals in all chemical forms. It is extremely toxic to fish and zooplankton, and has been found to accumulate in plant cells and some aquatic organisms. It also diminishes plant growth. Its toxicity increases with the presence of other metals, including zinc and copper (MELP 1998, Oram 2007). The majority of cadmium is released into the environment from natural sources, primarily from the weather of rocks that naturally contain various amounts of cadmium. In addition, it can be releases into the environment by forest fires and volcanoes. Anthropogenic sources of cadmium include industrial effluents, fossil fuels burning, and mining (ATSDR 1999).

2.2.3 COPPER

Copper (Cu) is a metallic element, which can occur as a free native metal or combined with ionic metals (Hem 1989). It is measured in either the total or dissolved state in water samples, and reported in µg/L or mg/L. Copper is typically found in trace concentrations from 1 to 10 µg/L (MELP 1998) and levels near 10 µg/L are common in river water (Hem 1989). The fresh water aquatic life criterion for copper depends on the hardness of the water body being tested. Copper toxicity decreases with increasing hardness and increases with increasing pH (EPA 1986, Wetzel 2001).

Copper is an essential element in plant and animal metabolism, but quantities above normal trace concentrations are highly toxic to most aquatic life forms (MELP 1998). Many of the deleterious effects of copper, such as inhibition of phosphorus uptake in green algae, are highly variable depending on other environmental conditions such as pH, alkalinity, total organic carbon, and water hardness (EPA 1986, Wetzel 2001). Copper may be released during industrial, agricultural, and mining activities. Other common sources include copper plumbing and equipment (Hem 1989, MELP 1998).

2.2.4 IRON

Iron (Fe) is the second most abundant metallic element in the Earth's outer crust, but concentrations in water tend to be small (Hem 1989). Iron can be measured in either the total or dissolved state and reported as µg/L or mg/L. Average iron concentrations of 40 µg/L are found in the world's lake and rivers. The typical amount found in neutral and alkaline surface waters ranges from 0.05 to 0.20 mg/L (Wetzel 2001), with an average of 0.16 mg/L in surface waters in North America (Schlesinger 1997). High concentrations of iron are generally only found in acidic waters (pH less than 3 to 4), such as in runoff of streams from strip mines (Wetzel 2001). Concentrations of iron above 0.3 mg/L cause undesirable taste, and when precipitated out of solution due to oxidation, cause a reddish brown color to the water.

Iron is an essential element in plant and animal respiration and its availability in lakes and streams can limit photosynthetic productivity (Wetzel 2001). The chemical behavior of iron is highly dependent on oxidation intensity and is a function of pH and temperatures (Hem 1989, Wetzel 2001). Iron is released in sediment when igneous rock minerals are broken down by water. Iron is also present in organic matter in soils and can be processed into surface water through oxidation and reduction activities that often involve microorganism (Hem 1989). Industrial effluent, acid mine drainage, and smelters are also sources of iron (MELP 1998).

2.2.5 LEAD

Lead (Pb) is a metallic element, which is widely dispersed in sedimentary rocks, but has low natural mobility due to low solubility (Hem 1989). The criterion for lead is expressed in terms of dissolved metal in the water column (MELP 1998). Lead concentration is reported in µg/L. The relative abundances of different species of lead are pH dependent and solubility increases with increasing alkalinity (EPA 1986). The freshwater aquatic life criterion for lead depends on the hardness of the water body being tested. The toxic effects of lead decreases as DO and hardness concentrations increase (MELP 1998).

Lead is toxic to all animals (MELP 1998) and is particularly toxic to aquatic organism at relatively low concentrations (Wetzel 2001). Fossil fuel combustion, especially of leaded gasoline, contributed greatly to the deposition of lead in waterways in the twentieth century. Other sources of lead include industrial effluent, smelting and refining, batteries, and lead pipe used to transport drinking water (Wetzel 2001).

2.2.6 MANGANESE

Manganese (Mn) is one of the more abundant metallic elements, although there is only one-fiftieth the amount of manganese in the Earth's crust as there is iron (Hem 1989). It does not naturally occur as a metal, but is found in association with various salts and minerals, often with iron compounds (EPA 1986). Its chemical reactivity is very similar to that of iron and they behave much the same way in freshwater systems (Wetzel 2001). It is a minor constituent of many igneous and metamorphic minerals (Hem 1989). It can substitute for iron, magnesium, or calcium in silicate structures, but it is not an essential element of silicate rock minerals (Hem 1989). Small amounts of manganese are often present in dolomite or limestone as a substitute for calcium. The average concentration of manganese in surface waters is about 35 µg/L (Wetzel 2001). It is rarely found in surface waters at concentrations greater than 1 mg/L (EPA 1986).

Manganese is an essential nutrient for microflora, plants, and animals as an enzyme catalyst and as an important component of photosynthesis and nitrogen fixation (EPA 1986, Hem 1989). High concentrations of manganese can have an inhibitory effect on cyanobacteria and green algae and tend to favor diatom growth (Wetzel 2001). Divalent manganese is released into aqueous solution during weathering of rock and through organic processes (Hem 1989).

2.2.7 NICKEL

Nickel (Ni) is one of the five ferromagnetic elements. It only occurs as a very small fraction (0.018 percent) in the Earth's crust (HSDB 2007). It can be combined with various other metals, including iron, copper, chromium, and zinc, and may substitute for iron in igneous rocks. Nickel also may be precipitated with iron oxides and manganese oxides (Hem 1989, ATSDR 2005). In addition, nickel can also be combined with other elements, most commonly sulfur, and oxygen. Many of the compounds containing nickel easily dissolve in water (ATSDR 2005). Concentrations in natural surface waters are usually low (10 µg/L, Hem 1989).

Nickel is an essential element in some enzymes found in bacteria and plants. It is an important component in nitrogen fixation and some enzymes (Wetzel 2001). However, when it occurs in large quantities and is combined with some elements, for example nitrate, sulfur, and chloride, nickel can be very toxic to aquatic biota. It may accumulate in some plants (ATSDR 2005). The toxicity of nickel to aquatic biota is dependent on hardness. Toxicity is greater when the water is softer compared to harder water conditions. It can also be released from volcanoes. Nickel is naturally found in all soils, and strongly attaches to particles that contain iron or magnesium. When this occurs, it is not readily available for uptake by plants and animals. Nickel is found in surface waters as a result of weathering of rocks containing nickel. Anthropogenic sources of nickel include industrial effluent, oil-burning and coal-burning power plants, mining, and trash incinerators (ATSDR 2005).

2.2.8 CHROMIUM

Chromium (Cr) is naturally present in the environment and has a number of oxidation states. The most common forms are chromium (0), trivalent (chromium (III)), and hexavalent (chromium (VI)). Hexavalent chromium (chromium VI) compounds are the most toxic state. It is usually measured as total chromium. Naturally, chromium concentrations in surface water are usually less than 10 µg/L (Hem 1989).

Chromium (VI) compounds adversely affect all aquatic biota, including algae. It does not appear to bioaccumulate in plants and animals. It is also a known human carcinogen (EPA 1986). The toxicity of chromium (VI) increases as hardness and pH increase. Chromium (III) is more toxic in soft waters. Chromium naturally occurs in rocks and soil, but in very small amounts. It is also released during volcanic eruptions. Anthropogenic sources of chromium (0), (III) and (VI) include emissions from coal and oil burning and industrial effluents (ATSDR 2000).

2.3 METALS - TOTAL

2.3.1 MERCURY

Mercury (Hg) is a trace element in the Earth's crust that normally occurs in quantities of only 1 to 2 ng/L in natural waters (MELP 1998). It may be present in the environment as elemental mercury (Hg^0), inorganic mercury (Hg^{2+}), or organic mercury (primarily methyl mercury, MeHg). Elemental mercury was commonly used in thermometers. Methyl mercury is the most toxic of these mercury compounds (EPA 1986). It is a serious neuron-toxin and has been found in high concentrations in lakes far removed from sources of mercury (EPA 1986). Methyl mercury bioaccumulates, which is the process by which organisms that are exposed to chemicals either from their diet, water, or other sources accumulate and retain the chemicals. Inorganic mercury does not accumulate in aquatic organisms. Various chemical and biological processes can readily convert the various forms of mercury. Anaerobic bacteria in sediments readily convert inorganic mercury into methyl mercury. With the exception of gold mining areas where elemental mercury is used, mercury is typically present in surface waters, sediment, or soils as inorganic mercury.

Mercury is highly toxic and has a long retention time in animal cells. Rates of methyl mercury production and bioaccumulation depend not only on the abundance of inorganic mercury but also on a complex assortment of environmental variables which affect the activities and species composition of the bacteria and the availability of the inorganic mercury for methylation (USGS 2003, HSDB 2007). These variables include, but are not limited to, pH of the water, the length of the food chain, dissolved organic matter, soil type, and the proportion of wetlands in the watershed. Once converted to methyl mercury by bacteria, it can bioaccumulate in aquatic organisms and be passed up the food chain (Hem 1989). Temperature, pH, alkalinity, suspended sediment load, and the geomorphology of the watershed are known to affect the accumulation of mercury in fish (Klasing et al. 2006). In addition to bioaccumulating, methyl mercury also biomagnifies (higher concentrations at higher levels in the food chain) (USGS 2003). Because bacteria mediate the rate of methyl mercury formation, fish living in even mildly contaminated waters are not safe to eat.

Detectible levels of mercury are found in almost all fish, with more than 95 percent of it occurring as methyl mercury (Klasing et al. 2006). People primarily become exposed to methyl mercury by consuming fish (Klasing et al. 2006). Fish at the highest trophic levels (higher up the food chain) tend to have higher levels of methyl mercury than those lower in the food chain. Larger and older fish of a given species also tend to have higher methyl mercury levels than smaller and younger fish of the same species. It is particularly toxic to the fetus and young children and can cause serious neurological abnormalities to a fetus even without symptoms in the mother. Recent studies indicate that the fetus is more sensitive to methyl mercury than adults. As a result, the Office of Environmental Health Hazard Assessment has established separate 'reference doses', which is "the daily exposure likely to be without significant risk of deleterious health effects during a lifetime". The reference dose for women of childbearing age and children aged 17 and younger is 1×10^{-4} mg/kg-day. For men and women beyond childbearing age, the reference dose is 3×10^{-4} mg/kg-day (Klasing et al. 2006).

Mercury contamination can occur from both natural processes and human activities. Mercury is highly volatile and thus, atmospheric deposition is a major pathway into aquatic systems (Hem 1989, MELP 1998). Impounded water and flooding also cause the release of sedimentary mercury (MELP 1998). Sources of mercury contamination include coal combustion, waste incineration, mining and smelting, and production of fertilizers (MELP 1998, USGS 2003). Mercury is typically measured as the total mercury in water, soil, or tissue samples. Water samples containing just 5 to 10 ng/L are considered polluted (MELP 1998).

2.4 BACTERIA

2.4.1 TOTAL COLIFORM

Coliform bacteria are a group of several genera of relatively harmless microorganisms that live in soil, water, and the intestines of cold- and warm-blooded animals including humans (Murphy 2007). Total coliform concentrations are reported as the most probable number of bacteria colonies present per 100 milliliter (mL) of sample water (Michaud 1994).

Total coliform bacteria occur naturally in surface and shallow ground waters and are essential in the breakdown or organic matter in water. Oxygen is not a requirement for these bacteria, but they can use it. They produce acid and gas from the fermentation of lactose. Coliform bacteria are not pathogenic and are only mildly infectious. The total coliform group is relatively easy to culture in the lab, and therefore, has been selected as the primary indicatory bacteria for the presence of disease-causing organisms. If large numbers of coliform bacteria are found in water, there is a high probability that pathogenic bacteria or organisms, such as Giardia may be present. Coliform bacteria, rather than actual pathogens, are used to assess water quality because they are easier to isolate and identify (Murphy 2007).

2.4.2 FECAL COLIFORM

Fecal coliform is a subgroup of the coliform bacteria that live in the intestinal tract and feces of warm-blooded animals (Murphy 2007). The most common member of this group is *Escherichia coli* (*E. coli*). Fecal coliform concentrations are reported as the number of bacteria colonies present per 100 mL of sample water (#/100 mL, Michaud 1991). Fecal coliform bacteria can multiply quickly under optimum growing conditions and die off rapidly when conditions change. For this reason, fecal coliform counts are difficult to predict (Michaud 1994).

Fecal coliform species by themselves are not usually harmful, but are an indicator of the possible presence of pathogenic organisms, such as bacteria, viruses, and parasites, that live in the same environment (Windell 1992; Murphy 2007). Thus, it is used as a parameter for testing the quality of waters used for recreation. The presence of fecal coliform indicates contamination from the feces of humans or other animals. Swimming in waters with high levels of fecal coliform bacteria (over 200 colonies/100 mL) presents a health risk of contracting diseases such as typhoid fever, hepatitis, gastroenteritis, ear infection, and dysentery (Windell 1992; Murphy 2007). Some strains of *E. coli*, such as *E. coli* O157:H7, which is found in the digestive tract of cattle, can cause intestinal illness. The major sources of fecal coliform to freshwater are wastewater treatment plant effluent, failing septic systems, and human and animal wastes. Human and animal wastes can be washed into storm drains, streams, and lakes during storms (Michaud 1994; Murphy 2007).

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APPENDIX B

Quality Assurance/Quality Control Review of Spring and Fall 2024 Sample Laboratory Analyses

Table B-1. Quality Assurance/Quality Control Review of Spring and Fall 2024 Sample Laboratory Analyses

	Spring Sampling		Fall Sampling			
Report ID	ZALCO: 2406558_rpt	ZALCO: 240585_rpt	ZALCO: 2410259_rpt	ZALCO: 2410283_rpt	BSK: AHJ3600	BSK: AHJ3577
Sample Locations	KRTR 43.94 KR44.0	KR 54.36 KR 55.2 KR 50.84 KR 50.3 KR 54.2	KR 43.94 KR 54.2 KR 53.46 KR 44.0 KR 50.84	KR 50.3 KR 55.2 (surface) KR 55.2 (mid-column)	KR 43.94 KR 54.2 KR 53.46 KR 44.0 KR 50.84	KR 50.3 KR 55.6 (surface) KR 55.6 (mid-column)
ZALCO Sample ID Numbers	2406558-01 2406558-02	2406585-01 2406585-02 2406585-03 2406585-04 2406585-05	2410259-01 2410259-02 2410259-03 2410259-04 2410259-05	2410283-01 2410283-02 2410283-03	2410259-01 2410259-02 2410259-03 2410259-04 2410259-05	2410283-01 2410283-02 2410283-03
Date Sampled	6/26/2024	6/27/2024	10/9/2024	10/10/2024	10/9/2024	10/10/2024
Analysis	General Parameters Dissolved Metals Total Mercury	General Parameters Dissolved Metals Total Mercury	General Parameters Dissolved Metals Total Mercury	General Parameters Dissolved Metals Total Mercury	General Parameters: Ammonia as N Total Kjeldahl Nitrogen	General Parameters: Ammonia as N Total Kjeldahl Nitrogen
Do all samples match COC?	Yes	Yes	Yes	Yes	Yes	Yes
Are Sample Locations correct on COC?	No: KRTR = KRTR 43.94	No: KR 53.84 = KR 50.84 KR 50.28 = KR 50.3 KR 55.6 = KR 55.2	No: KR 55.2 = KR 54.2	No: KR 55.6 = KR 55.2	Yes	Yes
Is sample ID consistent throughout report?	Yes	Yes	Yes	Yes	Yes	Yes

	Spring Sampling		Fall Sampling			
Were all sample holding times met?	Yes	Yes	Yes	Yes	Yes	Yes
Were there any quality control data issues?	No	No	No	No	No	No

KEY: BSK = BSK Associates
ZALCO = ZALCO laboratories