CITY OF
LAKE ELSINORE
DREAM EXTREME

August 2, 2019

The Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE Washington, D.C. 20426

RE: *FERC Docket No. P-14227-003*
Lake Elsinore Advanced Pumped Storage (LEAPS) Project
1. *Comments Regarding Nevada Hydro's Final Report of Impacts of LEAPS Project on Water Quality in Lake Elsinore (Study Requests 4 and 7); and*
2. *Submission of Stillwater Sciences' Peer Review of Final Report of Impacts of LEAPS Project on Water Quality in Lake Elsinore.*

Dear Secretary Bose:

We are writing concerning the Final License Application ("FLA") for the Lake Elsinore Advanced Pumped Storage ("LEAPS") Project, Project No. 14227, submitted by project applicant Nevada Hydro Company ("Nevada Hydro").

As noted in our prior correspondence to the Commission, the City owns the real estate constituting Lake Elsinore which is proposed to serve as the "lower reservoir" for the LEAPS Project.

Earlier this year, Nevada Hydro submitted its "Impacts of the Lake Elsinore Advanced Pumped-Storage (LEAPS) Project on Water Quality in Lake Elsinore Final Report" (hereinafter the "Final Report"). The Final Report addresses water quality impacts to Lake Elsinore as part of Study Requests 4 and 7. (*See* FERC eLibrary Accession No. 20190221-4001[V18 E1 1-Study 4 & 7].)

Following the City's initial review of Final Report, the City retained Stillwater Sciences, Inc. Notably, Stillwater Sciences was a key water quality consultant for the "Iowa Hill Pumped-storage Development" located in Northern California. (FERC Project No. 2101.) The advanced pumped storage project at Iowa Hill was successfully licensed by the Commission but later abandoned by the project applicant, Sacramento Municipal Utility District.

Stillwater Sciences conducted a peer review of the Final Report and found material deficiencies which are detailed in the technical memorandum included as Attachment A to this letter. The City requests that the Commission direct Nevada Hydro to correct the deficiencies found by Stillwater Sciences in Nevada Hydro's "Final Report" on water quality.

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We remain concerned that the applicant's studies routinely downplay and minimize the impacts of the LEAPS Project on Lake Elsinore and the surrounding communities. While the project and the Commission repeatedly refer to Lake Elsinore as a "reservoir," it is not an artificial water body. Lake Elsinore is the largest natural lake in Southern California and should be accorded the respect of a valued natural resource in which technical studies are rigorously reviewed and analyzed. The City will be submitting additional comments as our team continues its review of the FLA.

Thank you for considering our position on these important issues facing the Lake.

Sincerely,

David H. Mann
Assistant City Attorney

cc: Mayor Manos and Members of the City Council
Grant Yates, City Manager
Jim Fargo, FERC (via overnight delivery)
Rexford Wait, Nevada Hydro Company, Inc. (via overnight delivery)

ATTACHMENT A

Stillwater Sciences

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phone 510.848.8098

TECHNICAL MEMORANDUM

DATE: July 15, 2019
TO: David Mann, Leibold McClendon & Mann, P.C.
FROM: Stillwater Sciences
SUBJECT: Peer review of LEAPS project analysis of water quality in Lake Elsinore

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The Nevada Hydro Company filed its Final License Application (FLA) for the proposed Lake Elsinore Advanced Pumped Storage (LEAPS) Project with the Federal Energy Regulatory Commission (FERC Project No. 14227) on October 2, 2017. In response to information needs highlighted by the Santa Ana Regional Water Quality Control Board (RWQCB), a hydrodynamic modeling study was undertaken to assess the impacts of the LEAPS on the water quality of Lake Elsinore (Anderson 2019).

Stillwater Sciences was asked to conduct a peer review of the study to examine methodologies, results, and conclusions drawn related to the following study objectives included in the study plans submitted September 13, 2018 (NHC 2018):

1. quantify effect of LEAPS operation at different lake surface elevations on water quality in Lake Elsinore and identification of lake elevations when significant negative impacts would occur (Study #7);
2. assess impact of pumping, transient storage in the Upper Reservoir, and generation on total N, total P and cyanotoxin concentrations in return flows to Lake Elsinore during operation of LEAPS (Study #4); and
3. evaluate LEAPS design and operational strategies to enhance water quality in Lake Elsinore when compared with current conditions.

We have provided detailed technical comments as an attachment to this memorandum. After a brief overview of the LEAPS project and water quality modeling background, we provide general comments summarizing potential issues related to: documentation of modeling and results; model calibration, validation and uncertainty; water quality and limnology; as well as a summary of additional information needed to address the stated study goals.

1 LEAPS BACKGROUND

As described in the study plan, the LEAPS Project consists of three primary components: (i) Lake Elsinore that serves as the Lower Reservoir and pumped-water supply; (ii) an Upper Reservoir that provides transient storage of water used for generation; and (iii) the turbines/penstocks and related hydroelectric power infrastructure. Lake Elsinore is a shallow, eutrophic lake in southwestern Riverside County that has varied dramatically in lake surface elevation over time, from episodes of extreme flooding to being dry in the late 1950’s to early 1960’s. To address historical water quality impairments for nutrients and dissolved oxygen (DO), a total maximum daily load (TMDL) was developed by the RWQCB and incorporated into the Basin Plan in 2004. Since that time, several lake restoration and management projects have been undertaken, including fishery management; delivery of up to about 5,000 acre-feet per year of reclaimed wastewater to supplement natural rainfall and runoff during periods of low lake level and drought; installation in 2004 of 20 axial flow pumps to enhance natural wind-forced and convective mixing processes; and installation in 2007 of a dual diffused aeration system with over 20 km of diffuser lines driven by four 200 horsepower compressors. The TMDLs for Lake Elsinore are currently undergoing revision.

To provide available storage for power generation, the second component of LEAPS includes construction of an Upper Reservoir, proposed for siting in Decker Canyon at an elevation of over 2,600 ft above mean sea level (MSL), which will have a maximum capacity of 7,175 acre-feet, useable storage volume of approximately 6,300 acre-feet, maximum surface area of 76 acres and maximum depth over 150 ft.

The final component of LEAPS involves the turbines, penstocks and related hydraulic and hydroelectric elements that hydraulically link the Upper Reservoir to Lake Elsinore. Water will be pumped from and returned to Lake Elsinore through an inlet-outlet (I/O) structure sited on the western shore of the lake.

A series of studies were conducted in 2006-2007 to determine the potential water quality impacts of the LEAPS project at the request of the Santa Ana Regional Water Quality Control Board as part of the earlier FERC application process (Anderson, 2006a, b; Anderson, 2007a, b). Lake Elsinore has been evaluated more recently using the 1-D Dynamic Reservoir Simulation Model (DYRESM)-Computational Aquatic Ecosystem Dynamics Model (CAEDYM) model (e.g., Anderson, 2015a, b, c), including simulations in support of the TMDL revision for the lake (CDM-Smith, 2018).

Most recently, a coupled 3-D hydrodynamic-water quality model using the Aquatic Ecosystem Model (AEM3D) was developed for Lake Elsinore and the Upper Reservoir to numerically simulate initial filling of the Upper Reservoir and the daily, seasonal, and multi-year operations of LEAPS. The AEM3D model is based upon, and includes enhancements to, the Estuary Lake and Coastal Ocean Model (ELCOM)-Computational Aquatic Ecosystem Dynamics Model (CAEDYM) (Hodges and Dallimore, 2016). A horizontal grid of 40 m x 40 m for the Lake Elsinore model was developed from the hydroacoustic bathymetric survey conducted in 2010 (Anderson, 2010) and revised to 1,255 ft lake elevations based upon satellite imagery at known lake surface elevations. Bathymetry for the Upper Reservoir was taken from design documents.

The AEM3D model was calibrated to data from Lake Elsinore and the calibrated model was used to simulate the water quality conditions in Lake Elsinore and the Upper Reservoir to address the objectives for Study 4 and 7. Two weekly pump-generation schedules were modeled: (a) a nighttime-pumping/daytime-generation cycle during the work week, and (b) a schedule which maximizes use of early-to-mid-day renewable energy production for pumping and late afternoon and evening hydropower generation. The nighttime-pumping/daytime-generation schedule (Schedule A) was evaluated for three lake elevation scenarios representing an extremely low lake level (i.e., 1,235 feet), a moderate lake level (i.e., 1,240 feet), and a high lake level (i.e., 1,247 feet), while the maximum renewable schedule (Schedule B) was only evaluated at the moderate lake level. A 50-meter-wide intake/output (I/O) structure was typically used for simulations, but a 150-meter-wide I/O was used in some simulations as specified. In the sections below, we provide comments on the modeling documentation, associated uncertainties, and identify water quality and limnological issues.

2 Model Calibration, Validation, and Uncertainty

While additional details may be available in other reports not referenced, a major shortcoming in the "*Study 4 & 7 Impacts of the LEAPS Project on water quality in Lake Elsinore*" report (Report) is the incomplete documentation of model calibration, the absence of model validation results, and the absence of discussion of uncertainty in the model when presenting the model results. While the Report presents model calibration results for the lake levels and most water quality parameters modeled, there is no discussion of spatial variations in the observed data or a comparison of the observed and predicted water quality results at different locations within Lake Elsinore to evaluate model performance at different locations in the lake. The specific location within Lake Elsinore being evaluated in the comparison of observed and predicted water quality in the calibration results is never shown on a map. Five references in the Report to a similarly named monitoring location (i.e., sample station E2, site E2, or TMDL site E2) suggest the comparisons of observed and predicted water quality are for only one location in the center of Lake Elsinore, but water quality historically has been sampled at three locations within Lake Elsinore for the TMDL monitoring plan and continuously monitored with sondes at two locations (LESJWA, 2006; CDM-Smith, 2013; AMEC Foster Wheeler, 2017). There is no discussion of the location where vertical water quality profiles were measured and whether they all are data from one location across multiple water depths or multiple locations within Lake Elsinore. As such, the model calibration is potentially only documenting the model performance at one location and it is not possible to evaluate the model performance across different locations in Lake Elsinore. While there may not be sufficient water quality data within the model calibration period to evaluate the model performance at multiple locations throughout Lake Elsinore, this limitation should be explained in the Report. If available, the spatial variation in observed data should be examined over a longer time period and model calibration results should be compared with monitoring data from multiple locations in Lake Elsinore to identify the potential uncertainty associated with predicted water quality results across various locations within Lake Elsinore.

The model calibration documentation is also incomplete because there is no summary of the available observed water quality data for use in the model calibration results, and it is not specified whether all the available observed water quality data within the modeling period is used in the model calibration or whether only a portion of the data is used. Model calibration results for water temperature and dissolved oxygen only present the vertical profiles during 2016, but the model calibration period extended from February 8, 2016 to August 31, 2018. A comparison of observed and predicted dissolved oxygen concentrations or residual error over a longer period would help validate model performance. Model calibration results for microcystin (algal toxin) concentrations only compared observed and modeled microcystin concentrations from 2017 and 2018, with no comparison of observed and predicted microcystin concentrations in 2016. It is unclear whether partial data sets are available over a longer simulation period which could be used for validation purposes.

In addition to the root mean squared error (RMSE) metrics, some additional model performance statistics such as percent bias or Nash-Sutcliffe Efficiency for various water quality parameters would be desirable. Percent bias quantifies any consistent under- or over-prediction of a water quality parameter, while Nash-Sutcliffe Efficiency quantifies how well the observed and modeled data agree throughout the calibration periods (Moriasi et al., 2007). The RMSE and relative RMSE presented in the model calibration results are useful model performance statistics to understand the difference between observed and predicted water quality conditions, but they are not sufficient to evaluate the overall model performance. The RMSE and relative RMSE would not characterize any consistent under- or over-prediction of a water quality parameter by the model, so the percent bias may be necessary to understand model performance.

There are no model calibration results for algal nutrients (e.g., NH_4-N or PO_4-P) presented in the Report, so there is no quantification of the RMSE or relative RMSE to evaluate the uncertainty for these water quality parameters. Ammonia (NH_4-N) and orthophosphate (PO_4-P) model results are discussed in the analysis of water quality impacts of LEAPS operations, but the validity of these results is unknown without a quantification of the model calibration results. A discussion of the model calibration results for total nitrogen and total phosphorus is insufficient to quantify the model performance for NH_4-N and PO_4-P since multiple model calibration parameters are involved in the model that would potentially introduce error between observed and predicted NH_4-N and PO_4-P concentrations.

There is no model validation discussed or presented in the Report, so there is no quantification of performance of the calibrated AEM3D model outside of model calibration conditions (i.e., LEAPS operation conditions). Model calibration results evaluate model performance under calibration conditions (e.g., lake levels, meteorological conditions) when model parameters (summarized in Appendix A of the Report) can be adjusted to optimize agreement between observed and predicted water quality. However, model validation is necessary to quantify how well the observed and predicted water quality conditions would agree under different conditions (e.g., higher lake levels, LEAPS operations). Model validation evaluates the calibrated model with observed data not used in calibration to quantify the performance of the AEM3D model under these different conditions and determine the uncertainty associated with modeling conditions different from the calibration period. The validation dataset could be observations from a different monitoring period, partial or complete data sets available in a similar location, or a combination of both.

Although observed lake levels, temperature, and dissolved solids were well predicted in calibration results included in the report, relative RMSE for algae-related parameters were large. Relative RMSE for nutrients were on the order of 20%, and relative RMSE for chlorophyll-a and DO levels were 31% and 47%, respectively (Figures 8 through 10). The implications of the quantified model uncertainty for water quality parameters (i.e., the RMSE and relative RMSE) are not consistently considered in the discussion of model results under the LEAPS operations scenarios evaluated. Model results are typically presented without a discussion of the RMSE or relative RMSE and conclusions on the potential impacts of LEAPS operations scenarios are made without clarifying the magnitude of the uncertainty associated with these conclusions. Conclusions about the differences between dissolved oxygen concentration under native conditions (i.e., without LEAPS operations) and under various LEAPS operations scenarios needs to carefully consider this uncertainty to avoid overstating the potential impacts of LEAPS operations on dissolved oxygen concentrations. Model uncertainty is also important to discuss for predicted microcystin concentrations since the AEM3D model failed to reproduce trends in algal toxin concentrations in Lake Elsinore and the regression equation used to predict microcystin concentrations under LEAPS operations did not capture peak microcystin concentrations. In the Report section discussing the effects of duration of storage in the Upper Reservoir on microcystin (pages 63 to 64), the algal toxin subroutine in AEM3D was used to estimate microcystin concentrations in the Upper Reservoir and Lake Elsinore under various storage durations in the Upper Reservoir, but it does not explain why those model results would be valid if the AEM3D model had failed to reproduce trends in algal toxin concentrations in Lake Elsinore during calibration. Additional detailed technical comments on the model calibration, validation, and uncertainty are detailed in an attachment to this memorandum.

3 Documentation of Modeling and Results

As a result of incomplete documentation of model calibration and validation, as well as limited consideration of reported uncertainty with the model results, the Report does not include sufficient detail of the model results for the various LEAP operations scenarios to quantify the effect of LEAPS operation at different lake surface elevations on water quality in Lake Elsinore and identification of lake elevations when significant negative impacts would occur (Objective 1), or to assess the impact of pumping, transient storage in the Upper Reservoir, and generation on total N, total P and cyanotoxin concentrations in return flows to Lake Elsinore during operation of LEAPS (Objective 2). Specifically, there is limited discussion of the lateral and longitudinal (i.e., x- and y-axis, assuming vertical is the z-axis) spatial variability for some water quality parameters (i.e., total dissolved solids, water temperature, nutrients, microcystin), so the spatial impact of the pumping, storage, and generation on Lake Elsinore water quality cannot be determined. A 3-D model was used in the studies, but water quality model results under the various LEAPS operations scenarios are typically presented either as vertical and/or volume-weighted conditions across the entire lake or reservoir. Spatial variations in total dissolved sediments near the I/O are especially important to understanding how LEAPS operations would potentially impact water quality in Lake Elsinore, but the total dissolved solid model results are only presented as a volume-weighted concentration so more localized spatial variations cannot be assessed. The spatial variability of dissolved oxygen and chlorophyll-a are presented selectively, with no explanation or quantification about whether the spatial variations shown for these water quality parameters are representative of the range of spatial variations. In the evaluation of the storage duration in the Upper Reservoir on water quality conditions in Lake Elsinore, there is a brief mention that there are the spatial variations in chlorophyll-a concentrations under various storage durations ("more substantial reductions were predicted near the I/O during restart of hydropower generation as the stored water enters the lake"), but there is no discussion of the magnitude or spatial extent of these spatial variations in chlorophyll-a. Microcystin concentrations are estimated from chlorophyll-a concentrations in the LEAPS modeling approach, so understanding the spatial variations in chlorophyll-a concentrations is important to assess the potential impacts of LEAPS operations on microcystin concentrations in Lake Elsinore.

Model results for the various LEAPS operations scenarios typically present the model results without highlighting the biologically important differences in temperature, dissolved oxygen, or microcystin. The volume-weighted/volume-averaged water quality parameters typically used for comparing the model results under native conditions and under various LEAPS operations scenarios do not present the potential change in the frequency of meeting or exceeding biologically important thresholds.

In examining Objective 2, the primary concern related to future lake water quality conditions under LEAPS operation is the potential attribution of the effects of water supplementation for filling the upper reservoir at start-up with the effects of ongoing operations into the future. Since the initial supplementation of up to 15,000 acre-feet (af) of State Water Project (SWP) water represents a large proportion of the storage capacity of Lake Elsinore, large initial changes in algal nutrients would be expected to occur from dilution, followed by a slow return to existing conditions as annual SWP and recycled water inputs, watershed runoff, as well as internal nutrient sources reach a new dynamic equilibrium in the future.

Additionally, the initial supplementation of SWP water dilution benefit would potentially be lower than estimated because the Lake Elsinore water quality modeling assumed the water quality of the initial supplemental SWP water entering Lake Elsinore would be the same as the initial SWP water quality listed in Table 3 of the Report, even though the delivery of the initial supplementation of SWP water would be routed into Lake Elsinore through the upstream Canyon Lake and the San Jacinto River channel at a rate of 250 cfs for 30 days. While the Report notes that a preliminary simulation of a near full-pool Canyon Lake using the 3-D Canyon Lake model indicated Canyon Lake water quality would become similar to SWP water quality 3 to 4 days after the delivery of the initial supplementation of SWP water began, there are insufficient details presented to support the assumption that the water quality of the initial supplemental SWP water entering Lake Elsinore would be the same as the initial SWP water quality. Separating the influence of the initial supplementation of SWP water from LEAPS is an important consideration and should be attempted before making any conclusions regarding project benefits beyond the initial 1-2 years after project startup.

In addition to an inability to distinguish SWP supplementation benefits from the benefits of LEAPS operation, the discussion and conclusions of the potential for LEAPS operations to alter algae growth and microcystin concentrations in Lake Elsinore is insufficiently detailed. While the report recognizes that the model does not capture algal dynamics well, several LEAPS benefits regarding algae levels as well as algal toxin levels are stated without sufficient qualification regarding prediction intervals as well as unmodeled factors. There is no summary of the available data reviewed (e.g., the number of hydropower facilities considered, the years considered, number of data points) or citations supporting the conclusion that hydropower production at other facilities has not generally been found to increase microcystin concentrations. The subsequent citation to PacifiCorp (2017) and a comparison of the reservoir microcystin concentrations and riverine concentrations downstream of Iron Gate Dam is inappropriate and does not provide evidence that hydropower operation does not increase microcystin concentrations because it is comparing microcystin concentrations only under hydropower operations rather than with and without hydropower operations. Further, the example is not applicable to pumped storage hydropower because it compares microcystin concentrations in a slow-moving (lentic) reservoir environment that meets *Microcystis aeruginosa* pelagic habitat requirements (i.e., hydraulic residence slower than cellular reproduction times) and a faster-moving (lotic) riverine environment that does not meet these requirements. Interestingly, genetic analysis of *Microcystis aeruginosa* cells in the Klamath River identified Iron Gate Reservoir as the principal source of *Microcystis aeruginosa* downstream of Iron Gate Dam (Otten et al., 2015). The timing of the highest microcystin concentrations measured at Klamath River sites downstream of Iron Gate Reservoir also corresponded to the timing of peak microcystin concentrations measured in Iron Gate Reservoir (Otten et al., 2015). While microcystin concentrations in Iron Gate Reservoir are higher than microcystin concentrations in the Klamath River downstream of Iron Gate Dam, Iron Gate Reservoir was still likely a source of microcystin downstream in the Klamath River.

Additionally, there is no discussion of the conditions (e.g., the range of flows, pressure through turbines) PacifiCorp used in its analysis of a curtain to prevent the transport of algae cells from Iron Gate Reservoir to the downstream Klamath River or how those conditions would compare to the proposed flow rates during peaking from the Upper Reservoir into Lake Elsinore under LEAPS operations. Iron Gate Dam is not operated as a peaking power generation dam, so additional analysis is necessary to compare the range of conditions for the LEAPS operations with the PacifiCorp operations to determine whether results from Iron Gate Dam would be applicable to LEAPS operations and the potential for a curtain to prevent the transport of algae cells between the Upper Reservoir and Lake Elsinore.

Recognizing broad factors are associated with increased cyanobacteria blooms, including high nutrient loading, warm temperatures, and low turbulence (Berg and Sutula 2015), it is not clear that if the LEAPS operations were considered separately from SWP water supplementation would affect these factors sufficiently to affect the concentrations of algae or algal toxins over the long-term. While *Microcystis* were the dominant algal genera found in algal toxin monitoring of Lake Elsinore conducted by the Surface Water Ambient Monitoring Program in 2015–2017, other algae (e.g., diatoms) as well as other cyanotoxin producing species (e.g., *Aphanizomenon sp., Aphanocapsa sp., Cylindrospermopsis sp*.) were found at 10–50% of the community composition in individual surveys identified (Howard 2018). Other than the broad associations with Chlorophyll-a shown, it is not known precisely which factors, or combination of factors, trigger the production of cyanotoxins in algal cells.

In assessing Objective 3, the primary benefit of LEAPS operations considered was related to increased hypolimnetic dissolved oxygen concentrations resulting from supplemental diffused oxygen additions to the LEAPS return flows. These results should be discussed both in terms of the recognized uncertainties in predicted DO concentrations as well as limitations in assessing DO uncertainty at other locations than the central index station used for calibration and validation. In addition to periods of hypoxia persisting with O_2 supplementation (See Figure 55), identification of other reservoir zones with hypoxia/anoxia have important implication upon N and P flux and resulting concentrations (Nürnberg 2009).

Additional detailed technical comments about the model results are provided in an attachment to this memorandum.

4 CONCLUSION AND ADDITIONAL INFORMATION NEEDS

Based upon our review of the presented information, as a result of incomplete documentation of model calibration, lack of model validation results, reported uncertainties in model outputs may not be representative of other lake locations or other time periods than those analyzed. Further, separation of initial SWP supplementation from the simulation of LEAPS-only operations may result in model predictions that differ very little from existing Lake Elsinore conditions and within the identified uncertainty bounds. Because of the short periods analyzed, incomplete documentation of model uncertainty, and the inclusion of other factors unrelated to LEAPS (e.g., initial SWP supplementation, O_2 additions), the report does not provide a clear water quality assessment of LEAPS operations over the long-term.

The following information is necessary to determine AEM3D model performance for estimating water quality conditions under LEAPS operations scenarios, to evaluate the potential impacts of LEAPS operations scenarios on water quality in Lake Elsinore, and to identify lake elevations when significant negative impacts would occur:

- A summary of the spatial variability in observed Lake Elsinore water quality data.

- A table summarizing the available observed water quality data, including location(s) it was measured, typical frequency of measurement, period of record, and the number of measurements within the period of record.

- A map specifying the locations where Lake Elsinore observed water quality data was measured and the location(s) where model results are shown (e.g., TMDL Site E2).

- Comparison of observed and predicted water quality calibration results at multiple locations within Lake Elsinore to evaluate the range of model performance at different locations within the lake, if sufficient spatial data is available during the modeling period (i.e., February 8, 2016 to August 31, 2018).

- Model calibration results for NH_4-N and PO_4-P concentrations along with the model performance statistics for these water quality parameters.

- Calculation of the model performance statistics percent bias and Nash-Sutcliffe Efficiency for each water quality parameter in addition to the RMSE.

- Model validation analysis for each water quality parameter predicted using data not included in the calibration process.

- Discussion of the spatial variability in each water quality parameter, including plots showing the range of spatial variability across Lake Elsinore.

- Discussion of the model uncertainty during the presentation of model results, especially when making conclusions about the impacts of LEAPS operations on Lake Elsinore water quality.

- Quantification of the change in frequency Lake Elsinore water quality parameters exceed the relevant water quality thresholds (e.g., Basin Plan objectives) between native conditions and the various LEAPS operations scenarios.

- A more detailed analysis of the potential for a curtain to reduce transport of *Microcystis aeruginosa* and microcystin between the Upper Reservoir and Lake Elsinore, if a curtain is being considered for use to mitigate potential impacts under LEAPS operations scenarios.

- Quantification of the water quality of the initial SWP supplementation into Lake Elsinore after it has been routed through Canyon Lake and the San Jacinto River or a more detailed explanation of why it is reasonable to assume the water quality of the SWP supplementation does not change during transport from Canyon Lake to Lake Elsinore.

- Simulations of water quality that separate SWP supplementation from LEAPS operations. This could be accomplished by modeling Lake Elsinore without LEAPS but considering SWP supplementation, by modeling LEAPS with water quality of the supplemented water matching existing conditions, or through a longer-term reservoir simulation with results examined after an equilibration period (e.g., 10 years) using hydraulic residence time or estimates of the characteristic times of other water quality determinants.

5 References

Note that Anderson, 2015b and 2015c were not included in the report.

AMEC Foster Wheeler. 2017. Lake Elsinore and Canyon Lake Watersheds Nutrient TMDL Monitoring 2016-2017 Annual Report. Final Report to the Lake Elsinore & San Jacinto Watersheds Project Authority. 76 pp.

Anderson, M.A. 2006a. Technical Analysis of the Potential Water Quality Impacts of the LEAPS Project on Lake Elsinore. Draft Final Report submitted to the Santa Ana Regional Water Quality Control Board. 30 pp.

Anderson, M.A. 2006b. Heating, Cooling and Stratification during LEAPS Operation. Draft Final Report submitted to the Santa Ana Regional Water Quality Control Board. 24 pp.

Anderson, M.A. 2007a. Effects of LEAPS Operation on Lake Elsinore: Predictions from 3-D Hydrodynamic Modeling. Draft Final Report submitted to the Santa Ana Regional Water Quality Control Board. 49 pp.

Anderson, M.A. 2007b. Ecological Impacts from LEAPS Operation: Predictions Using a Simple Linear Food Chain Model. Draft Final Report submitted to the Santa Ana Regional Water Quality Control Board. 22 pp.

Anderson, M.A. 2015a. Technical Memorandum Task 1.0: Surface Elevation and Salinity in Lake Elsinore: 1916-2014. Draft Technical Memorandum to Lake Elsinore-San Jacinto Watersheds Authority. 13 pp.

Anderson, M.A. 2019. Impacts of the Lake Elsinore Advanced Pumped-Storage (LEAPS) Project on water quality in Lake Elsinore. Final Report. Prepared for The Federal Energy Regulatory Commission, Washington D.C. Project No. 14227 by Michael A. Anderson, Ph.D., Riverside, CA. January 30, 2019.

Berg M and Sutula M. 2015. Factors affecting the growth of cyanobacteria with special emphasis on the Sacramento-San Joaquin Delta. Southern California Coastal Water Research Project Technical Report 869. August 2015.

CDM-Smith. 2013. Comprehensive Nutrient Reduction Plan for Lake Elsinore and Canyon Lake. Riverside County Flood Control & Water Conservation District on behalf of: County of Riverside and the Cities of Beaumont, Canyon Lake, Hemet, Lake Elsinore, Menifee, Moreno Valley, Murrieta, Perris, Riverside, San Jacinto, and Wildomar. January 28, 2013.

CDM-Smith. 2018. TMDL Technical Report: Revision to the Lake Elsinore and Canyon Lake Nutrient TMDLs. Lake Elsinore and San Jacinto Watersheds Authority (LESJWA) in collaboration with the Lake Elsinore and Canyon Lake TMDL Task Force. Prepared by: CDM Smith in collaboration with GEI Consultants, Risk Sciences, UC Riverside, Wood Environment and Infrastructure and CGRME.

Hodges, B. and C. Dallimore. 2014. *Estuary, Lake and Coastal Ocean Model: ELCOM. v.3.0 User Manual.* Centre for Water Research, Univ. of Western Australia.

Howard, M.D. 2018. Cyanotoxin and Cyanobacteria Monitoring in Lake Elsinore and Canyon Lake 2015-2017. Final Report. SWAMP-MR-RB8-2018-0004. Southern California Coastal Water Research Project. Costa Mesa, CA.

LESJWA (Lake Elsinore and San Jacinto Watersheds Authority). 2006. Lake Elsinore and Canyon Lake Nutrient TMDL Monitoring Plan. Prepared for California Regional Water Quality Control Board, Santa Ana Region by Lake Elsinore and San Jacinto Watersheds Authority. February 15, 2006.

Moriasi, D.N., J.G. Arnold, M.W. Van Liew, R. L. Bingner, R.D. Harmel, and T.L. Veith. 2007. Model evaluation guidelines for systematic quantification of accuracy in watershed simulations. Transactions of the ASABE 50(3): 885 – 900.

NHC (Nevada Hydro Company). 2018. Lake Elsinore Advanced Pumped Storage Project FERC Project No. 14227 Filing of Requested Additional Information and Additional Study Plans. September 11, 2018.

Nürnberg, G.K. 2009. Assessing internal phosphorus load - Problems to be solved, Lake and Reservoir Management, 25: 4, 419–432.

Otten, T. G., J. R. Crosswell, S. Mackey, and T. W. Dreher. 2015. Application of molecular tools for microbial source tracking and public health risk assessment of a Microcystis bloom traversing 300 km of the Klamath River. Harmful Algae 46: 71 – 81. http://dx.doi.org/10.1016/j.hal.2015.05.007.

PacifiCorp. 2017. 2016 Evaluation of Intake Barrier Curtain in Iron Gate Reservoir to Improve Water Quality in the Klamath River. Final Report. PacifiCorp, Portland, OR. October 2017.

6 ATTACHMENT A

Table A-1. Detailed technical comments on the Study 4 & 7 Impacts of the LEAPS Project on water quality in Lake Elsinore report.

Section	Page	Paragraph	Comment
Background	6	3	Please consider presenting a brief summary of the historical and draft TMDLs for Lake Elsinore either in the text or in an appendix. An understanding of the Lake Elsinore TMDLs would provide helpful context on the magnitude of the potential impacts on Lake Elsinore water quality under operation of the Upper Reservoir.
Background	6	n/a	Please consider discussing the historical water quality monitoring in Lake Elsinore, including the parameters monitored, the time period of available data, and the frequency of monitoring during the time period.
Background	6	n/a	There is no discussion of spatial variability in water quality conditions. Please include a brief discussion of any consistent spatial trends in water quality or note that there are not any spatial trends.
Calibration	11	n/a	Please include a figure (map) specifying the locations where monitoring data has been collected, including the meteorological data near Lake Elsinore and the water quality data in Lake Elsinore.
Calibration	13	n/a	While there is a table of the meteorological data, a table summarizing the water quality monitoring data used in the calibration is not included. Please include a table that specifies the parameter, the number of data points available for the parameter, the frequency of monitoring (e.g., continuous, daily, monthly, irregular), the location of monitoring in Lake Elsinore, the mean, median, 95%, and 5%.
Calibration	13	n/a	There is no time-series of the volume-weighted water quality concentrations for various inflow sources or a quantification of the variability of these water quality parameters. Please either include figures showing the time-series of the volume-weighted water quality concentrations for various inflow sources or an explanation for why this information is not available.
Calibration	n/a	n/a	There is no calculation of the model percent bias or Nash-Sutcliffe Efficiency for various water quality parameters. Please calculate these model performance statistics for each water quality parameter to improve evaluation of model performance.

Calibration	n/a	n/a	There is no validation of the model results. All the data presented was used to calibrate the model and there was no portion of the dataset reserved for model validation to evaluate how well the model performs outside of calibration conditions.
Calibration Results	n/a	n/a	Comparisons of observed and predicted water quality in the model calibration results appear to be for only one location within Lake Elsinore, with profiles occurring at one location across multiple water depths. There is no discussion of whether observed water quality data varies spatially in Lake Elsinore. Please explain whether water quality data exists at multiple locations within Lake Elsinore to determine observed spatial variations in water quality in the lake. If there is water quality data at multiple locations within Lake Elsinore, please either explain why this data is not included in the calibration or present a comparison of the observed and predicted water quality at multiple locations to quantify the model performance across these different locations.
Calibration Results - Temperature Profiles	15	2	There is no location specified for the observed or predicted temperature profiles. Is the predicted temperature profile specifically at the location where the observed temperature profile was measured or is the predicted temperature profile a spatial average across the lateral and longitudinal (x- and y-axis) dimensions of Lake Elsinore (assuming the vertical dimension is the z-axis)? Please specify.
Calibration Results - Temperature Profiles	15	2	The temperature profiles in Figure 6 only show data from 2016, but the modeling period is from 2016 through 2018. Why is no data shown for 2017 or 2018? Is the model performance during 2017 and 2018 under higher lake surface elevation conditions similar or different to the model performance during 2016 at lower water levels? Please compare the model performance in 2017 and 2018 or explain why data is unavailable for this comparison.
Calibration Results - Temperature Profiles	15	2	It is not specified whether the RMSE and relative RMSE was calculated for the entire modeling period (2016 through 2018) or was based on only 2016 data. It also does not specify whether the RMSE and relative RMSE were calculated based on data from only the temperature profile at one location or on data from multiple locations throughout the lake. Please clarify this by stating the time period used and the data used in the calculation of the RMSE and relative RMSE.

Calibration Results - Temperature Profiles	15	2	There is no comparison of observed and predicted average or volume-weighted water temperature for Lake Elsinore, but the volume-weighted water temperature is frequently used as a model result later in the report. If data is available, please calculate the observed volume-weighted water temperature for Lake Elsinore from the available data, compare the observed and predicted volume-weighted water temperature, and calculate the RMSE and relative RMSE between the observed and predicted volume-weighted water temperature to facilitate a better understanding of the uncertainty (error) associated with the volume-weighted water temperature results. If data is unavailable for this calculation and comparison, please note this in the calibration results.
Calibration Results - Dissolved Oxygen	16	1	There is no location specified for the observed or predicted dissolved oxygen profiles. Is the predicted dissolved oxygen profile specifically at the location where the observed dissolved oxygen profile was measured or is the predicted dissolved oxygen profile a spatial average across the lateral and longitudinal (x- and y-axis) dimensions of Lake Elsinore (assuming the vertical dimension is the z-axis)? Please specify.
Calibration Results - Dissolved Oxygen	16	1	The dissolved oxygen profiles in Figure 7 only show data from 2016, but the modeling period is from 2016 through 2018. Why is no data shown for 2017 or 2018? Is the model performance during 2017 and 2018 under higher lake surface elevation conditions similar or different to the model performance during 2016 at lower water levels? Please compare the model performance in 2017 and 2018 or explain why data is unavailable for this comparison.
Calibration Results - Dissolved Oxygen	16	1	It is not specified whether the RMSE and relative RMSE was calculated for the entire modeling period (2016 through 2018) or was based on only 2016 data. It also does not specify whether the RMSE and relative RMSE was calculated based on data from only the dissolved oxygen profile at one location or on data from multiple locations throughout the lake. Please clarify this by stating the time period used and the data used in the calculation of the RMSE and relative RMSE.
Calibration Results - Dissolved Oxygen	16	1	There is no comparison of observed and predicted average or volume-weighted dissolved oxygen for Lake Elsinore, but the volume-weighted dissolved oxygen is frequently used as a model result later in the report. If data is available, please calculate the observed volume-weighted dissolved oxygen for Lake Elsinore from the available data, compare the observed and predicted volume-weighted dissolved oxygen, and calculate the RMSE and relative RMSE between the observed and predicted volume-weighted dissolved oxygen to facilitate a better understanding of the uncertainty (error) associated with the volume-weighted dissolved oxygen results. If data is unavailable for this calculation and comparison, please note this in the calibration results.

Calibration Results - Dissolved Oxygen	16	1	There is no presentation of observed spatial patterns in dissolved oxygen or comparison of observed and predicted (i.e., modeled) spatial patterns in dissolved oxygen, but the spatial variations in predicted dissolved oxygen under various pumping scenarios or oxygen enhancement (i.e., Objective 3) are occasionally presented. Please present this comparison or acknowledge that the accuracy of predicted spatial variations in dissolved oxygen cannot be determined for the calibration period.
Calibration Results - Dissolved Oxygen	16	1	While the discussion acknowledges that errors between the observed and predicted dissolved oxygen were often quite large, it states the "model reproduced general trends on most dates." However, comparison of observed and predicted dissolved oxygen in Figure 7 shows that the model did not capture vertical variations in dissolved oxygen on any of the dates shown. On 4/26/2016, the observed and predicted dissolved oxygen were within 0.5 mg/L at the surface and observed and predicted dissolved oxygen concentrations both decreased with depth, but the predicted dissolved oxygen concentration was approximately 3 mg/L higher than the observed dissolved oxygen concentration at the bottom. On 7/25/2016, the observed and predicted dissolved oxygen were within 0.5 mg/L at the surface, but the observed and predicted dissolved oxygen had different vertical variations with depth, with predicted dissolved oxygen approximately 3 mg/L greater than observed at 2 and 3 m depths. On 9/19/2016, the model predicted a more rapid decrease in dissolved oxygen with depth than the observed data, with the predicted dissolved oxygen approximately 3 mg/L less than the observed dissolved oxygen at bottom depths. As such, the comparison shown in Figure 7 does not support the statement that the model reproduced general trends on most dates. Please add a more nuanced discussion of the differences between the observed and predicted dissolved oxygen concentrations.
Calibration Results - Total Nitrogen	16	2	Minor typo: "2016-218" should be "2016-2018"
Calibration Results - Total Nitrogen	16	2	There is no location specified for the observed or predicted total nitrogen (TN) concentrations. Is the predicted TN specifically at the location where the observed TN was measured or is the predicted TN a spatial average across the lateral and longitudinal (x- and y-axis) dimensions of Lake Elsinore (assuming the vertical dimension is the z-axis)? Please specify.

Calibration Results - Total Phosphorus	17	1	There is no location specified for the observed or predicted total phosphorus (TP) concentrations. Is the predicted TP specifically at the location where the observed TP was measured or is the predicted TP a spatial average across the lateral and longitudinal (x- and y-axis) dimensions of Lake Elsinore (assuming the vertical dimension is the z-axis)? Please specify.
Calibration Results - Chlorophyll-a	18	1	There is no location specified for the observed or predicted chlorophyll-a concentrations. Please specify the location where the chlorophyll-a was measured and confirm the predicted chlorophyll-a is for that location.
Calibration Results - Algal Toxins	19	1	In Figure 12, there are no observed algal toxin data shown for 2016. Please explain whether this data is unavailable or why it was excluded from the comparison between observed and modeled.
Calibration Results - Algal Toxins	19	1	In Figure 12, the predicted microcystin concentration continuously exceeded 8 ug/L for summer 2016. Is there any monitoring data (from any time period) that supports microcystin being continuously greater than 8 ug/L for months? Please provide some discussion about the reasonableness of this predicted microcystin to provide context about the uncertainty associated with model results during LEAPS simulations.
Analysis of Water Quality Impacts of LEAPS Operation	21	2	There is no explanation for why the maximum renewable schedule was modeled only at the nominal 1240 ft lake level scenario. Is it assumed that the results would be similar between the nighttime-pumping/daytime-generation schedule and the maximum renewable schedule? If yes, please explain this and provide a justification for why the two schedules would be similar.
Results - Objective 1 - Scenario 1	23	n/a	There is no water quality initial condition specified for Scenario 1, but a water quality initial condition is specified for Scenario 2. While it is implied that the initial condition for Scenario 1 would be water quality conditions on the first day of the modeling, please specify the initial conditions for completeness.
Results - Objective 1 - Scenario 1	23 - 32	n/a	The volume-weighted or volume-averaged concentrations are typically used for comparing the model results under native conditions and with LEAPS. However, these metrics do not highlight biologically important differences in temperature, dissolved oxygen, or microcystin. Please consider including evaluation of biologically important or Basin Plan thresholds for water temperature, dissolved oxygen, and microcystin.
Results - Objective 1 - Scenario 1 - ii. TDS	24	n/a	In Figure 15, is the TDS concentration a spatial average over the entire lake or is it the TDS concentration at a specific location in the lake? Please specify this and the magnitude of spatial variations in TDS.

Results - Objective 1 - Scenario 1 - iii. Temperature	24	1	Site E2 near the center of the lake is never specified in a map in the report. Please include a map that shows this location.
Results - Objective 1 - Scenario 1 - iii. Temperature	25	1	There is no discussion of spatial variability in water temperature at different locations in the lake. Specifically, what is the comparison of the existing conditions and LEAPS water temperature closer to the I/O and on the opposite side of the lake? Please include a discussion of the magnitude of spatial variations in water temperature.
Results - Objective 1 - Scenario 1 - iv. Dissolved Oxygen	25	3	There is no discussion of the comparison of the dissolved oxygen concentrations with respect to the dissolved oxygen calibration error. When discussing the statistical significance of the ensemble mean dissolved oxygen concentration under "native conditions" and "with LEAPS", please include a discussion of the error and evaluate whether the differences between the scenarios are greater than the associated calibration error.
Results - Objective 1 - Scenario 1 - iv. Dissolved Oxygen	25	3	There is no discussion of spatial variability in dissolved oxygen at different locations in the lake. Specifically, what is the comparison of the existing conditions and LEAPS dissolved oxygen closer to the I/O and on the opposite side of the lake? Please include a discussion of the magnitude of spatial variations in dissolved oxygen.
Results - Objective 1 - Scenario 1 - iv. Dissolved Oxygen	26	n/a	While Figure 18 provides the vertical variation in dissolved oxygen and the volume-weighted dissolved oxygen under "native conditions" and "with LEAPS”, it is difficult to quantitatively assess the variations in dissolved oxygen between the two conditions from the graphs. As part of Figure 18, please include figures specifying the vertical and volume-weighted difference between the dissolved oxygen under "native conditions" and "with LEAPS" to assist the reader in assessing the magnitude of variations.
Results - Objective 1 - Scenario 1 - vi. Total P	28	n/a	There is no discussion of any changes in total phosphorus due changes in dissolved oxygen concentrations near the bottom sediments in the lake (i.e., reduced production of PO_4 due to reduced anoxic conditions). Please explain whether any of the differences in total phosphorus between native conditions and with LEAPS in Figure 20 are due to changes in dissolved oxygen concentrations.

Results - Objective 1 - Scenario 1 - vii. Chlorophyll a	29	1	There is no discussion of the comparison of the chlorophyll-a concentrations with respect to the chlorophyll-a calibration error. When discussing the chlorophyll-a concentrations under "native conditions" and "with LEAPS", please include a discussion of the error and evaluate whether the differences between the scenarios are greater than the associated calibration error.
Results - Objective 1 - Scenario 1 - viii. Microcystin	31	n/a	Is there a reason the caption for Figure 23 does not specify the microcystin concentrations are volume-weighted? If yes, please explain.
Results - Objective 1 - Scenario 1 - viii. Microcystin	31	1	How much confidence is there that the microcystin concentration results are representative of actual conditions considering the calibration error? When discussing the microcystin concentrations under native conditions and with LEAPS, please include a discussion of the calibration error and the ability of the model results to predict actual conditions.
Results - Objective 1 - Scenario 1 - Cumulative Distribution Functions	31	2	Please explain why the cumulative distribution functions shown in Figure 24 are based on the volume-weighted/volume-averaged conditions rather than the water quality conditions at the individual modeling points?
Results - Objective 1 - Scenario 2 -	33 - 44	n/a	The volume-weighted or volume-averaged concentrations are typically used for comparing the model results under native conditions and with LEAPS. However, these metrics do not highlight biologically important differences in temperature, dissolved oxygen, or microcystin. Please consider including evaluation of biologically important or Basin Plan thresholds for water temperature, dissolved oxygen, and microcystin.
Results - Objective 1 - Scenario 2 -	33 - 44	n/a	There is no discussion of the lateral and longitudinal (i.e., x- and y-axis, assuming vertical is the z-axis) spatial variability for some water quality parameters (i.e., water temperature, nutrients, chlorophyll-a, microcystin). Please discuss these spatial variations in their respective sections.
Results - Objective 1 - Scenario 2 -	33 - 44	n/a	Station E2 is mentioned several times in this section, but there is no map showing the location of Station E2. Please include a map showing this location.
Results - Objective 1 - Scenario 2 - iii. Temperature	37	n/a	Why is the water temperature difference between the near-surface (1 m) and lower depth (5 m) waters negative 2°C in early 2017? Please explain how an unstable stratification condition (i.e., cooler, less dense water on top of warmer, more dense water) would occur.

Results - Objective 1 - Scenario 2 - iv. DO	38	2	There is no discussion of the magnitude of the dissolved oxygen calibration error when discussing the average modeled dissolved oxygen results. If the error bars associated with the modeled dissolved oxygen were considered, would the change in dissolved oxygen between the various LEAPS operations scenarios still be similar? Please include a discussion of the error and evaluate whether the differences between the scenarios are greater than the associated calibration error.
Results - Objective 1 - Scenario 2 - iv. DO	38	n/a	Figure 29 (e) is not labeled in the figure caption. Please add a caption explaining what Figure 29 (e) is plotting.
Results - Objective 1 - Scenario 2 - iv. DO	40 - 41	n/a	Figure 31 and the discussion of spatial variations in dissolved oxygen is helpful to understanding the differences between the various LEAPS scenarios, but there is only one day (i.e., 7/12/2017) of model results presented for only one depth (i.e., "directly above sediments"), there is no discussion of the dissolved oxygen concentration during the day (i.e., Is Figure 31 plotting the daily average dissolved oxygen or is it the dissolved oxygen at one specific time-step during the day), the range of conditions that may occur under the different scenarios, and the discussion of the results from that day do not explain why the variations occur along the edges of the lake. Is this one day representative of average conditions or is it representative of the most extreme spatial differences in dissolved oxygen across Lake Elsinore? Is the higher dissolved oxygen around the edges due to increased mixing due to LEAPS operation or other processes associated with the increased water level under LEAPS? Please develop this discussion more, including details on the range of spatial variations in dissolved oxygen to be expected. A quantification of the area with dissolved oxygen less than 5 mg/L at various depths (as a time-series) potentially would be helpful for understanding spatial variations within the lake.
Results - Objective 1 - Scenario 2 - v. Nutrient Concentrations	41 - 42	n/a	There was no calibration data presented for NH_4-N model results. How can a reader assess the accuracy of the model results? Please include a comparison observed and modeled NH_4-N concentrations in the calibration section or explain why it is not possible to do this comparison (e.g., NH_4-N was not measured during the modeling period). There was also no presentation of NH_4-N under Scenario 1 either, so please consistently present NH_4-N model results for all scenarios or explain why NH_4-N model results are not being presented for a scenario.

Results - Objective 1 - Scenario 2 - v. Nutrient Concentrations	41 - 42	n/a	There is no presentation of PO_4-P model results, but there is a presentation of NH_4-N model results. Why are no PO_4-P model results presented?
Results - Objective 1 - Scenario 2 - vi. Chlorophyll a	42	1	The reduction in chlorophyll-a between native conditions and the LEAP operation scenarios (i.e., about 50 ug/L) is approximately the same magnitude as the calibration RMSE (i.e., 60 ug/L). Please discuss this and its implications for the comparison of the model results.
Results - Objective 1 - Scenario 2 - vii. Microcystin	43	1	Chlorophyll-a concentrations less than 100 ug/L were infrequent or did not occur in the observed data during summer conditions. There is no discussion that the range of the modeled chlorophyll-a during summer used to estimate the microcystin concentrations is outside of the range of chlorophyll-a concentrations during summer used to develop the relationship between microcystin and chlorophyll-a. Please discuss this and the validity of estimating microcystin from chlorophyll-a concentrations under these conditions.
Results - Objective 1 - Scenario 3	45 - 52	n/a	There is no discussion of the lateral and longitudinal (i.e., x- and y-axis, assuming vertical is the z-axis) spatial variability for some water quality parameters (i.e., water temperature, dissolved oxygen, nutrients, chlorophyll-a, microcystin). Please discuss these spatial variations in their respective sections.
Results - Objective 1 - Scenario 3 - iii. Temperature	47	n/a	There is no plot of the volume-weighted temperature over time presented for Scenario 3. Please include this comparison for completeness, especially since it was compared in Scenario 1 and 2.
Results - Objective 1 - Scenario 3 - iv. DO	48	1	There is no discussion of the calibration error with respect to interpretation of the model results. Please include this discussion for each water quality parameter presented.
Results - Objective 1 - Scenario 3 - v. Nutrient Concentrations	50	1	There was no calibration data presented for NH_4-N model results. Please include a comparison observed and modeled NH_4-N concentrations in the calibration section or explain why it is not possible to do this comparison (e.g., NH_4-N was not measured during the modeling period).

Results - Objective 1 - Scenario 3 - v. Nutrient Concentrations	49-50	n/a	There is no presentation of PO_4 model results, but there is a presentation of NH_4-N model results? Why are no PO_4 model results presented?
Results - Objective 1 - Scenario 3 - vii. Microcystin	51	1	Chlorophyll-a concentrations less than 100 ug/L were infrequent or did not occur in the observed data during summer conditions. There is no discussion that the range of the modeled chlorophyll-a during summer used to estimate the microcystin concentrations is outside of the range of chlorophyll-a concentrations during summer used to develop the relationship between microcystin and chlorophyll-a. Please discuss this and the validity of estimating microcystin from chlorophyll-a concentrations under these conditions.
Results - Objective 2	57	n/a	The Total N and Total P concentrations in Lake Elsinore plotted in Figure 44 (a) and (b), respectively, do not agree with the Total N and Total P in Lake Elsinore with LEAPS under Scenario 1 plotted in Figure 19 (b) and Figure 20 (b). As an example, the Total N in Figure 19 (b) and Total P in Figure 20 (b) under Scenario 1 with LEAPS are both less than 3 mg/L at the end of the modeling period, but the Total N in Figure 44 (a) and Total P in Figure 44 (b) under Scenario 1 with LEAPS are both greater than 3 mg/L at the end of the modeling period. Please explain this difference (e.g., additional evaporation losses from the upper reservoir).
Results - Objective 2	60	2	There is no discussion of where the depth-averaged dissolved oxygen concentration (Figure 47 (b)) is calculated in Lake Elsinore (e.g., near the I/O, near the middle). Please specify this.
Results - Objective 2	60	2	While the discussion acknowledges that there are the spatial variations in dissolved oxygen concentrations under various storage durations ("with further transient reduction near the I/O following restart of the hydropower generation"), there is not a discussion of the magnitude or spatial extent of the spatial variations in dissolved oxygen. Please specify this.
Results - Objective 2	61	n/a	In Figure 48, why are there large spikes in dissolved oxygen at the bottom of the Upper Reservoir during some periods? Is there a physically based explanation for this or is this a model artifact? Why does the dissolved oxygen at the surface decrease to such low levels in mid-August 2016? Does the phytoplankton growth at the surface decrease during this period? Please add some discussion clarifying these points.

Results - Objective 2	62	1	While the discussion acknowledges that there are the spatial variations in chlorophyll-a concentrations under various storage durations ("more substantial reductions were predicted near the I/O during restart of hydropower generation as the stored water enters the lake"), there is not a discussion of the magnitude or spatial extent of the spatial variations in chlorophyll-a. Please specify this.
Results - Objective 2	62	2	Why is the Total Nitrogen (TN) and Total Phosphorus (TP) slightly higher in the Upper Reservoir than in Lake Elsinore? Please explain the processes that are resulting in the TN and TP in Lake Elsinore to decrease more rapidly than the TN and TP in the Upper Reservoir.
Results - Objective 2	62	n/a	In Figure 50, the scale of the y-axis is too large to evaluate small variations in the TN or TP. Please reconsider the scale of the y-axis and use a scale that is appropriate to showing the magnitude of the nutrient concentration variations.
Results - Objective 2	63	1	There was no calibration data presented for NH_4-N or PO_4-P model results. Please include a comparison observed and modeled NH_4-N concentrations in the calibration section or explain why it is not possible to do this comparison (e.g., NH_4-N was not measured during the modeling period).
Results - Objective 2	63	1	What is the magnitude and extent of spatial variations in the NH4-N or PO4-P modeled concentrations in Lake Elsinore when water from the Upper Reservoir enters? Please specify.
Results - Objective 2	63	2	Is the algae toxin subroutine in AEM3D discussed here the same subroutine that "failed to reproduce trends in algal toxin concentrations in Lake Elsinore" (page 18, paragraph 2)? Please explain why the microcystin concentrations predicted by this subroutine in AEM3D would be valid or meaningful, if the model calibration indicated it could not reproduce microcystin concentrations in Lake Elsinore?
Results - Objective 3	66	3	There is no discussion of the calibration error with respect to interpretation of the model results. Please include this discussion and its implications for the comparison between the modeled conditions (i.e., native conditions, with LEAPS, with LEAPS+O_2).
Results - Objective 3	69	1	There is no map showing the location of TMDL Site E2 in the report. Please include a map in the report showing this location.

Results - Objective 3	69-70	n/a	Why did it take 16 months for the increased dissolved oxygen concentrations above bottom sediments to reduce the flux total phosphorus and total nitrogen? Were the increases in dissolved oxygen most significant during this period? Please discuss this more and explain potential physical/chemical reasons for why it took 16 months before the change in nutrients between LEAPS and LEAPS+O_2 occurred.
Results - Objective 3	74-75	n/a	There are no citations provided to support the statement "review of limited available data indicates that hydropower production at other facilities has not generally been found to increase microcystin concentrations." The subsequent citation to PacifiCorp (2017) and a comparison of the microcystin in Iron Gate Reservoir and downstream of Iron Gate Dam does not provide evidence that hydropower operation does not increase microcystin concentrations because a) it is comparing microcystin concentrations only under hydropower operations rather than with and without hydropower operations; and b) it is comparing microcystin concentrations in a slow-moving reservoir environment that meets *Microcystis aeruginosa* habitat preferences and a faster-moving riverine environment that does not meet *Microcystis aeruginosa* habitat preferences. Genetic analysis of Microcystis aeruginosa cells in the Klamath River identified Iron Gate Reservoir as the principal source of *Microcystis aeruginosa* downstream of Iron Gate Dam (Otten et al., 2015). The timing of the highest microcystin concentrations measured at Klamath River sites downstream of Iron Gate Reservoir also corresponded to the timing of peak microcystin concentrations measured in Iron Gate Reservoir (Otten et al., 2015). While microcystin concentrations in Iron Gate Reservoir are higher than microcystin concentrations in the Klamath River downstream of Iron Gate Dam, Iron Gate Reservoir was still likely a source of microcystin downstream in the Klamath River. Please provide additional citations and analysis of data from hydropower operations to support the statement that hydropower production has not generally been found to increase microcystin concentrations.
Results - Objective 3	75	n/a	Figure 57 (a) is blurry/low resolution. Please improve the resolution so it is not blurry. Also, please explain the importance of the dashed (0.8 ug/L) and solid (8 ug/L) lines on Figure 57 (a) and (b). The y-axis on Figure 57(a) appears truncated with an "orange" symbol cut off at the top. Please either show the entire range of data available or explain why the y-axis is truncated.

Results - Objective 3	75	2	Would installation of a curtain be effective for reducing exchange of cyanobacteria (i.e., blue-green algae) under the peaking operation conditions? There is no discussion of the conditions (e.g., the range of flows, pressure through turbines) PacifiCorp used in its analysis of the curtain and how those conditions would compare to the proposed flow rates during peaking from the Upper Reservoir. Iron Gate Dam is not operated as a peaking power generation dam, so it is necessary to compare the range of conditions for the LEAPS operations with the PacifiCorp operations to determine whether results from Iron Gate Dam would be applicable to LEAPS.