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February 9, 2010

Catherine Kuhlman, Executive Officer
c/o Katherine Carter
North Coast Regional Water Quality Control Board
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RE: Transmittal of PacifiCorp's Comments on the Revised Draft TMDL

Dear Ms. Kuhlman:

Thank you for the opportunity to comment on the Revised Draft TMDL. Enclosed with this transmittal letter are PacifiCorp's "Comments on the Public Review Draft of the Staff Report for the Klamath River Total Maximum Daily Loads (TMDLs) and Action Plan Addressing Temperature, Dissolved Oxygen, Nutrient, and Microcystin Impairments in California, the Proposed Site Specific Dissolved Oxygen Objectives for the Klamath River in California, and the Klamath River and Lost River Implementation Plans." PacifiCorp's comments include, by reference, PacifiCorp's prior comments on the TMDL submitted on August 27, 2009. Along with these comments, PacifiCorp is separately submitting the entire set of referenced materials on a CD. The referenced materials have been couriered to the Regional Board.

As you are aware, PacifiCorp, the United States, the States of California and Oregon, and many other governmental and non-governmental stakeholders may soon enter into the Klamath Hydroelectric Settlement Agreement (KHSA). Under the draft KHSA, the Project would be decommissioned and removed based upon a determination by the Secretary of the Interior that to do so would be in the public interest, as well as other contingencies. PacifiCorp strongly supports the KHSA, and is committed to ensuring that ongoing regulatory processes such as the TMDL accurately and appropriately assign water quality responsibilities to the Project. Regulatory processes such as the TMDL have the potential to inform other ongoing regulatory and settlement processes, and so it is critically important that the TMDL analyses are sound and that the TMDL's regulatory goals be realistic and feasible.

PacifiCorp remains concerned about the technical integrity of the TMDL modeling and the appropriateness and achievability of the TMDL's proposed load allocations. Should you have any questions in regard to these comments please feel free to contact me at (503) 813-6170.

Sincerely,

Tim Hemstreet

Tim Hemstreet, P.E.
Project Manager

Cc: Geoffrey Hales, Chair – NCRWQCB
Matt St. John, TMDL Unit Manager – NCRWQCB
Charles R. Hoppin, Chair – SWRCB
Dorothy R. Rice, Executive Director – SWRCB

Comments on the Public Review Draft of the Staff Report for the Klamath River Total Maximum Daily Loads (TMDLs) and Action Plan Addressing Temperature, Dissolved Oxygen, Nutrient, and Microcystin Impairments in California, the Proposed Site Specific Dissolved Oxygen Objectives for the Klamath River in California, and the Klamath River and Lost River Implementation Plans

February 9, 2010

EXECUTIVE SUMMARY

PacifiCorp Energy's principal comments on the *Public Review Draft of the Staff Report for the Klamath River Total Maximum Daily Loads (TMDLs) and Action Plan Addressing Temperature, Dissolved Oxygen, Nutrient, and Microcystin Impairments in California, the Proposed Site Specific Dissolved Oxygen Objectives for the Klamath River in California, and the Klamath River and Lost River Implementation Plans* (hereafter referred to as the "Revised Draft TMDL") can be summarized as follows:

1. **The Revised Draft TMDL continues to repeat the error of the original Draft TMDL in assigning water quality targets and load allocations that are inappropriate and unachievable because they do not reflect the Klamath River Basin's nutrient-enriched characteristics**. The Revised Draft TMDL points out that Upper Klamath Lake's (UKL) hypereutrophic status "has had profound water quality implications and has resulted in impairment of beneficial uses … in downstream waters" of the Klamath River. However, the Revised Draft TMDL does not acknowledge the impossibility of the huge nutrient reductions in the Klamath River downstream of UKL that would be required to achieve its water quality goals, which are based on returning to "pre-disturbance" conditions that, as defined by the Revised Draft TMDL, would require reductions even below natural pollutant loadings. Indeed, the Revised Draft TMDL's "natural conditions" scenario reflects its unnecessarily stringent water quality objectives and targets rather than any plausible scenario of actual natural conditions.

2. **The Revised Draft TMDL would require nutrient load allocations that are not achievable, practicable, or enforceable.** The Revised Draft TMDL assigns nutrient allocations that call for reductions in total phosphorus (TP) of up to 98 percent and total nitrogen (TN) of up to 75 percent at Stateline (and other downstream locations by extension). The Revised Draft TMDL's resulting targets would require in-water nutrient concentrations that are impossibly low – so low, in fact, as to be substantially less than naturally-occurring groundwater concentrations that discharge to the Klamath River.

3. **The nutrient reductions identified in the natural conditions simulations of the Revised Draft TMDL create dramatically unrealistic conditions in the upper reaches of the Klamath River that have profound effects on downstream reaches.** The Revised Draft TMDL model assumes nutrient concentrations (including organic matter sources) between Keno Dam and the large springs complex below J.C. Boyle Dam that are so low that

modeled benthic algae do not grow in the natural conditions simulation. If these unrealistic modeled conditions are assumed to be accurate, the implications of such conditions on aquatic system function are profound. Food webs would be significantly altered, possibly having profound adverse impacts on native fisheries and other aquatic flora and fauna. Discussion of the potential implications of massive nutrient reduction as a strategy to achieve numerical targets and objectives are not presented in the Revised Draft TMDL.

4. **The Revised Draft TMDL's load allocations are improper because they have not been demonstrated to be reasonably achievable and are not achievable.** Under the Clean Water Act's implementing regulations, load allocations must be "attributed" to nonpoint sources, including natural sources. Moreover, the regulations require such an attribution to be based on a reasonable estimate of the pollutant loadings from the source. An estimated loading is not reasonable if it cannot be shown to be reasonably achievable (*e.g.*, because the source's pollutant loadings are not regulated or because the loading is technically or economically impracticable). The Revised Draft TMDL is based on load allocations that are improper because they have not been demonstrated to be reasonably achievable and are not achievable. These include load allocations that would require reductions from natural loadings; reductions that cannot be enforced because the source is not regulated or, in some cases, such as sources in Oregon, cannot be regulated by California; and reductions that are not technically or economically practicable. The CWA anticipated situations where water quality standards (WQS) or a TMDL would not be achievable by including processes such as Use Attainability Analyses (UAA) or development of site-specific criteria. In fact, use of the UAA process is the first recommendation by the National Research Council (NRC 2001) on improving the TMDL program, whereby "States should develop appropriate use designations for waterbodies in advance of assessment and refine these use designations prior to TMDL development".

5. **The Revised Draft TMDL's load allocations to PacifiCorp are improper to the extent that they are not addressed to pollutant loadings from PacifiCorp.** TMDL load allocations must be addressed to a source's pollutant loadings. Improper allocations to PacifiCorp include (1) the requirement to achieve a "compliance lens" of simultaneously achieved temperature and dissolved oxygen criteria in portions of Copco and Iron Gate Reservoirs and (2) negative nutrient "load allocations" upstream of Copco Reservoir. Neither of these allocations is addressed to pollutant loadings to the Klamath River from PacifiCorp or that PacifiCorp can control.

6. **The Revised Draft TMDL analysis of annual nutrient loadings from source areas contains significant discrepancies in the accounting of loads.** The magnitude of unaccounted loads that can be calculated from information provided in the Revised Draft TMDL is troublesome and suggests serious shortcomings in the TMDL analysis.

7. **The thermal TMDL presented in the Revised Draft TMDL is inconsistent with the Clean Water Act (CWA) because it does not determine, and would not establish, the thermal load limits *required* to ensure a balanced indigenous population of aquatic life (BIP).** The thermal effects associated with the Klamath Hydroelectric Project (Project) are consistent with a BIP.

8. **The Revised Draft TMDL model – the analytical tool relied upon to develop the TMDL's allocations and targets – includes inappropriate boundary condition values.** The Revised Draft TMDL states that nutrient concentrations used in assigning upstream boundary conditions in the TMDL model reflect median conditions expected upon attainment of Oregon's UKL TMDL. However, the selected values used in the model are not consistent with the median values predicted by the UKL TMDL model, but instead are too low and do not properly account for inter-annual variability. As such, the allocations and targets set using the Revised Draft TMDL model are biased.
9. **The TMDL temperature model includes inappropriate and biased reductions in solar radiation of 20 percent in certain modeled river reaches and scenarios.** The reservoir reaches are modeled with 100 percent of solar radiation (no reduction). For example, where Iron Gate and Copco reservoirs are included in an analysis, 100 percent solar radiation is applied. For the same reach under a no-dams analysis, 80 percent solar radiation is applied. This results in a bias in which the downstream temperature effects of the reservoirs are overstated in excess of 1°C. As such, the temperature allocations and targets set using the Revised Draft TMDL model are biased. Other significant changes have been made to parameter values in the TMDL model used for the Revised Draft TMDL compared to the original Draft TMDL. These changes result in predicted water quality conditions that are substantially different in the Revised Draft TMDL than the original Draft TMDL. Because of this, the model is essentially a new model and not just a minor revision of the previously-released model as the Regional Board staff suggested to Regional Board members and the public prior to release of the Revised Draft TMDL.

Despite these concerns, PacifiCorp remains committed to working with the Regional Board and other stakeholders to enhance the water quality conditions in the Klamath River. As the Regional Board is aware, PacifiCorp has been active in supporting strong science and prudent actions related to water quality in the Klamath River. Even as the TMDL is still under development, PacifiCorp is already proactively implementing important water quality measures and activities designed to bring about substantial water quality improvements in the Klamath River basin. PacifiCorp has and will continue to implement these measures and activities under a number of separate but related commitments, including elements of the Agreement in Principle (AIP), Klamath Hydroelectric Settlement Agreement (KHSA), the Interim Conservation Plan (ICP), Reservoir Management Plans (RMP), as well as other planned activities.

I. INTRODUCTION

PacifiCorp provides the following detailed comments on the *Public Review Draft of the Staff Report for the Klamath River Total Maximum Daily Loads (TMDLs) and Action Plan Addressing Temperature, Dissolved Oxygen, Nutrient, and Microcystin Impairments in California, the Proposed Site Specific Dissolved Oxygen Objectives for the Klamath River in California, and the Klamath River and Lost River Implementation Plans* (hereafter referred to as the "Revised Draft TMDL"). The North Coast Regional Water Quality Control Board ("Regional Board") made the Revised Draft TMDL publicly available by posting chapters and appendices to the Regional Board's website on December 23, 2009, and asked for public comments on the Revised Draft TMDL by February 9, 2010.

The Revised Draft TMDL includes substantive revisions to the previous *Public Review Draft of the Staff Report for the Klamath River Total Maximum Daily Loads (TMDLs) and Action Plan Addressing Temperature, Dissolved Oxygen, Nutrient, and Microcystin Impairments in California* (hereafter referred to as the "original Draft TMDL"). The Regional Board made the original Draft TMDL publicly available by posting chapters and appendices to the Regional Board's website over the course of a month, from June 15 to July 13, 2009.

PacifiCorp's specific comments on the Revised Draft TMDL are provided in this document according to chapter and section of the Revised Draft TMDL, and for the various appendices to the Revised Draft TMDL. PacifiCorp's specific comments on the Revised Draft TMDL include many that address new materials that have been added to the previous draft. In addition, there are numerous instances in which PacifiCorp's previous comments to the original Draft TMDL were not addressed in the Revised Draft TMDL. Accordingly, PacifiCorp incorporates by reference its previous comments on the original Draft TMDL, which were submitted to the Regional Board on August 27, 2009.

Based on our numerous conversations with Regional Board staff, we understand that nutrient and algae reduction measures are the primary focus of TMDL efforts. The measures that have been identified by PacifiCorp in the AIP, KHSA, ICP and RMP will directly address the water quality problems in the Klamath River related to nutrients and organic matter. These efforts also will address dissolved oxygen (DO) and water temperature conditions in the Klamath River basin below Iron Gate dam and within the Project area. For example, PacifiCorp is pursuing or evaluating wetlands treatment in the upper basin (a critical nexus of water quality for lower river conditions), in-reservoir treatments, and other management actions above, within and below the Project area. In addition, comprehensive water quality monitoring will be continued and expanded to extend baseline monitoring at a basin scale and address public health monitoring needs. The baseline program will be valuable in assessing long-term trends, assessing the efficacy of actions associated with implementation of water quality measures, including but not limited to TMDL actions, and tracking progress toward TMDL goals and objectives. The public health monitoring elements of the plan utilize the latest information and approaches to blue-green algae ("BGA") monitoring and assessment through continued input from the Klamath BGA working group. The program will provide the necessary public health information and will identify inter-annual variability and long-term trends.

COMMENTS: CHAPTER 1. INTRODUCTION

1.1 Overview

Page 1-1, Paragraph 1, Lines 4-5 and Lines 9-11. The Revised Draft TMDL introduces a new term: "recalculated Site Specific Objectives". This term is then used throughout the Revised Draft TMDL with regard to dissolved oxygen (DO) targets and allocations. This term should be defined for the reader, and an explanation given as to the reason, purpose, and rationale for "recalculated Site Specific Objectives" for DO.

1.5 Other Ongoing Processes in the Klamath River Basin

This section is missing important specific and updated information on the KHSA, ICP, RMP, and Klamath Basin Restoration Agreement (KBRA) that are directly relevant to the TMDL and its eventual implementation.

COMMENTS: CHAPTER 2. PROBLEM STATEMENT

2.1 Introduction

Page 2-2, under *2.1.1 Non-TMDL Factors and other Regulatory Processes*. The naturally-eutrophic nature, and currently hypereutrophic status, of Upper Klamath Lake (UKL) has been and remains an overwhelmingly important factor to Klamath River water quality. Yet it is not mentioned as a factor impacting beneficial uses in the bullets listed under this section of the Revised Draft TMDL.

Page 2-2, Paragraph 1, Lines 3-4. The Revised Draft TMDL indicates that water quality monitoring data were compiled "from several sources" to support the Revised Draft TMDL analysis, including "data from eleven stations along the length of the Klamath River". However, the data used in the Revised Draft TMDL does not include or cite many key water quality studies and data for the Klamath River Basin. See the list provided in the attached Appendix A in PacifiCorp's August 2009 comments on the original Draft TMDL. Omission of these key reports and documents indicates that a thorough review of available reports and data was not completed, but rather a selective set of data were used in the TMDL analysis and development of load allocations.

2.2 Water Quality Standards

Page 2-4, Paragraph 1. The Revised Draft TMDL notes all of the existing beneficial uses for the Klamath River and makes particular note of uses "that are currently not fully supported due in part to degraded water quality," including aquaculture. The Revised Draft TMDL did not address, however, the potentially significant negative effect to the hatchery and its aquaculture beneficial uses should the dams be eliminated. Aquaculture at the hatchery is made possible by Iron Gate reservoir, which provides a cold water supply for the hatchery (especially certain hatchery programs, such as a yearling program which requires sufficient cold water flow during the summer months). Iron Gate reservoir supports the aquaculture beneficial use since the cold water supply to the hatchery is free of disease parasites. This is due to the fact that the reservoir does not provide suitable habitat for spore survival. Fish from the hatchery are thus free of fish disease - which is significant in a river in which fish disease is a major concern. As a result, the removal of Project dams may have the effect of impacting or possibly eliminating at least portions of the existing hatchery operations whereas there are water quality conditions that could reasonably be achieved through the coordinated control of all factors which affect water quality.

Page 2-6, Paragraph 9, Lines 3-5. The Revised Draft TMDL states, "The federal Clean Water Act (CWA) imposes a criterion for setting loads *in addition to* the water quality standards defined by the State. For waters impaired by temperature, CWA 303(d)(1)(D) requires that states estimate 'the total maximum daily thermal load required to assure protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife.'" (Emphasis added.) PacifiCorp agrees that thermal TMDLs must be established at the level required to ensure protection of a balanced, indigenous population of shellfish, fish, and wildlife (BIP). Establishing the maximum thermal load required to ensure a BIP, however, is not a requirement that is "in addition to" establishing the maximum thermal loads necessary to achieve water quality objectives or criteria for temperature. Rather, under the CWA, the maximum thermal load required to ensure a BIP is the only permissible basis for a thermal TMDL. *See* 33 U.S.C. § 1313(d)(1)(D). *Cf.* 40 C.F.R. § 130.7(c)(1) ("*For pollutants other than heat*, TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical WQS [water quality standards]") (emphasis added). The thermal TMDL may not be based on narrative or numeric temperature objectives or criteria, such as those in the Basin Plan or the Thermal Plan. As explained below and in PacifiCorp's previous comments, the thermal TMDL presented in the Revised Draft TMDL is inconsistent with the CWA because it does not determine, and would not establish, the thermal load limits *required* to ensure a BIP.

Page 2-8, under Nutrient-Related Water Quality Objectives. The Revised Draft TMDL states: "[T]he cycling of nutrients in an aquatic environment is strongly influenced by several factors." However, the Revised Draft TMDL does not tackle this problem in any quantitative manner. The specific cycling of nutrients in the aquatic system is stated several times throughout the document, but no analysis on nutrient cycling (Kaplan and Newbold, 2003), spiraling, spiraling rates or velocities (Elwood et al,1983; Kalff, 2002) or other similar analysis is included. The role of the benthic environment, in eutrophic systems in particular, is critical to these discussions, yet these important attributes are unquantified and not discussed in the Revised Draft TMDL.

2.3 Numeric Targets for the Klamath River Basin TMDLs

Pages 2-16 and 2-17. The Revised Draft TMDL contains new text on these pages that describe current trophic conditions in Upper Klamath Lake and the Klamath River. On page 2-16, the Revised Draft TMDL correctly points out that "In the case of Upper Klamath Lake (UKL), the transition from a natural background condition of eutrophic to its current hypereutrophic status has had profound water quality implications and has resulted in impairment of beneficial uses within the UKL and in downstream waters". By this statement, and elsewhere on these pages, the Revised Draft TMDL is much more clear than the original Draft TMDL that the headwaters of the Klamath River (that is, the outflow from UKL) is hypereutrophic (and has been for about the last 100 years), and prior to that was eutrophic.

Page 2-16, Paragraph 2 through Page 2-17, Paragraph 1. The Revised Draft TMDL states: "Another consideration is ensuring that the target values for the selected indicator(s) are consistent with the desired trophic status of the waterbody, and that the desired trophic status is appropriate for the waterbody." Subsequently, there is discussion of "trophic classification." Such classification scheme is undefined in the TMDL, although a wide range of basic limnology texts provide guidance on trophic status for both rivers and lakes (e.g., Kalff, 2002; Wetzel, 2001; Horne and Goldman, 1994).

On page 2-16, Paragraph 4, the Revised Draft TMDL included new text indicating that the fact that UKL has always been a eutrophic system "…should not be used as an excuse for inaction…or the argument that it useless to reduce nutrient loading because the lake will still be eutrophic…".

To be clear, PacifiCorp has no interest in inaction, nor do we believe it is useless to reduce nutrient loading from UKL. In fact, PacifiCorp believes that actions to reduce nutrient loading are essential to achieve future water quality improvements in the Klamath River downstream of UKL. As discussed above, PacifiCorp is already proactively implementing important water quality measures and activities designed to bring about water quality improvements in the Klamath River basin.

Rather, PacifiCorp is concerned that the Revised Draft TMDL, as with the original Draft TMDL, is based on a huge nutrient reduction goal that is simply unrealistic and unachievable. For example, the Revised Draft TMDL's nutrient allocations at Stateline (and other downstream locations by extension) call for the reduction in total phosphorus (TP) of 90 to 98 percent and total nitrogen (TN) of 65 to 75 percent in the upper Klamath River as required in the Draft TMDL at Stateline. Moreover, as discussed in detail elsewhere in this document, the Revised Draft TMDL's TP and TN concentration targets at Stateline (and other downstream locations by extension) call for in-water nutrient concentrations that are impossibly low – so low, in fact, as to be substantially less than naturally-occurring groundwater concentrations that discharge to the Klamath River in the J.C. Boyle bypass reach just above Stateline.

As a result, the Revised Draft TMDL fails to provide proposed nutrient load allocations that are achievable, practicable, or enforceable. As PacifiCorp made clear in our August 2009 comments on the original Draft TMDL, the Regional Board must address in a realistic manner how the huge reductions of nutrient loads proposed in the Revised Draft TMDL would be achieved. To our knowledge, there have been no documented cases in which nutrient load reductions on such a large scale have been achieved elsewhere, or even concluded as feasible and achievable for planning and implementation purposes, particularly where nutrient sources are overwhelmingly nonpoint source-dominated as in the case of the Klamath Basin.

The federal Clean Water Act (CWA) anticipated situations were water quality standards (WQS) or a TMDL would not be achievable by including processes such as Use Attainability Analyses (UAA) or development of site-specific criteria. In fact, use of the UAA process is the first recommendation by the National Research Council (NRC) on improving the TMDL program, which says that "States should develop appropriate use designations for waterbodies in advance of assessment and refine these use designations prior to TMDL development" (NRC 2001).

Given the unrealistic and unattainable TP and TN reductions needed to meet the Revised Draft TMDL's goals, the TMDL does not comply with the CWA and EPA's implementing regulations. Load allocations to natural and non-NPDES sources must be based on reasonable estimates of actual loadings from these sources. *See* 40 C.F.R. § 130.2(g). If allocations to these sources are less than actual current loadings, then the TMDL must provide a legal and technical justification for the achievability of those allocations; otherwise, the estimates are unreasonable. *See id.*, § 130.2(g), (i). Load allocations to natural and non-NPDES sources that are unenforceable or unachievable given available technology and financial resources are not reasonable. A TMDL cannot be based on fantasies or wishful thinking.

If a proposed TMDL is unachievable, then either (1) the water quality objectives or "targets" on which the TMDL is based are unnecessary to protect beneficial uses or (2) the beneficial uses are not attainable. In the former circumstance, the appropriate courses before establishing the TMDL are either to reconsider the water quality "targets" that interpret the water quality objectives or to adopt and obtain EPA approval of revised water quality objectives. In the latter circumstance, the appropriate course before establishing the TMDL is to conduct a use attainability analysis (UAA) to specify the attainable beneficial uses. But regardless whether the appropriate course is to revise water quality targets or objectives or to conduct a UAA, a TMDL that cannot be demonstrated to be achievable is inconsistent with both the CWA and a rational, intellectually honest public policy.

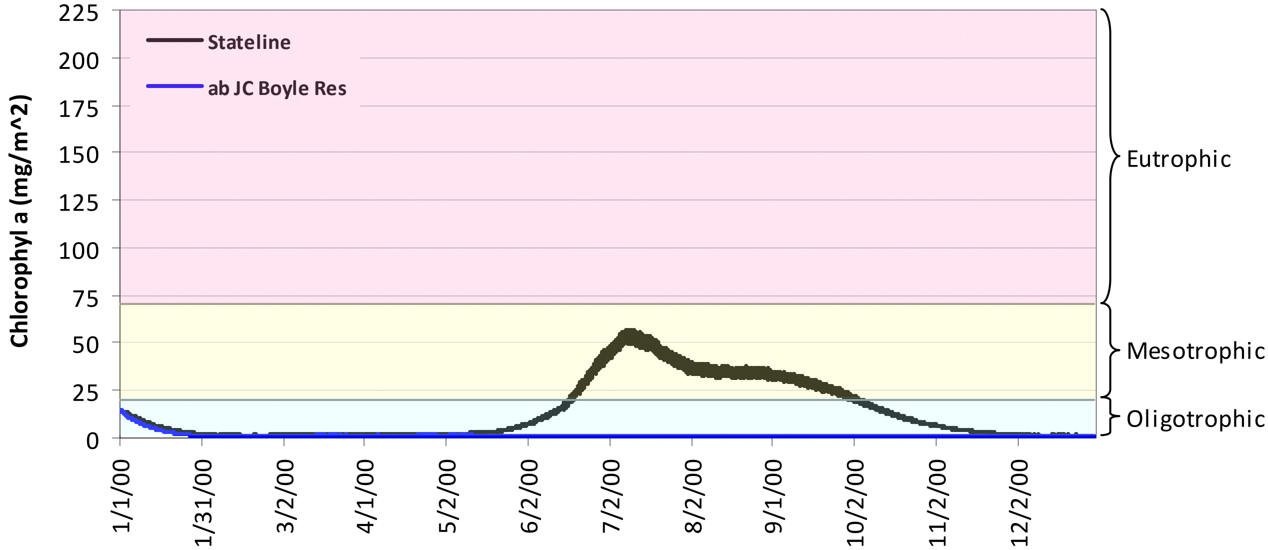
Potential Adverse Consequences of TMDL Nutrient Reductions on Aquatic Species

A significant concern associated with the low nutrient targets identified in the draft TMDL is limited primary production. The natural baseline conditions identifies that available inorganic nutrients in certain reaches are near or below detection limits from late spring into early fall (with very low levels of organic matter during this period as well). In fact, the Revised Draft TMDL model assumes nutrient concentrations (including organic matter sources) that are so low that modeled benthic algae do not grow in the natural conditions simulation. An examination of benthic algae densities in the Revised Draft TMDL model's natural conditions baseline illustrates this concern (see Figure A1 below).

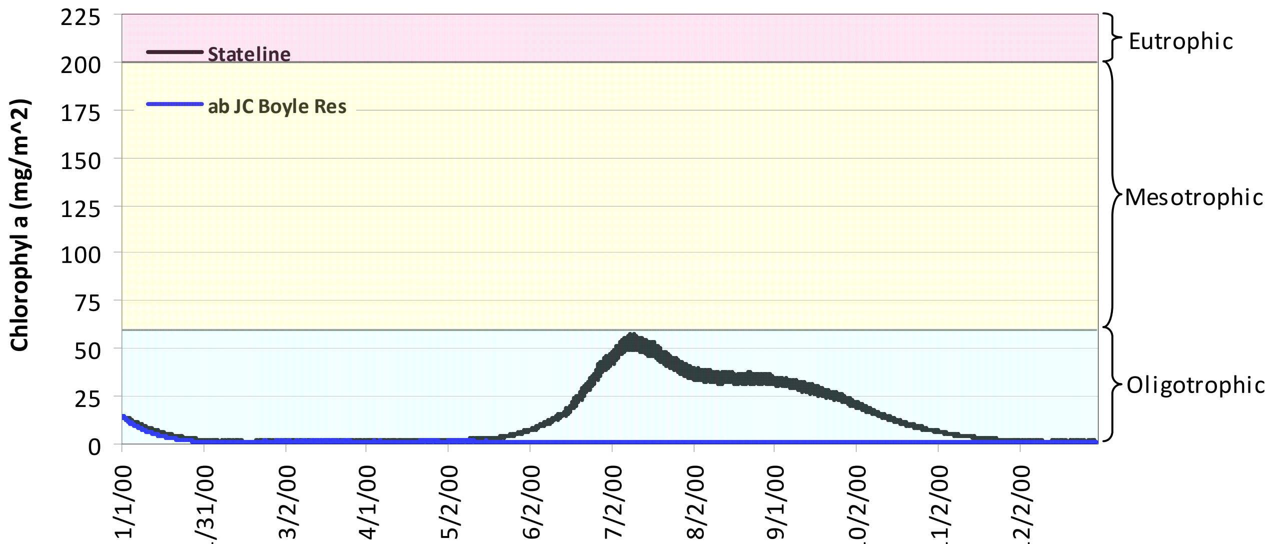
The simulated benthic chlorophyll *a* concentrations from the natural conditions baseline scenario for the Klamath River above J.C. Boyle Reservoir and at Stateline approximate conditions above and below the large springs complex below J.C. Boyle Dam. Above the springs complex, the simulated benthic algae densities are essentially zero in this scenario throughout the year. The reduction in density through January is due to the influence of the initial conditions specified by the model user. The minimum value through the remainder of the year approximately represents the minimum standing crop as specified by the model user, i.e., there is no significant growth and this minimum is a function of a user specified minimum.

In short, the Revised Draft TMDL model simulation results indicate that there are insufficient nutrients (neither inorganic nor organic forms) to support a standing crop of benthic algae. This nearly complete lack of primary production (phytoplankton are moving through this reach, but concentrations are low, ranging from 1 to 2 mg/l) simulated by the model is unrealistic and infeasible. If these unrealistic modeled conditions are assumed as accurate, then the Revised Draft TMDL is based on nutrient reductions that would have profound implications on the food web within the aquatic system (and possible terrestrial implications as well).

Further, these simulation results indicate that mean benthic algae conditions (represented as chlorophyll *a* with a conversion of 67 mg of algae per mg of chlorophyll *a* (APHA et al, 2005), which is consistent with Appendix 6 of the Revised Draft TMDL) are ultra-oligotrophic below Keno Dam and mesotrophic below the large springs complex. The mesotrophic status in summer is presumably due to benthic algae growth as a result of naturally elevated nutrient concentrations in the springs complex. When examining maximum benthic algae conditions (represented as chlorophyll *a*) in these simulations, the system is always oligotrophic. The implications of the basic assumptions used in modeling natural baseline conditions – those assumptions that resulted in what is essentially an oligotrophic system between Keno Dam and the large springs complex – on food webs and productivity are critical to anadromous fish and are not presented in the TMDL.



(a)



(b)

Figure A1. Simulated benthic algae densities. Natural Conditions scenario from the Revised Draft TMDL with trophic classifications for streams shown for (a) mean and (b) maximum chlorophyll a concentrations (after Wetzel, 2001)

Anadromous fish production in oligotrophic streams can be limited by primary productivity (Sanderson et al, 2009, Fisher, 2006) and subsequent impact on food web dynamics (i.e., secondary productivity, tertiary productivity, etc.). Specifically, the level of reduction identified for the natural conditions in the Revised Draft TMDL does not consider food web impacts and overall productivity of the Klamath River under the naturally warm thermal regime, i.e., food web dynamics may be affected to the detriment of beneficial uses (e.g. anadromous fisheries and possibly other aquatic life).

As noted by Peterson (1993) nutrients can have "bottom up" effects on higher trophic levels in aquatic food webs. Further, for those streams with minimal shade, nutrient availability is often the most important factor affecting primary productivity (Peterson, 1993; Hill and Knight, 1988). Coupled with these extreme nutrient reductions, the role of ration for anadromous fish in thermally challenged conditions is important. Myrick and Cech (2000) identify that maximum juvenile growth occurred at lower temperatures when ration was limited. Brett et al (1982 as cited in Myrick and Cech, 2000) illustrated that juvenile fish can tolerate higher temperatures, to a point, so long as ration was not limited. Further, ample ration can also be beneficial to juvenile fish growth in less thermally challenged conditions, increasing their overall fitness (Myrick and Cech, 2000).

Recent studies on the Shasta River (Jeffres et al, 2008; Jeffres et al, 2009) clearly indicate that nutrients fuel the food web (flow → nutrients → primary producers → secondary producers). Steelhead, Chinook, and coho salmon rearing occurs in reaches of the upper Shasta River where water temperatures are seasonally in excess of 20^{o}C (Jeffres et al, 2008) – largely due to the abundant food availability in this reach which is driven from naturally elevated nutrient concentrations in local springs (Jeffres et al, 2009). These discussions have focused on anadromous fish, but the implication on native Redband Trout and other native species, which would not be limited to juvenile rearing life stages, would potentially be substantial.

Thus, there is a fine balance required when managing nutrients in thermally challenged streams to ensure that overall productivity is not sacrificed to meet targets or objectives for other uses. The Revised Draft TMDL has failed to identify these critical processes and does not provide discussion or detailed assessment of the potential implications of dramatic nutrient reductions on food web dynamics and how beneficial uses are affected.

Page 2-17, Paragraph 1, Lines 1-2. The TMDL neither presents nor cites any data to support the assertion that the Klamath River downstream of UKL "historically has ranged from eutrophic to mesotrophic". Assertions such as this must be supported with data or citations to relevant studies or reports. This statement is also in conflict with statements on the previous page (2-16) in which it was acknowledged that Upper Klamath Lake, the headwaters of the Klamath River, has "a natural background condition of eutrophic ". Estimates of the background concentration of phosphorus in Klamath Basin groundwater range from 0.06 mg/L (NRC 2004) to 0.08 mg/L (based on PacifiCorp water quality monitoring data). Thus, it is unlikely that the Klamath River just downstream of UKL was ever mesotrophic – a status typically defined by phosphorus concentrations ranging between 0.01 to 0.20 mg/L (Chapra 1997).

Further, the application of trophic state language to rivers in the same way it is applied to lakes leads to confusion and analytical error. For example, trophic state in a lake can be defined based on planktonic chlorophyll concentration or Secchi depth, which would be clearly inappropriate in a river where most of the chlorophyll is in the form of attached vegetation, and Secchi depth measurements are not possible.

Page 2-17, Paragraph 1, Lines 3-6. The Revised Draft TMDL states that "Reducing pollutant loading in the upper basin is critical to restoring conditions in the upper Klamath River, currently eutrophic and hypereutrophic, to a range more consistent with pre-disturbance conditions that is mesotrophic to eutrophic." The Revised Draft TMDL's statement that restoring condition in Upper Klamath Lake is critical to restoring conditions in the Klamath River is an important finding and statement in the Revised Draft TMDL that was unclear in the original Draft TMDL. However, Upper Klamath Lake's hypereutrophic state and its affect on the river downstream are not realistically dealt with in the Revised Draft TMDL with regard to assessing the attainability of designated beneficial uses, setting realistic water quality objectives and targets, attaining TMDL compliance, and maintaining that compliance into the future. The above statement from page 2-17 of the Revised Draft TMDL clearly states that TMDL's de facto goal with respect to nutrient targets and allocations (as described later in Chapter 4), which calls not just for a shift in trophic status, but an unrealistic and unachievable reduction to the trophic state assumed under "pre-disturbance" conditions (that is, conditions without and before human development and disturbance activities over at least the last century).

Page 2-17, Paragraph 1, Lines 10-12. The TMDL presents no evidence that the mere existence of the Project dams has "shifted the trophic status" of the portion of the river between Stateline and Iron Gate Dam. The TMDL provides no metric by which the trophic status of the river was measured historically or presently, no indication that such a metric, should it exist, is equally applicable to both free-flowing rivers and impounded reservoirs, and no evidence that such a metric, should it exist, is altered by the mere presence of the reservoir, rather than by the influx of excessive nutrients from upstream.

Page 2-17, Paragraph 1, last sentence of paragraph. The Revised Draft TMDL states "[T]he TMDL numeric targets are intended to set restoration goals that are consistent with the formerly supporting trophic status of mesotrophic to eutrophic for the reaches now occupied by the reservoirs." If the TMDL targets are intended to re-establish a formerly existing mesotrophic status, the TMDL must present some evidence to support the assertion that such a former status actually existed, and at what former time that occurred. The TMDL provides no evidence to support its claims. In any case, the Revised Draft TMDL's nutrient targets (identified in Chapter 5) are unrealistic in that they represent nutrient targets for oligotrophic-to-mesotrophic conditions (e.g., see Wetzel 2001) that are far below the Klamath River's naturally-eutrophic condition. Although a "natural conditions" simulation is presented in the TMDL, the supporting information formulating the basis for this state, e.g., "pre-disturbance conditions", is not presented. Thus, the "natural conditions" scenario cannot be evaluated to determine if it is realistic. Load allocations developed in the TMDL to achieve these "natural conditions" therefore cannot be adequately reviewed to determine their appropriateness. This lack of transparency in how "natural conditions" were arrived at impedes the public review process.

Page 2-17, under *2.3.1 Temperature*. The Revised Draft TMDL states, "Establishing load allocations and targets based on natural conditions is the best possible means of achieving a balanced indigenous population . . . . The protection of all beneficial uses ensures a balanced indigenous population of aquatic life." This misunderstands the CWA's thermal TMDL requirement, which is that TMDL must establish "the *maximum* daily thermal load *required* to assure" a BIP. 33 U.S.C. § 1313(d)(1)(D) (emphasis added). Or, as described in EPA's regulations, "the total maximum daily thermal load which cannot be exceeded in order to assure" a BIP. 40 C.F.R. § 130.7(c)(2). Simply taking the most conservative approach possible by setting the thermal TMDL equal to zero is insufficient because it makes no effort to determine the maximum thermal load that is required to ensure a BIP. Although water temperatures are not ideal for salmonids at all places and all times within the Klamath River, these temperatures and the temperature effects of the Project are consistent with a BIP. See, e.g., Findings of Fact on USFWS/NMFS Issue 2(A) and at pages 14-19, 36, 68-69 in McKenna (2007) and 401 Certification Application (2008) at pages 5-60 to 5-104.

Page 2-18, Paragraph 3, Lines 6-8. The Revised Draft TMDL indicates that the California nutrient numeric endpoint (NNE) boundary target is "based on a review of both regional and international studies and the recommendation of university and regional experts". Please cite the studies and provide documentation of the recommendation of experts for the target as it pertains to the Klamath River.

Page 2-18, first bullet, Lines 10-13. The Revised Draft TMDL incorrectly indicates that the Klamath headwaters are eutrophic. Upper Klamath Lake, which is the headwaters of the Klamath River, is well known to be hypereutrophic (e.g., Kann and Smith 1993, Eilers et al. 2001, Walker 2001, ODEQ 2002, Kann and Welch 2005, Wee and Herrick 2005, PacifiCorp 2006). Hypereutrophic lakes are very nutrient-rich lakes characterized by frequent and severe nuisance algal blooms and low transparency; they typically have greater than 40 micrograms/liter total chlorophyll *a* and greater than 100 micrograms/liter phosphorus (Welch 1992, Cooke et al. 2005). Upper Klamath Lake often exceeds these chlorophyll *a* and phosphorus concentrations.

Page 2-18, Paragraph 4, Lines 1-6. The Revised Draft TMDL cites "Ward and Armstrong 2009 in press". The Regional Board should make this document available immediately for public review. The use of documents still "in press" or otherwise unavailable to the public does not allow a thorough review of this TMDL by the public and affected parties. For example, the "Ward and Armstrong 2009 in press" citation is used to support the target of 150 mg/m^2 of benthic chlorophyll *a* as consistent with mesotrophic conditions. However, while trophic classifications in rivers can be difficult to pin down, many researchers have reported that nuisance conditions occur in rivers when periphyton exceeds about 100 mg/m^2 of benthic chlorophyll *a* (e.g., Welch and Jacoby 2004).

Page 2-18, Paragraph 5. The Revised Draft TMDL indicates that "the scoping tool" used for the TMDL estimated benthic chlorophyll *a* levels of 109 to 157 mg/m^2, with a mean of 141 mg/m^2 under natural conditions (which the Revised Draft TMDL indicates is "consistent with pre-disturbance conditions"). Therefore, the Revised Draft TMDL's own estimates indicate that benthic chlorophyll *a* consistently exceeded nuisance conditions (of 100 mg/m^2) and on occasions exceeded the TMDL's target (of 150 mg/m^2) under natural (pre-disturbance) conditions.

Page 2-19, Paragraph 2. Line 1-2. In addition to the above comment, the benthic chlorophyll *a* target of 150 mg/L is also questionable because the methodology to measure it is undefined. Other than stating that it is a "reach average" (undefined) value, there is no information about how this target will be measured. Any benthic biomass value is quite susceptible to measurement methodology. Without precisely defining how the target is to be measured, there is no way to establish if it has been met. In addition, the target makes no mention of attached macrophytes, which are a major portion of the aquatic plant biomass in the Klamath River, especially where suitable habitat exists.

Page 2-19, Paragraph 2. Line 2-3. The Revised Draft TMDL states "this is a reach-average benthic algae biomass target". There is limited data on benthic biomass in the Klamath River, and that which is available indicate a wide range of conditions present in the river, i.e., high spatial and temporal variability. In fact, data from different years and sites are combined into a single metric, different sample sizes are treated equally, the duration of the sampling programs in any one year do not exceed two months, except 2007, and in that year there are no samples above Weitchpec.

Species counts are available for periphyton for limited reaches of the river and completely absent in other reaches; macroalgae, macrophytes, filamentous algae and other non periphyton forms have not been quantified; associated chlorophyll *a* data to estimate biomass of periphyton are lacking; spatial variability in species has not been quantified. Thus, predictions of algal biomass (using any of the methods identified) are unsubstantiated, and extending these results to future conditions is thus tenuous. These sparse data sets with an analysis that does not detail assumptions and uncertainty are used to arrive at the 150 mg/L target (consistent with a eutrophic stream) that is inconsistent with the Revised Draft TMDL nutrient targets (consistent with oligotrophic-to-mesotrophic conditions). As mentioned in previous comments, the Revised Draft TMDL should include a sensitivity analysis to bracket the range of potential conditions and to compensate for data gaps and shortfalls in understanding.

Page 2-19, Paragraph 4, first bullet. The Revised Draft TMDL's chlorophyll *a* target of 10 µg/L is inconsistent with Oregon's guideline chlorophyll *a* criterion of 15 µg/L, which is itself used only as a conservative screening level to identify waterbodies that may be impaired. The Revised Draft TMDL does not explain this inconsistency or why a more stringent target is needed in California. The Oregon guideline criterion also has a defined methodology for data collection to determine if it has been met. The Revised Draft TMDL lacks a defined methodology.

Page 2-19, Paragraph 4, second and third bullets. The Revised Draft TMDL's targets for *Microcystis* and microcystin targets are not necessary for the protection of the beneficial use (REC1). Both the Oregon Department of Health and the California Office of Environmental Health and Hazard Assessment have set 40,000 cells/mL (of *Microcystis* or *Planktothrix*) and 8 µg/L microcystin as the criteria that are protective of public health. The TMDL should present data or citations to relevant sources to justify the necessity of a 50 percent reduction in the guideline.

Page 2-19, Paragraph 5, last sentence of the paragraph. Prolonged high levels of chlorophyll *a* are typical of eutrophic *and* hypereutrophic water bodies.

Page 2-20, Paragraph 2. The Revised Draft TMDL includes new text here that attempts to explain that the 10 µg/L chlorophyll *a* target is appropriate for the reservoirs and other "quiescent waters" in the Klamath River "…because it marks the boundary between eutrophic and hypereutrophic". However, a 10 µg/L chlorophyll *a* concentration more approximately marks the boundary between mesotrophic and eutrophic (Chapra 1997, Wetzel 2001, Welch 1992, Lampert and Sommer 1997). Additionally, the chlorophyll *a* target is meaningless because there is no information about how this target will be measured. Any chlorophyll *a* value is susceptible to measurement methodology. Without precisely defining how the target is to be measured, there is no way to establish if it has been met.

Page 2-20, Paragraph 2. The Revised Draft TMDL includes new text stating, "The river upstream rarely exceeds 10 µg/L of chlorophyll- a, despite the currently eutrophic condition of the system". As in the original Draft TMDL, the Revised Draft TMDL continues to make inappropriate and misleading comparisons between river and reservoir conditions using the 10 µg/L chlorophyll *a* target, which the Revised Draft TMDL clearly states is applicable only to the reservoirs as a "surrogate measure of suspended algae (phytoplankton) biomass…for the Klamath River reservoirs" (page 2-19, paragraph 4). The Revised Draft TMDL has developed and applied a different chlorophyll *a* target for the river – that is, the benthic algae biomass target of 150 mg/m^2 of chlorophyll *a*.

Page 2-22, Paragraph 1. The Revised Draft TMDL includes new text discussing relationships of chlorophyll *a* and algal biomass related to potential health effects. The Revised Draft TMDL cites Graham (2009) to the effect that 10 µg/L would equate to a moderate probability of acute health effects from microcystin. The table referenced in Graham (2009), cited by the Revised Draft TMDL to support its unnecessarily low target misrepresents the World Health Organization (WHO) guidelines for recreational water. In fact, the WHO (2003) guidelines equate a moderate probability of adverse health effects to the presence of 100,000 cyanobacterial cells/mL or 50 µg/L of chlorophyll *a*, with no mention of "acute" effects. This is five times greater than the proposed TMDL target. The TMDL must present data or citations to relevant sources to justify this extreme reduction.

The 10 µg/L chlorophyll *a* target in the reservoirs was not chosen to protect the beneficial use, but because it correlates to a relatively low probability of exceedence of 20,000 Microcystis cells/mL or 4 ppb microcystin/L. The values of 20,000 cells/mL and 4 ppb microcystin are not necessary for the protection of beneficial uses (water contact recreation), as demonstrated by the WHO guidelines for recreational water (WHO 2003), which identifies a "moderate probability of adverse health effects" at 50 µg/L chlorophyll *a* and 100,000 cyanobacterial cells/mL. The Oregon Department of Health and the California Office of Environmental Health and Hazard Assessment both use criteria of 40,000 cells/mL (of *Microcystis* or *Planktothrix*) and 8 ppb of microcystin for posting water bodies to protect public health. As such, 40,000 cells/mL (of *Microcystis* or *Planktothrix*) and 8 ppb of microcystin are protective of the beneficial use. It is unreasonable to use a target that is half the established public health criterion, and the Revised Draft TMDL needs to provide evidence to justify this choice.

Based on Figure 2.3 in the Revised Draft TMDL, using the same probability of exceedence acceptable to the TMDL (approximately 24 percent) for a public health-protective 40,000 cells/mL, the corresponding chlorophyll *a* value is approximately 18 µg/L. Likewise, the same operation on Figure 2-4 for 8 ppb microcystin gives a corresponding chlorophyll *a* value of approximately 17 µg/L.

Given the above, 15 µg/L chlorophyll *a* (as a growing season average) would be a reasonable chlorophyll *a* target that would be protective of the beneficial use (water contact recreation).

Page 2-22 to 2-30. On these pages, the Revised Draft TMDL cites at length an analysis (in Draft form) by Kann and Corum (2009) that purports to show that increasing chlorophyll-a concentration leads to increasing likelihood of exceeding the WHO guidelines for *Microcystis aeruginosa* abundance or microcystin concentration. This Revised Draft TMDL analysis misstates the situation. The threshold analysis shows some correlation between the targets chosen, but it does not show that the targets are necessary or appropriate for protecting beneficial uses. These targets must be supported by data that demonstrates the targets are protective of beneficial uses.

The Revised Draft TMDL has selected target levels of 20,000 cells/mL for *Microcystis* and 4 µg/L for microcystin, and set the chlorophyll-a target at 10 µg/L based on a simplistic correlation to *Microcystis* and microcystin. However, this correlation shows that, at the proposed target level of 20,000 cells *Microcystis*/L, it is more likely than not (53 percent) that the microcystin concentration would be less than 4 µg/L (see Revised Draft TMDL, page 2-28), a value that WHO has determined has a low probability of causing adverse health effects, when in drinking water, during a lifetime (75 years) of consumption. The Revised Draft TMDL's targets for *Microcystis* and microsystin are substantially lower than the current guidelines used by both Oregon and California (i.e., 40,000 cells/mL and 8 µg/L, respectively), but the Revised Draft TMDL provides no justification for choosing such low targets. Without such justification, based on data or citations to relevant reports, the selected targets are arbitrary.

The 10 µg/L chlorophyll *a* target is not achievable. Extensive research over decades (e.g., Vollenweider and Kerekes 1982) has established a clear relationship between total phosphorus and chlorophyll *a* concentration. Because of the permeable nature of the volcanic rocks prevalent throughout the upper Klamath basin, groundwater forms a major portion of the flow of upper Klamath Basin streams including the Klamath River. A total phosphorus concentration of 0.07 to 0.08 mg/L (or 70 to 80 µg/L) – the natural background concentration of groundwater entering the Klamath River – puts the Klamath reservoirs clearly in the naturally-eutrophic range. Based on empirical relationships between phosphorus and chlorophyll *a* (OECD 1982), the baseline chlorophyll *a* concentration in the reservoirs under natural conditions would likely be greater than 20 µg/L with short-term maximums exceeding 70 µg/L (Wetzel 2001). As discussed elsewhere in these comments (see comments on Page 2-66, Figures 2.16 and 2.17), the phosphorus concentration necessary to meet the 10 µg/L chlorophyll *a* target cannot be achieved.

2.4 Water Quality Conceptual Models Overview

Page 2-36 to 2-39. The Revised Draft TMDL discusses a hypothesized linkage between increased nutrient loading and increased incidence of fish disease. On page 2-36, the Revised Draft TMDL states "The pathways that have resulted in major documented fish mortalities in the Klamath River in the last several years are illustrated as follows: increased nutrient loading (NA1) $\rightarrow$ elevated periphyton/macrophyte growth (NB1) and elevated suspended algae and blue-green algal growth (NB2) $\rightarrow$ increased polychaete habitat (NB4) $\rightarrow$ increased polychaete population and *Ceratomyxa shasta* (*C. shasta*) population and dosing (NB9)". However, the Revised Draft TMDL presents no evidence or citations to evidence that such pathways "have resulted in major documented fish mortalities in the Klamath River." In the absence of such evidence, the hypothesized causal relationship between nutrient loads and fish disease in the Klamath River is unsubstantiated and speculative. Moreover, the Revised Draft TMDL does not describe or consider important uncertainties in the hypothesized causal connections between nutrient loads and fish disease.

Page 2-36 and 2-37. The Revised Draft TMDL includes new text describing anecdotal information obtained from personal communications with Richard Stocking. These personal communications are used to support the Revised Draft TMDL's "conceptual model" assumption that "…high levels of FPOM [fine particulate organic matter] exported from the reservoirs during the summer months….appear to be a critical factor determining distribution and abundance of M. speciosa". There is no definition of what constitutes "high" levels of fine particulate organic matter (FPOM). There is no evidence to support the Revised Draft TMDL's assumption that there is increased deposition of organic matter below the dams in the river channel below the dams or that, if there were, it increases polychaete habitat. This assumption is purely speculative. In fact, from the available data, it is clear that if the Project reservoirs have altered the distribution of organic matter in the lower Klamath River, it has reduced it. Actual empirical information on organic matter in the river is and has been available to the Regional Board that is not presented in the Revised Draft TMDL (e.g., see Deas 2008). The available empirical data show that average values for dissolved organic carbon (DOC) are significantly lower at the hatchery bridge below Iron Gate Dam compared to above J.C. Boyle reservoir ($P < 0.01$) and that total suspended solids (TSS) and volatile suspended solids (VSS) are not significantly different ($P > 0.05$)[1]. The values at the hatchery bridge tend to be slightly higher, but not significantly different than, those measured in Iron Gate reservoir. However, there are several hundred meters of prime habitat for benthic algal species – a potential source of increased organic matter and diatoms - between the tailrace of Iron Gate dam and the hatchery bridge where measurements were made. DOC measured at the hatchery bridge and Iron Gate tailrace is the same.

Page 2-38, Paragraph 1. The Revised Draft TMDL disregards some key findings from Stocking and Bartholomew (2007) on the distribution and relative abundance of polychaetes and their habitats throughout the Klamath River to the estuary. Stocking and Bartholomew (2007) found the highest densities of polychaetes in the reservoir *inflow* areas compared with the river samples. This contradicts the Revised Draft TMDL's assumption that reservoirs are contributing to higher polychaete densities. Stocking and Bartholomew (2007) indicated that it was the capacity for a habitat to buffer against disturbances that was the critical factor in determining the distribution and abundance of the polychaetes in riverine environments and did not mention nutrients as a potential factor.

Stocking and Bartholomew (2007) examined live specimens of the polychaete and found that their diet consisted of very fine detritus and diatoms. There is no evidence that FPOM increases in a downstream direction from Link River dam, and diatoms are found throughout the river. There are no data presented or cited to support the assertion that suspended algae and cyanobacteria growth in Iron Gate reservoir contribute to increased polychaete populations, particularly in the identified "hot spot" of disease infection located downstream of the Beaver Creek confluence, which is approximately 16 miles below Iron Gate dam.

[1] Data for DOC, TSS, and VSS from Deas (2008).

The available data do not support the Revised Draft TMDL's assertion that large quantities of phytoplankton (specifically diatoms) grow in and are released from Iron Gate reservoir. Conversely, the data show that very few diatoms are released from the reservoir compared to the quantity that grows in the river between the dam and the sampling point at the hatchery bridge. Removal of the reservoirs would provide considerably more riverine habitat to grow extensive quantities of diatoms and increase that fraction of the food source for the polychaetes that would colonize the new habitat, thus exacerbating the potential for disease transmission.

Page 2-38, Figure 2.10. It is not clear how the diagram in Figure 2.10 illustrates anything about the balance between parasite, host and environment or what relevance that has to the Project reservoirs. Elevated nutrient concentration is not a function of the Project reservoirs, but of Upper Klamath Lake and other upstream sources. Increased habitat is not a function of the Project reservoirs – if anything the Project reservoirs act to decrease polychaete habitat since the reservoirs do not provide suitable polychaete habitat. No data are presented to support the assertion that elevated phytoplankton growth in Iron Gate reservoir increases downstream polychaete populations.

Page 2-39, Paragraph 1. The Revised Draft TMDL asserts that reduced peak flows are a factor in the proliferation of *C. shasta*, but it provides no data or citations to support this assertion. However, there are ample data and reports to the contrary that have been and are available to the Regional Board (e.g., see PacifiCorp's March 2004 Exhibit E Environmental Report and the 2007 FERC EIS on the Klamath Hydroelectric Project Proposed Relicensing). PacifiCorp's Project reservoirs do not change Klamath River peak flow conditions. This is because the reservoirs have minimal active storage, and elevated flows are simply passed over the spillways. Thus, the magnitude and frequency of peak flows or "scouring" flows are not affected by the Project as asserted.

Further, on page 2-39, the Revised Draft TMDL needs to clarify that the "hotspot" of *C. shasta* density is actually located in the reach extending from the Shasta River to the Scott River, and that the reach just below Iron Gate dam has a relatively low *C. shasta* density (see Figure A2 below). The Revised Draft TMDL states that among the "…parasite promoting factors included in the conceptual model… is that high densities of salmonids trapped in the reach below Iron Gate lead to increase[d] shedding of the myxosporean spore…" (page 2-39). However, the Revised Draft TMDL needs to discuss that a major source of myxospores is salmon spawners in Bogus Creek downstream of Iron Gate Hatchery. Bogus Creek fall Chinook escapement has averaged 9,000 fish since 2002. This constitutes about 30 percent of the total fall Chinook production for the Klamath River (Trinity River excluded). In fact, the number of fall Chinook that spawn in the mainstem Klamath River is a relatively small proportion of the total basin-wide escapement (see the FERC Final EIS on the Project relicensing).

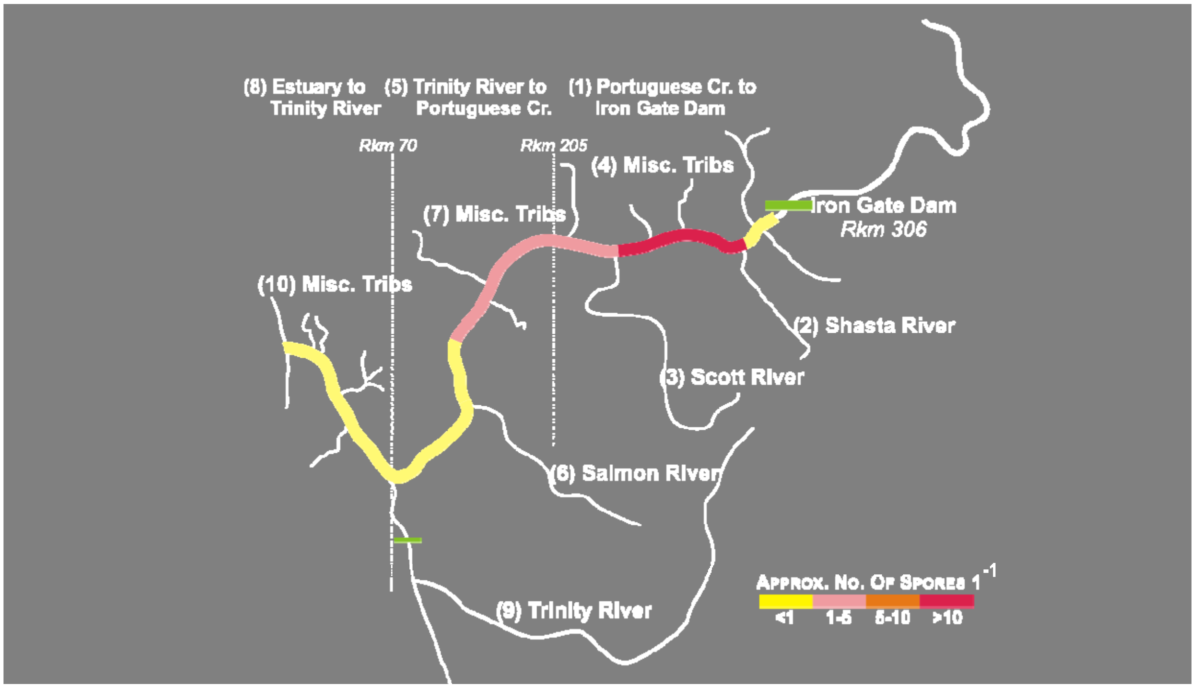


Figure A2. Density of C. shasta in the Klamath River below Iron Gate dam (Scott Foott, pers. comm.. 2008).

In addition, Stocking's (2006) data indicates that mortality due to *C. shasta* infection was both greatly reduced and delayed in rainbow trout groups exposed in the Upper Klamath River (from Link to Iron Gate dam) when compared to groups exposed in the Lower Klamath River (Iron Gate dam downstream). In general, mortality was reduced and delayed in the reservoir groups when compared to groups exposed in the free-flowing stretches of the river.

Stocking (2006) states that the presence of the four reservoirs in the upper basin likely significantly reduces the abundance and distribution of the *C. shasta* actinospore. The infectious stage (actinospore) is viable for less than 10 days under laboratory conditions. Because of their higher capacity and longer retention time relative to the free-flowing stretches, the reservoirs may serve to dilute incoming spore densities and impede passage of the fragile actinospore by means of spore sedimentation. Stocking (2006) states that, if high spore densities resulted in the high mortality documented in exposure groups held in the Lower Klamath River, then it seems likely that continuity of water flow (absence of obstructions) is an important factor in explaining the differences between the Upper Klamath River and the Lower Klamath River results.

Page 2-40 to 2-44, under 2.4.2.3 Nutrient Risk Cofactors. The Revised Draft TMDL does not discuss the variation in these nutrient risk cofactors with regard to space or time, but implies that such conditions are prevalent at all times in all places. In fact, many of the "cofactors" are not consistently applicable in the basin, and certain of these processes are not naturally amenable to implementation actions described in the Revised Draft TMDL. For example, the "reduced riparian habitat" description (page 2-40) suggests that riparian vegetation restoration serves as a panacea for restoring DO and pH, slowing down SOD and BOD processes, and cleansing pollutant runoff. However, the Revised Draft TMDL includes no discussion of where such habitat exists or where such habitat is lacking (naturally or unnaturally). The Revised

Draft TMDL identifies no measures of quantifiable benefit, or the limitations that may exist for such restoration or management. The Revised Draft TMDL provides only general statements that do not support the selection and relevance of "cofactors" for the Klamath River, except in a conceptual or theoretical manner.

Page 2-41, First Bullet, Altered flow conditions. As discussed above, PacifiCorp's Project reservoirs do not change Klamath River peak flow conditions. The reservoirs have minimal active storage and elevated flows are simply passed over the spillways. Thus, the magnitude and frequency of peak flows or "scouring" flows are not affected by the Project as asserted. There are ample data and reports on this matter that have been and are available to the Regional Board (e.g., see PacifiCorp's March 2004 Exhibit E Environmental Report or the 2007 FERC EIS on the Klamath Hydroelectric Project Proposed Relicensing). In addition, PacifiCorp's March 2004 Water Resources Final Technical Report includes a detailed geomorphology analysis showing that peak flows regularly exceed flow levels capable of mobilizing and transporting gravels.

Page 2-41, First Bullet, Altered flow conditions. The Revised Draft TMDL needs to specifically define "periphyton accrual time".

Page 2-41, Paragraph 4, first bullet under "Impoundments". The Revised Draft TMDL cites analysis and results from "Asarian et al. (2009)". This citation is not included in the References (page 2-102), and has not been made available for public review. This is another example of the TMDL's use of documents still "in press" or otherwise unavailable to the public, preventing a thorough review of this TMDL by the public and affected parties. The Regional Board may not base its analysis and TMDL upon evidence outside the record and not made publicly available.

Page 2-41, Paragraph 4, under "Impoundments ($_N$C7)". The Revised Draft TMDL includes new text on the matter of net annual retention of nutrients in Copco and Iron Gate reservoirs. The Revised Draft TMDL states that the results of the publically-unavailable study by "Asarian et al. (2009)" determined that the net annual retentions of nutrients in Copco and Iron Gate reservoirs includes "[a} reduction of 15% Total Nitrogen and 10% Total Phosphorous delivered downstream", and "[d}uring the summer critical growth months (May – September) the reservoirs had a combined retention for TP of 8% and 31% for TN." The Revised Draft TMDL states that "This level of reduction on an annual mass loading basis is not large and the net effect on downstream water quality if this loading was to occur in the absence of the dams is not significant" (page 2-42, paragraph 2, under second bullet). Retention of the inflowing load of TP at a rate of 10 percent annually equates to a reduction of about 71,000 pounds of total phosphorus, and retention of the inflowing load of total nitrogen at a rate of 15 percent annually equates to a reduction of about 453,000 pounds of TN. The Revised Draft TMDL's characterization of these reductions as "not large" and "not significant" is misleading and discounts the very reduction in nutrients levels that the TMDL seeks to achieve.

In addition to downplaying reservoir retention of nutrients, the Revised Draft TMDL also does not recognize the beneficial role of the reservoirs in shifting the timing of inflowing nutrient "peaks" from upstream sources, notably Upper Klamath Lake. On page 2-42, paragraph 1, under the first bullet, the Revised Draft TMDL includes new text on the "event-driven spikes of nutrient loads". The Revised Draft TMDL acknowledges that "It is clear that the reservoirs spread out event-driven spikes of nutrient loads", but it goes on to suggest that "this is not necessarily beneficial in regard to algal response in the lower river" because "a good portion of such load would flush through the system without elevating concentrations long enough to allow full periphyton response". The Revised Draft TMDL mischaracterizes and misunderstands the effect of the reservoirs on "event-driven spikes of nutrient loads".

PacifiCorp (2006) provides a detailed analysis of the role of the reservoirs in shifting the timing of inflowing summertime nutrient "peaks" from upstream sources, notably Upper Klamath Lake. The travel times of flows in the river are important to understanding and explaining nutrient dynamics in the Klamath River. It is apparent that the very large loads of nutrients and organic matter in the Klamath River from Upper Klamath Lake and other upstream sources are often "event-driven" – that is, characterized by large "spikes" of organic matter delivered to the river following the collapse of large algae blooms that are typical in Upper Klamath Lake during the algae growing season. Therefore, it follows that such substantial nutrient "events" would have a downstream influence on nutrient concentrations at a particular point in space and time along the river. This influence would manifest itself in the form of a downriver "lag" in the event, the extent of which would depend on river travel times.

To assess potential "lag", Watercourse Engineering simulated the downstream movement of nutrient events using the RMA-2 dynamic hydraulic model and the RMA-11 water quality model (PacifiCorp 2006). These simulations clearly illustrate the occurrence of a lag associated with travel time through the reservoirs. Figure A3 below shows notable decreases in the magnitude of the peak of the event in Copco reservoir, and the lag of the peak due to travel time through Copco reservoir. Similar decreases and lag times occur through Iron Gate reservoir. The reservoir lag times are considerable, allowing for processes such as decay and settling to occur. These simulated results also support empirical data findings of nutrient reductions in reservoirs and "lag" of peak nutrient concentrations (see Figure A4 below).

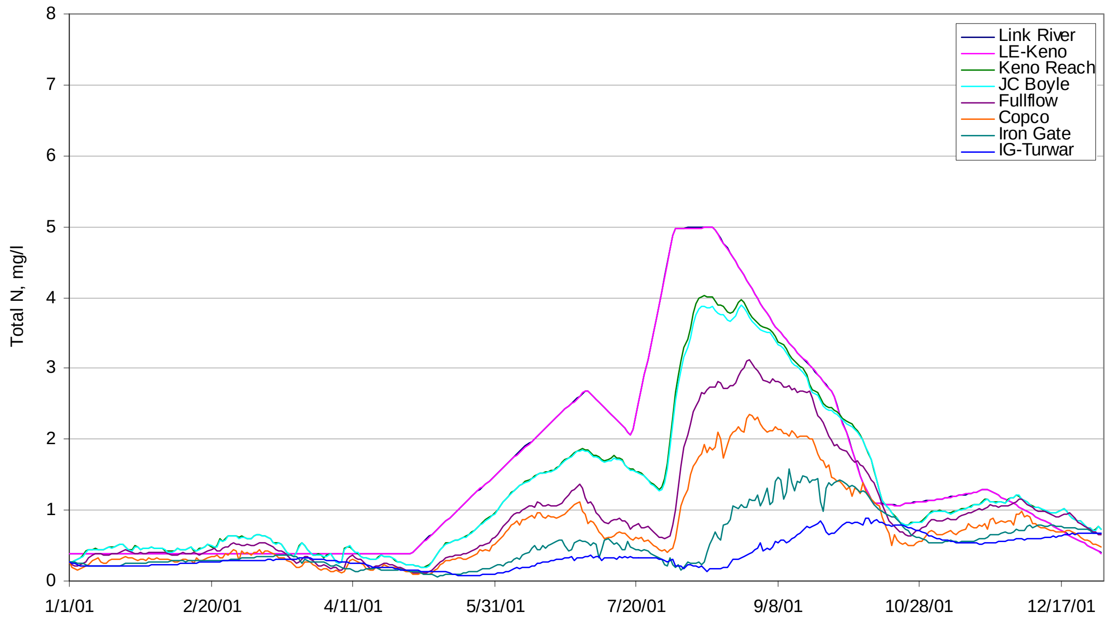


Figure A3. Model simulations of total nitrogen in the downstream direction for the Klamath River from Link dam to Iron Gate dam for existing condition (graphic labels correspond to the head of each reach).

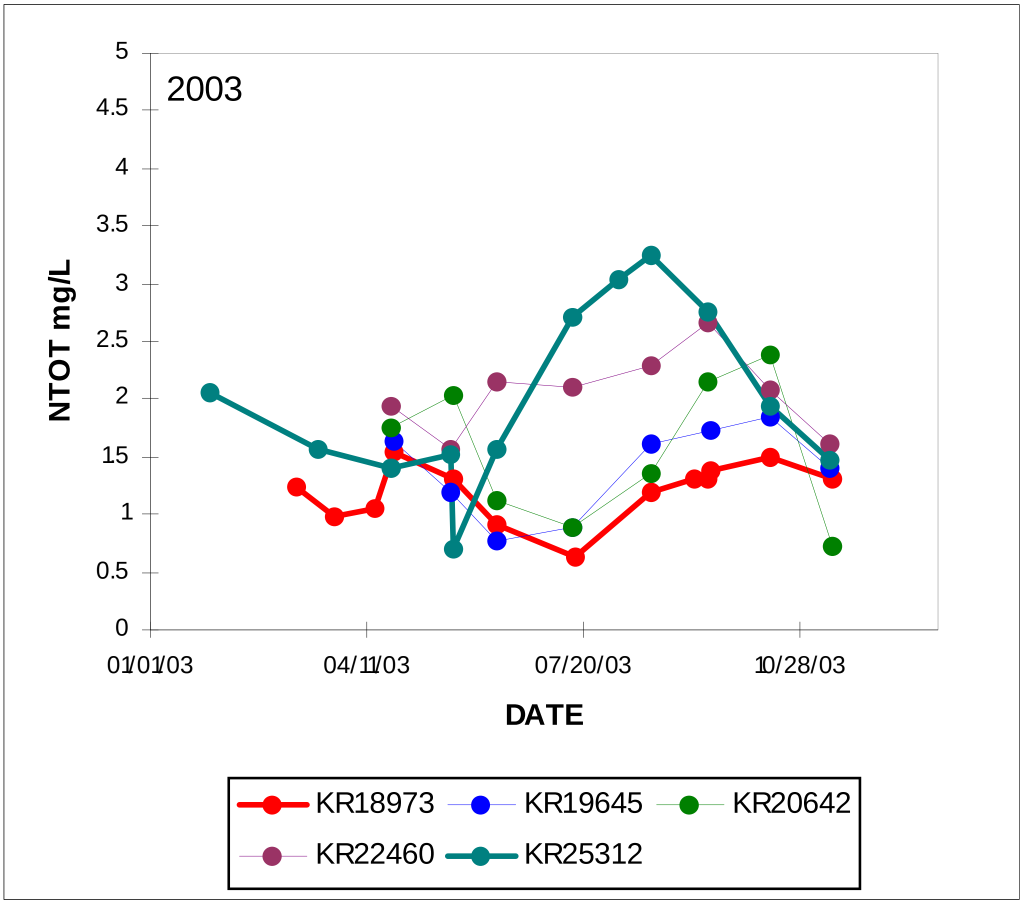


Figure A4. Observed total nitrogen values (NTOT; in mg/L) during 2003 in the Klamath River below Iron Gate dam (KR18973), above Iron Gate reservoir (KR19645), above Copco reservoir (KR20642), below J.C. Boyle dam (KR22460), and below Link dam (KR25312).

The lag effect from the reservoirs attenuates the peak influx of nutrients in the River. In the cases shown in Figures A2 and A3, the peak TN leaves Link dam in late July in the middle of the algae growth season. This peak does not manifest itself at Copco dam until some weeks later, and does not appear at Iron Gate dam until well into October, and then is considerably attenuated. This attenuation of TN influx further into the future suggests the reservoirs have a beneficial effect on reducing downstream attached benthic algae (periphyton) in the river during the peak algae growing season. Without the reservoirs, the simulations indicate that peak TN conditions would occur coincident with the maximum standing crop of benthic algae in late July or early August. With the reservoirs, the simulations indicate that peak TN conditions are lagged by several weeks into late summer and early fall when the benthic algae community is in overall senescence due to lower solar altitude and decreased day length. Conversely, in the absence of the Copco and Iron Gate reservoirs, it is likely that attached benthic algae (periphyton) would increase in the river downstream of Iron Gate during the peak algae growing season. Nutrients released to the river system below Iron Gate dam in midsummer rather than in late summer and early fall would have a considerably greater potential for being sequestered in algal biomass (Biggs 1996).

Page 2-42, Paragraph 2, under first bullet. The Revised Draft TMDL should define what is meant by "event-driven pulses", and what upstream conditions cause or create them. The Revised Draft TMDL states "Without the dams, much of the nutrient load would move in event-driven pulses and a good portion of such load would flush through the system without elevating concentrations long enough to allow full periphyton response". This statement is incorrect and misleading. First, pulses of nutrients in the Klamath River originating from Upper Klamath Lake and other upstream sources are on the order of weeks, not hours or days, so there is ample time for periphyton "response". Second, benthic algae (periphyton) have a natural capability to respond to available nutrient. They are highly effective at carbon, nitrogen, and phosphorous uptake across a wide range of nutrient concentrations. Benthic algae can dramatically deplete carbon dioxide, the principal carbon source in the water column, on an hourly basis (Horne and Goldman, 1994). Third, the statement in the TMDL that the reservoirs "spread out" peak nutrient events is not supported by the model results presented in Figure A3. The overall duration of all the peaks is nearly identical, the only difference is in the magnitude. In sum, to state that nutrients can "flush" through the system is counter to basic understanding of algal uptake and storage dynamics, neglects the naturally-enriched background levels of nutrients, ignores the actual duration of nutrient pulses in this system, and misrepresents the effect of the reservoirs on the duration of nutrient pulses.

Page 2-42, Paragraph 2, under second bullet. The Revised Draft TMDL includes new text on the effect of nutrient retention on downstream river reaches. The Revised Draft TMDL states, "River reaches downstream of the dams (below the I-5 bridge to Seiad Valley) are saturated with nutrients with or without the reservoir nutrient retention". There is no basis or reference provided for this statement. Available field data (USFWS, PacifiCorp) show that nitrate concentrations steadily decrease in the downstream direction (with increasing distance from Iron Gate dam) to levels that suggest potential nutrient limitation in the lower river. Regional Board staff has selected total nitrogen (TN) and total phosphorus (TP) as metrics throughout the Revised Draft TMDL. However, what is critical in identifying any level of nutrient for benthic algae requirements are the bioavailable forms (i.e., the inorganic forms), such as ammonia, nitrate, and orthophosphate. To state that the system is saturated based on TN and TP is invalid, particularly when field data suggest otherwise.

Additional data on benthic algae densities (i.e., standing crop) and available substrate would be required to identify if algae had completely occupied the bed to the extent that no additional growth could be accommodated (i.e., no additional nutrient uptake). With continuous grazing, algae senescence, and sloughing/erosion, it is difficult for benthic algae to attain bed densities that would preclude additional growth and associated nutrient uptake.

Page 2-42. The Revised Draft TMDL is self contradictory when it attempts to argue that a slight increase in nutrients over a longer time (PacifiCorp's comment above points out that the reservoirs do not in fact increase the duration of upstream nutrient pulses passing through the reservoirs) resulting from the time shift of upstream nutrient pulses is an impairment (bullet 1) while at the same time claiming that the significant retention of nutrients within the reservoirs is of no benefit (bullet 2). If, as stated in bullet 2, the Klamath River is saturated in nutrients, so that the significant retention of nutrients by the reservoir has no effect, then a slight increase in nutrients resulting from a pulse from upstream would also have no effect. Conversely, if a slight increase in nutrients from upstream would have a noticeable detrimental effect on the lower river, as argued in bullet 1, then the significant reduction as a result of retention in the reservoirs should also have a noticeable beneficial effect. Saying that any effect the reservoirs have on nutrient abundance, either to increase or decrease, has a negative effect is biased.

Page 2-42, Paragraph 2, under second bullet. The Revised Draft TMDL states that "dams can contribute to conditions that would tend to promote increased periphyton densities in the downstream reaches such as reduced scouring flows and warmer waters". As discussed above, PacifiCorp's Project reservoirs do not change Klamath River peak flow conditions. The reservoirs have minimal active storage, and elevated flows are simply passed over the spillways. Thus, the magnitude and frequency of peak flows or "scouring" flows are not affected by the Project as asserted. There are ample data and reports on this matter that have been and are available to the Regional Board (e.g., see PacifiCorp's March 2004 Exhibit E Environmental Report, PacifiCorp's March 2004 Water Resources Final Technical Report, the 2007 FERC EIS on the Klamath Hydroelectric Project Proposed Relicensing). Peak flows regularly exceed flow levels capable of mobilizing and transporting gravels.

Page 2-42, Paragraph 2, under second bullet. The Revised Draft TMDL states, "This level of reduction on an annual mass loading basis is not large and the net effect on downstream water quality if this loading was to occur in the absence of the dams is not significant." This statement misleads the reader by stating that the annual loading is not appreciably reduced, but the seasonal load – during the growth season - is the important element. Annual loading reductions provided by the Project reservoirs are significant. More importantly, the reduction in seasonal load during the growth season is highly significant and important. A seasonal (May-September) reduction of 31 percent in total nitrogen in a system that is nitrogen-limited is considerable. To divert the reader to the annual number, and to term this seasonal reduction insignificant without specific analysis or supporting information is misleading. Additionally, during the late spring through fall water quality conditions vary considerably due to dynamics at Upper Klamath Lake. These variable conditions result in weeks-long deviations where water quality is considerably degraded. The reservoirs tend to dramatically reduce these "peak" periods. As evidenced by the Revised Draft TMDL numbers: if the May to September reduction is 31 percent, the short term peak loads moving through the reservoir are notably higher. These increases are supported by model simulations using the TMDL models supplied by the Regional Board.

Page 2-42, Paragraph 2, under third bullet. What are the green algae species that the Revised Draft TMDL is referring to under this bullet? What are the species, time of year, densities, duration of bloom, locations, and methods that the Revised Draft TMDL is assuming to define and quantify a "nuisance bloom"?

Page 2-42 to 2-43, under fourth bullet. Under this bullet, the Revised Draft TMDL restates text presented at pages 2-36 to 2-39 on the Regional Board's "hypothesis" or "conceptual model" that "…high levels of FPOM exported from the reservoirs during the summer months….appear to be a critical factor determining distribution and abundance of *M. speciosa*". As discussed in comments above on pages 2-36 to 2-39, there is no empirical evidence to support the Revised

Draft TMDL's "hypothesis" or "conceptual model". In fact, from the available data, it is clear that if the Project reservoirs have altered the distribution of organic matter in the lower Klamath River, they have reduced it. As discussed in comments above on pages 2-36 to 2-39, actual empirical information on organic matter in the river is and has been available for the Regional Board that is not presented in the Revised Draft TMDL. In addition, the very studies that the Revised Draft TMDL references to support its conceptual model do not consider nutrients to be a factor related to the distribution and abundance of *M. speciosa* in the Klamath River (Stocking and Bartholomew 2007).

Further, under this bullet, the Revised Draft TMDL indicates that "dams acting as barriers may also be contributing to the high levels of infection" under the assumption that without the dams (i.e., in "a free flowing river system") "salmon would be widely dispersed". To support this assumption, the Revised Draft TMDL states that "below Iron Gate Dam, dense spawning redds…and salmon carcasses can be found on top of, or very near, dense populations of the polychaete host". Again, the Revised Draft TMDL provides absolutely no empirical evidence to support this claim. In addition, the data that is available on spawning escapement and redds in the river below Iron Gate dam is not presented or discussed in the Revised Draft TMDL. The available spawning data shows that the situation is different from that suggested in the Revised Draft TMDL. For example, available spawning data show that the maximum number of spawning Chinook salmon in the mainstem Klamath River between Iron Gate dam and the mouth of the Shasta River is on the order 5,000 fish, with average numbers around 3,000 fish. However, in Bogus Creek next to the Iron Gate Hatchery, the number of spawning Chinook salmon is about 9,000 on average, with a maximum of 42,000 fish (FERC 2007). This data shows that dense spawning redds below Iron Gate dam are not a barrier issue, but an issue with management of hatchery-returning fish. Moreover, even if dams were a barrier, the establishment of fish passage above Iron Gate Dam, as would be required by a new FERC license for the Project, would eliminate the barrier.

Also, the Revised Draft TMDL does not point out that the Iron Gate Hatchery produces fish that are uninfected until they are released to the Klamath River. The Iron Gate Hatchery obtains its water from Iron Gate reservoir, indicating the source waters from the reservoirs are either clear of actinospores or counts are sufficiently low that the hatchery has no infection rate. This shows the benefits of the reservoir, particularly given that the disease otherwise occurs in the Klamath River basin upstream of Copco reservoir. In fact, Stocking and Bartholomew(2007) found the densities of polychaetes to be higher at the reservoir inflow areas compared to the river samples.

Page 2-44, Paragraph 1, Lines 1-3: The Revised Draft TMDL asserts that the reservoirs increase organic matter loading and describes this as a nutrient "risk cofactor." The increased organic load to the Klamath River comes from upstream sources, notably Upper Klamath Lake in Oregon, not the Project reservoirs. The Revised Draft TMDL asserts that compliance with the Oregon TMDLs will result in compliant conditions at Stateline. The Revised Draft TMDL must explain how increased organic matter loading, or the failure to achieve reductions in Oregon, is a risk factor in achieving compliant conditions at Stateline.

Page 2-47, Paragraph 4, Lines 7-8. The Revised Draft TMDL states "In the Klamath River, these effects [delays in seasonal temperature changes] may extend downstream to the Pacific Ocean under certain conditions (Bartholow et al. 2005)". This statement is so general and caveated as to be essentially meaningless. The Revised Draft TMDL does not present a detailed, accurate and balanced description of the influence of the Project reservoirs on the nearly 200 miles of Klamath River downstream of Iron Gate dam. In addition to Bartholow et al. (2005), the Revised Draft TMDL also needs to cite the substantial information reported elsewhere on this topic (e.g., see PacifiCorp's March 2004 Exhibit E Environmental Report, PacifiCorp's March 2004 Water Resources Final Technical Report, the 2007 FERC EIS on the Klamath Hydroelectric Project Proposed Relicensing, PacifiCorp's 2008 401 Application to the State Water Resources Control Board). Also, see more response on this topic in the comment below for Page 2-54, last paragraph.

Pages 2-48 and 2-49, bullets under Temperature Risk Cofactors. All of these bullets are general statements that can be found in any limnology book. Linkage to the Klamath River is necessary. For example, Bullet 1, Line 3: The Revised Draft TMDL states, "In waterbodies that have high concentrations of ionized ammonia and frequent excursions of high pH such as the Klamath River…." There is no evidence, data, or locally relevant citations presented to support the statement that the Klamath River has high concentrations of ionized ammonia, or to support a conclusion that $NH4+$ is a problem in the Klamath River. This assertion must be supported by locally relevant data or citation. Also, to properly assess the temperature co-factors as listed, the TMDL model must be a robust tool. However, as discussed with regard to our comments in Appendix 7, the river models used in the Revised Draft TMDL have included a factor that reduces solar radiation assumed in the model by 20 percent, leading to erroneously low predicted water temperatures.

2.5 Evidence of Water Quality Objective and Numeric Target Exceedances

Page 2-49 to 2-51. The Revised Draft TMDL discusses temperature effects asserted to be due to the Project reservoirs, and concludes, "[i]n summary, the temperature alterations…result in adverse effects to salmonids" (page 2-51). However, the Revised Draft TMDL discussion of the effects of reservoir "thermal lag" on migrating anadromous salmonids is speculative, incorrect, and lacks balance. In fact, as discussed in PacifiCorp's comment package on the original Draft TMDL, the Revised Draft TMDL's temperature allocations and targets continue to be based on "ideal" or near-ideal temperatures for salmonids in the generally colder waters of the Pacific Northwest, not the "thermal load which cannot be exceeded in order to assure protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife [BIP]" in the Klamath River per 40 C.F.R. § 130.7(c)(2). As discussed in depth in PacifiCorp's comments on the original Draft TMDL from August 27, 2009, the temperature effects of the Project are consistent with the protection and propagation of a BIP in the Klamath River. This conclusion is based on the testimony of experts from the U.S. Fish and Wildlife Service and the National Marine Fisheries Service and the findings of fact in the Energy Policy Act of 2005 (EPAct) trial-type proceeding on Project FERC relicensing requirements conducted in 2007. See Findings of Fact on USFWS/NMFS Issue 2(A) and at pages 14-19, 36, 68-69 in McKenna (2007). See also 401 Certification Application (2008) at pages 5-60 to 5-104.

The Revised Draft TMDL erroneously implies that the cooler temperature releases at Iron Gate dam during late winter (as compared to modeled "natural" temperature conditions) "may reduce the growth rates of salmonids rearing in the Klamath River, and may ultimately reduce the survival rate of salmonids in the ocean" (page 2-60). The Revised Draft TMDL provides no substantive evidence for this assertion, but only assumes that the cooler temperature releases at Iron Gate dam during late winter are adverse because "the optimal temperature range for juvenile salmonids is 10-15°C, with a lower limit of 4°C" (page 2-60). However, both current and "natural" temperature conditions are below the optimal range for juvenile salmonids during the winter, and modeled Without-Project temperature conditions are below 4°C (and therefore below the optimal range) more frequently than current conditions during the winter.

Page 2-54, Paragraph 2, Lines 2-3: The Revised Draft TMDL states, "Some of the key sources [of nutrient loads] include…internal nutrient cycling from nutrient enriched sediments…." It should be made clear that this relates specifically to Upper Klamath Lake, not the Project reservoirs.

Page 2-54, Last Paragraph. Page 2-54. The Revised Draft TMDL uses EPA (2003) Pacific Northwest guideline criteria to evaluate chronic temperature effects on Klamath River salmonids without considering site specific conditions in the Klamath River. In Appendix 5 of the Revised Draft TMDL, the applicable species are identified as occupying the mainstem Klamath River during every month of the year. However, available temperature data show that conditions in the middle and lower Klamath River in the vicinity of Happy Camp downstream to the Trinity River – a reach that is influenced little, if any, by upstream reservoirs – chronically exceed these temperature guidelines. For example, daily maximum and minimum water temperatures in the vicinity of Happy Camp can be up to 30°C and 25°C, respectively, for over a week at a time in late July and early August. The maximum weekly mean temperature (MWMT) exceeds the guideline temperature by over 10°C for juvenile rearing, and exceeds the guideline temperature for lethal effects by several degrees C in portions of the river below Seiad Valley. During summer periods, the flows are much lower, leaving the river in a large bedrock or alluvial channel that has appreciable exposure. Topographic shading has a modest effect when solar altitude is at an annual maximum (Deas et al. 2006). In summary, the river is naturally warm, and the EPA (2003) guideline criteria for the colder waters of the Pacific Northwest are inconsistent with local conditions (see also Bartholow 2005). The Revised Draft TMDL discussion also neglects to mention climate change, which will also present considerable challenges to meeting the Revised Draft TMDL's temperature targets in the Klamath River. Climate change is expected to result in 2°C to 6°C warmer water temperatures (above current conditions) under a range of climate change conditions (Barr et al. 2009).

Page 2-55, Second to last paragraph. The Revised Draft TMDL states, regarding a longitudinal temperature distribution in the Klamath River from Stateline to the estuary, that "these data clearly demonstrate that the river has no capacity to assimilate increased heat loads during the hottest critical periods without adversely affecting the beneficial uses COLD, SPWN, RARE, and MIGR." The Revised Draft TMDL provides no assessment of whether or not these temperatures under pre-development conditions would meet the criteria presented in Tables 2.8 and 2.9, nor under a pre-development condition with warmer temperatures caused by climate change.

Page 2-55, Last paragraph (and on to page 2-56). This paragraph is misleading. NRC (2004) does not state explicitly that the thermal changes caused by the dams are adverse to coho salmon, rather that the mainstem Klamath River resides in an environment that is not going to provide thermal conditions for coho salmon rearing in the warm parts of the year. NRC (2004) does state that reduced diurnal variation can be adverse to coho, but it does not state that the dams create thermal conditions that are adverse to coho rearing. This is misleading and mischaracterizes NRC (2004).

Page 2-59, Table 2.10. The Revised Draft TMDL's modeling results presented in Table 2.10 (for both the existing conditions and natural conditions based on Year 2000) are not reliable and should not be used because they include a 20 percent reduction in solar radiation. This reduction has a direct, negative bias (i.e., it produces lower water temperatures) of over 1°C during the warmer parts of the year. In the runs completed by PacifiCorp and subsequently used by Dunsmoor and Huntington (2006), the solar radiation is not reduced, so the comparison of results in Table 2.10 is not valid.

Page 2-61. Second to last paragraph. The Revised Draft TMDL states, "These data clearly demonstrate that these tributaries have no capacity to assimilate increased heat loads during the hottest critical periods without adversely affecting beneficial uses." It is overly-simplistic for the Revised Draft TMDL to dismiss the entire tributary based on temperatures at the mouth. This statement lacks important context in that there are fish that rear in thermal refugia at the mouths of tributaries when conditions are appropriate. In addition, many of these tributaries have considerable rearing habitat in upstream reaches. There may be some lower reaches of these tributaries that are: (1) naturally warm due to the geologic and alluvial processes present; (2) have been affected by anthropogenic activities; or (3) been affected by other conditions (e.g., wildfire).

Page 2-62. First full paragraph. The Revised Draft TMDL states, "However, it is well documented that the erosion associated with the 1997 flood in the Klamath River basin resulted in widespread stream channel alteration, loss of riparian vegetation, and shade reductions (further discussed in Section 2.5.8) and that a significant amount of the erosion was caused or exacerbated by human activities (De La Fuente and Elder 1998)." The Revised Draft TMDL should state that much of this vegetation has recovered, and water temperatures have dropped in response to vegetation recovery. Flood impacts on natural streams occur and recovery can be rapid. This is a natural process in many systems. An assessment of current conditions is required to ascertain current conditions, and the Revised Draft TMDL should account for the frequency of floods, fires, disease, and other factors that can periodically affect conditions along a tributary or tributaries.

Page 2-62. Section 2.5.2.3 Reservoirs. The Revised Draft TMDL states, "The available Iron Gate and Copco Reservoir temperature and DO profile data indicate that during summer stratified conditions, temperatures are only suitable for cold water species, including salmonids, rearing at depths where the DO concentrations are near lethal levels." This is contrary to the testimony of USFWS and NMFS agency experts, and the findings of fact of the administrative law judge which concluded that anadromous fish stocks possess the biological and behavior traits needed to successfully spawn, rear and migrate in the Project reaches upstream of Iron Gate dam (assuming passage facilities at the dams). The ALJ concluded that the record clearly establishes that existing water temperatures will not preclude anadromous salmonid migration. The ALJ cited agency testimony that the temperature conditions are faced by anadromous fish to an equal degree both above and below Iron Gate dam. The ALJ cited agency testimony that coho salmon in other parts of the Klamath system occupy water with temperatures in excess of 26°C (the data relied upon by the draft TMDL cites 25°C as "lethal" for coho adults), and juvenile coho salmon observations in the main stem Klamath River where temperatures exceed 20°C (the data relied upon by the draft TMDL considers chronic effects to be observed in core juvenile rearing habitat at temperatures above 16°C). The ALJ also concluded that the evidence also demonstrates that juvenile fish most likely would not outmigrate during periods of sub-optimal water temperatures. See Findings of Fact on USFWS/NMFS Issue 2(A) in McKenna (2007). See also 401 Certification Application (2008) at pages 5-60 to 5-104.

Page 2-64, First paragraph and second paragraph. The Revised Draft TMDL states, "[T]herefore the first step in evaluating impairment due to biostimulatory conditions is to determine whether existing nutrient loading and water column concentrations exceed natural baseline conditions." However, in the second paragraph, the Revised Draft TMDL states, "[N]atural baseline conditions are estimated based on TMDL model simulations (described in Chapter 3). *These estimates are not interpreted literally but only as approximations of conditions that may have existed under natural conditions.*" (Emphasis added.) It is apparent from examining the modeling used in the Revised Draft TMDL that the "natural conditions" scenario has been developed to support the water quality targets that are asserted to be protective of the designated beneficial uses, regardless of their attainability and regardless of what actual pre-disturbance natural conditions really were. There is no clear discussion, for example, of what beneficial uses were actually supported or not supported (and at what times of the year and in what reaches) under "natural conditions." As a consequence, the "natural conditions" scenario results in nutrient and organic matter concentrations that are not only unachievable, but that are far lower than the concentrations that have ever likely existed in the Klamath River.

An honest approach to the TMDL requires that the "natural conditions" scenario be reasonably developed on the basis of available evidence and comport with accepted understandings of likely pre-disturbance conditions and the physical realities of the Klamath River and aquatic systems in general. The water quality targets and objectives asserted to be protective of beneficial uses would then have to be assessed against the natural conditions to determine whether those targets and objectives could be attained. If not, a use attainability analysis would be required. Instead, the Revised Draft TMDL has established an unrealistic "natural conditions" scenario with implausibly low nutrient concentrations in an effort to avoid the fact that the Revised Draft TMDL's overly stringent water quality targets and objectives cannot be attained. The establishment of a TMDL that would require unachievable load allocations is contrary to the CWA.

Much of the discussion in Chapter 2 is based on the Revised Draft TMDL's "conceptual model", wherein many processes have little or no supporting data. Where is the analysis of what natural conditions would be like? There is no discussion that, for example, states what:

- the natural hydrograph (tributaries too) might be expected to look like, illustrating inter- and intra-annual variability;
- the natural thermal regime in the basin by season, and what natural variability might be compared to today;

- the geomorphic characteristics that exist in the basin today and how they might differ from natural conditions;
- the nutrient concentrations or loads were expected to be under natural conditions; and
- what natural or "pre-disturbance" benthic assemblages were expected.

The California NNE relied upon in the Revised Draft TMDL was developed at a state wide level and does not consider the site specific, unique attributes of the Klamath River basin that are pertinent to an appropriate analysis of this issue. For example, the Klamath River: (1) is one of only two rivers which cross the Cascades Range in California and Oregon, and thereby is subject to very different climates and other conditions as it flows from its source to the ocean; (2) the river has naturally-eutrophic and currently-hypereutrophic Upper Klamath Lake as its source; and (3) the extensive marsh and wetland systems in the upper basin and around Upper Klamath Lake also cause much higher background levels of dissolved organic matter than occurs in other systems.

Page 2-66, Figures 2.16 and 2.17. The natural conditions background values for total phosphorus and total nitrogen (approximately 0.025 - 0.03 mg/L for total P, and 0.25 mg/L for total N) assumed in these figures are unrealistically low (somewhere between oligotrophy and mesotrophy). These assumed values in no way correspond to the documented historical evidence of the Klamath system, which has been nutrient enriched throughout recorded history. Examples of historic information from Upper Klamath Lake include:

1. "The water from the [Upper Klamath] lake had a dark color and a disagreeable taste, occasioned apparently by decayed tule.… The taste of the water was so disagreeable that several vain attempts were made to discover a spring in the vicinity." (Source: Reports of Explorations and Surveys, to Ascertain the Most Practicable and Economical Route for a Railroad from the Mississippi River to the Pacific Ocean, House Ex. Doc. No. 91, 33rd Congress, 2nd Session, Volume VI, Routes in California and Oregon Explored by Lieut. R. S. Williamson, Corps of Topographical Engineers, and Lieut. H. I. Abbot, Corps of Topographical Engineers, in 1855, General Report (Washington, D.C.: A. P. P. Nicholson, Printer, 1857), 67.)
2. In 1894, Charles H. Gilbert, a professor of zoology at Leland Stanford Junior University, observed "many dead and dying fish" in both Upper Klamath Lake and the Klamath River. Barton Evermann and Seth Meek, investigators of fish populations for the US Fish Commission, noted in 1896 that Upper Klamath Lake "contains considerable water vegetation." The "impurities" of Upper Klamath Lake's water became the focus of a 1905 controversy in Klamath Falls regarding possible "disease laden ice." One Klamath Falls citizen commented "there is no pure ice in Klamath county … the waters of the lake are not fit to drink …" while another held that "the ice on the Upper [Klamath] Lake runs a chance of being infected with the flotsam and jetsam of that great body of water. A great many fish of the sucker species die and float into the waters of the lake, which give a chance for impurity… (Source: Charles H. Gilbert, "The Fishes of the Klamath River Basin," Bulletin of the United States Fish Commission 17 (1897), 2; Barton Warren Evermann and Seth Eugene Meek, "A Report Upon Salmon Investigations in the Columbia River Basin and Elsewhere on the Pacific Coast in 1896," Bulletin of the United States Fish Commission 17 (1897), 60-62;

"Owners of Ice Make Statements to the Klamath Republican," Klamath Republican, February 9, 1905, in Vertical File, "Health Department," Klamath County Historical Society, Klamath Falls, Oregon.)

3. In the Klamath River near Klamathon: "Cotton is king and so is Siskiyou for she produces an article of cotton on her barren rocks that is superior to Dixie cotton for many purposes. It is formed where torrents of water run through rocks, leaving a green slime, which changes to pure white when sun-dried. The texture is very fine, and is an excellent article for mattresses, being springy. It lays on the rocks in layers, like wadding, about the right thickness for lining. There is a large quantity of it near Cottonwood, on the Klamath, a sample of which was brought to us by H.T. Sheppard." (Source: Yreka Semi-Weekly Journal 3 page, Wed. Nov. 12, 1862.)

The NRC (2004) determined that the natural baseline phosphorus concentration in water flowing to Upper Klamath Lake was approximately 0.06 mg/L. Several years of data collected at the bottom of the bypass reach above the J. C. Boyle powerhouse and available on PacifiCorp's website[2] show that the natural total phosphorus concentration of baseline groundwater flow from springs to be 0.07 – 0.08 mg/L. The TMDL presents no evidence to demonstrate how this natural background concentration in the Klamath River at approximately River Mile (RM) 221 could be reduced to 0.025 mg/L (a factor of more than three-fold) by RM 209 in a pre-disturbance "natural conditions" scenario. A simple mass balance suggests that to attain such a concentration at Stateline, that total phosphorus concentrations above the large springs complex below J.C. Boyle dam would have to be on the order of 0.01 mg/L or less - approximately an order of magnitude less than natural groundwater contributions that dominate the Upper Basin hydrology. Given:

- the description of Upper Klamath Lake as naturally eutrophic (e.g., NAS, 2004; Eilers et al, 2004; Walker, 2001),
- that background levels of phosphorus for springs in the upper basin (Boyd et al, 2001) are similar to those springs below the J.C. Boyle,
- that groundwater dominates inflow the Upper Klamath Lake (Gannett, 2007), thus providing considerable phosphorus loading, and
- that surrogates, such as Big Springs Creek in the Shasta River basin, indicate that naturally nutrient rich springs produce extensive aquatic growth which can deplete inorganic forms to low levels, but in turn contribute to total forms (Jeffres et al, 2009). In the case of the Shasta River, total phosphorus concentrations are five to eight times greater than the Klamath River mainstem target value (total P of 0.025 mg/L) identified in the draft TMDL - below the Big Springs Creek confluence, and above all major diversions.

In sum, the draft TMDL identifies natural background phosphorus levels that are clearly in conflict with 1) previous literature, 2) existing conditions in the basin (background spring phosphorus concentrations and groundwater dominated upper basin hydrology), and 3) surrogate basins, such as the Shasta River, where the implications of nutrient rich groundwater

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[2] See Water Quality Reports & Data available at http://www.pacificorp.com/es/hydro/hl/kr.html.

are clearly documented. Because the target phosphorus concentrations in the Revised Draft TMDL are lower than established natural background levels in the Klamath River basin the Revised Draft TMDL is not achievable.

The natural conditions background values for total phosphorus and total nitrogen shown on the graphs also display unrealistically small variability. A comparison of Figures 2.16 and 2.17 between the original Draft TMDL and the Revised Draft TMDL shows these nutrient concentration assumptions to be even further detached from physical and historical reality. The previous versions of these figures showed greater variability and recognized that water quality in the Klamath River improves as the river flows downstream. This improvement in water quality results from accretions from tributaries in the lower basin that are less impacted by nutrients. An examination of these figures shows that the Revised Draft TMDL assumes that, under "natural conditions", the nutrient concentrations at Stateline imposed from Upper Klamath Lake were identical to concentrations found throughout the river on down to the estuary. This assumption is contrary to physical reality and ignores the naturally higher nutrient concentrations that are present in the upper basin as a result of the volcanic geology of that area. These values in no way correspond to the conditions in the Klamath River caused by its naturally-eutrophic and currently-hypereutrophic source water from Upper Klamath Lake, which as recognized in the Revised Draft TMDL earlier on page 2-42, can produce "event driven spikes" of nutrient loading as a result of algal bloom dynamics that impart significant water quality variability.

Page 2-70 to 2-73. The Revised Draft TMDL discusses chlorophyll *a* conditions and effects attributed to the Project reservoirs. As discussed in detail in PacifiCorp's August 2009 comments on the original Draft TMDL, the Revised Draft TMDL's chlorophyll *a* analysis and recommended target of 10 µg/L for the reservoirs is inappropriate, particularly in light of the naturally eutrophic nature of the upper Klamath River system, and the unrealistically large nutrient reductions that would be required for the target to be achieved. The 10 µg/L target was not selected with the naturally-enriched and productive Klamath River system in mind. Rather, it was selected for the Revised Draft TMDL as the most restrictive of several possible targets under the general, statewide Nutrient Numeric Endpoints (NNE) approach (Tetra Tech 2006).

The 10 µg/L chlorophyll *a* target is not appropriate for the naturally eutrophic Klamath River system. Throughout the Revised Draft TMDL, it acknowledges that higher concentrations of nutrients result in higher levels of chlorophyll *a*, or that high levels of chlorophyll *a* are typical of nutrient-enriched water bodies (e.g., page 2-19). For example, as the Revised Draft TMDL analyses show, achieving a chlorophyll *a* concentration of 10 µg/L would require total phosphorus load reduction to the reservoirs of 90 percent, resulting in an average growing-season phosphorus concentration of 0.03 mg/L (Appendix 2, page 17). As discussed above, such low phosphorus concentrations are below natural background phosphorus concentrations. As such, load allocations to achieve these low phosphorus concentrations are infeasible and unachievable. That, in turn, means that 10 µg/L chlorophyll *a* is not a reasonable or achievable target in this naturally-enriched system.

As a key rationale for the 10 µg/L chlorophyll *a* target for the reservoirs, the Revised Draft TMDL incorrectly states that the 10 µg/L chlorophyll *a* target is "achieved above the reservoirs but not within the reservoirs, thus the reservoirs themselves are the cause of these impairments" (page 4-35). But, in contradiction to this statement, and based on modeling analyses, the Revised Draft TMDL concludes that the Klamath River entering Copco reservoir (at Shovel Creek) "exhibit high chlorophyll *a* concentrations in the middle of the year"…"largely due to upstream conditions being carried downstream", and, "in many of these situations, chlorophyll *a* data are not available for comparison" (Appendix 7, page 11).

In addition, it is not correct to state that the chlorophyll *a* target is achieved above the reservoirs because the 10 µg/L chlorophyll *a* target is not applicable to flowing river reaches. A correct upstream comparison for this target can only be made to Upper Klamath Lake, where the target is definitely not achieved. Comparison to the river reaches would require the use of the 150 mg chlorophyll *a*/m^2 benthic algae target.

The 10 µg/L chlorophyll *a* target for the reservoirs is inappropriate given that the chlorophyll *a* levels in the river waters flowing into the reservoirs from upstream are occasionally higher than 10 µg/L. Therefore, advected input of chlorophyll *a* alone could prevent achieving the target in the reservoirs. Data presented in the Revised Draft TMDL clearly shows very high levels of chlorophyll *a* in excess of 10 µg/L in the river from sampling sites above J.C. Boyle reservoir, at Keno dam, and at the Link River mouth (near the outlet of Upper Klamath Lake). The Revised Draft TMDL states that "the high concentrations at these three stations are due in large part to residual algal biomass from Upper Klamath Lake" (page 2-60). Furthermore, measured concentrations of chlorophyll *a* in the river upstream of Copco reservoir at Shovel Creek are shown to be higher than 10 µg/L during certain times of the year such that advected input makes the chlorophyll *a* target unachievable. Indeed, the modeling analyses performed for the Revised Draft TMDL to develop recommended TMDL allocations shows chlorophyll *a* levels in the river upstream of Copco reservoir ("Klamath River at Shovel Creek") that are much higher than 10 µg/L, particularly during summer, when the target is to be applied (as a "summer mean"). See the Revised Draft TMDL's model results for chlorophyll *a* levels in the river upstream of Copco reservoir (Appendix 6, pages H-16 and H-19).

Page 2-71, Paragraph 1, Line 4. The Revised Draft TMDL states that similarity between the median and the mean indicates a normal distribution. This is incorrect. Close similarity between the median and the mean indicates only that the distribution is nearly symmetrical. Any symmetrical distribution (including a normal distribution, uniform distribution, bimodal distribution, etc.) would have similar median and mean values.

Page 2-72, Paragraph 1, Lines 1-2. The Revised Draft TMDL states that "Figures 2.22 and 2.23 demonstrates the effect of quiescent waters…". However, Figures 2.22 and 2.23 do not show the effect of quiescent waters, but rather show the effect of the inappropriate comparison of the reservoir chlorophyll *a* target applied to the river. Attributing the algal blooms to quiescent waters in the reservoirs because the chlorophyll *a* numbers are lower in the river upstream is based on the inappropriate and misleading application of the unachievable reservoir target to the flowing river. The chlorophyll *a* target of 10 µg/L as drawn on Figures 2.22 and 2.23 is not applicable or relevant to the river reaches. The tendency for the Revised Draft TMDL to examine river data in light of this target for the reservoirs recurs elsewhere in the document (e.g., see page 4-35), and indicates a fundamental misunderstanding of the applicability of the target. This is an inappropriate comparison, just as it is inappropriate to apply the river-related benthic chlorophyll *a* target of 150 mg/m^2 to the reservoirs.

Page 2-72, Paragraph 3, Lines 2-6. The Revised Draft TMDL states, "Elevated levels of fine organic material including suspended algae in the Iron Gate Reservoir outlet waters are then available as a food source for polychaetes in the river", and "fine particulate organic matter discharged from the outlet of Iron Gate reservoir is deposited in the river bottom sediments below the reservoir". As previously discussed in these comments, the Revised Draft TMDL presents no data and cites no report to support the assertion that elevated levels of fine particulate organic matter occur in the river below Iron Gate dam as compared to the river above Copco reservoir. These statements are assertions with no supporting data. In fact, the available empirical data (Deas 2008) indicates that organic matter concentrations are usually significantly less below Iron Gate dam as compared to above Copco reservoir. Also, as discussed earlier in these comments, the Revised Draft TMDL misinterprets cited study results and does not acknowledge that the "hot spot" of infection is not directly below Iron Gate dam, but in the Beaver Creek area downstream of the Shasta River (Bartholomew et al. 2007).

Page 2-73, Paragraph 1, Lines 8-10. The Revised Draft TMDL claims that Iron Gate reservoir is "the source of blue-green algae that continues to grow in backwater and slower sections within the river reaches below the dams", and that "[t]he Iron Gate/Copco Reservoir complex greatly increases the quantity of algal biomass supplied to the river below Iron Gate Dam; this export is considered to be an innoculant which would contribute to downstream blooms". Even in the absence of Project reservoirs, however, cyanobacteria would be abundant in the Klamath River, because the system is nutrient-enriched and cyanobacteria are abundant in Upper Klamath Lake, which is the source of the Klamath River. Moreover, cyanobacteria are ubiquitous in the environment and will grow wherever suitable conditions exist. Removing the Project reservoirs will not preclude the growth of cyanobacteria in the Klamath River. Indeed, cyanobacteria have also been documented in area rivers such as the Eel and Van Duzen rivers. Thus, the absence of Iron Gate and Copco reservoirs is not likely to eliminate cyanobacteria in the Klamath River.

Page 2-73, Paragraph 1, Lines 8-10. The Revised Draft TMDL's statement that "the Iron Gate/Copco Reservoir complex greatly increases the quantity of algal biomass supplied to the river below Iron Gate Dam" is not supported by the data. In using Figures 13 and 15 from Raymond (2009), the Revised Draft TMDL misrepresents the facts. The Revised Draft TMDL uses figures that show only *Microcystis* as though that were the total algal biomass, when in fact *Microcystis* is merely a fraction of the total algal biomass. When the correct data from 2009 are used, it is clear that there is no significant difference in biomass measured at any site below Link River dam. Analysis of variance of biovolume vs. site followed by Tukey's HSD test for all pairwise comparisons shows that algal biovolume at the mouth of Link River is significantly higher than the other sites ($P < 0.05$) and that all other sites form a homogenous group not significantly different from one another. Additional analysis shows there is no significant increase in algal biovolume below Iron Gate dam compared to above Copco reservoir. A two-sided Dunnett's multiple comparison with site KR20642 (Klamath River near Shovel Creek) as a control showed no significant difference from any site, except KR25312 (the mouth of Link River). Similar results are obtained when the analysis is done considering algal abundance (count data). It is clear from this analysis that algal abundance is not increased below Iron Gate dam as a result of the reservoirs. The results are similar when considering data from all years. As shown in Figure A5 below, algal biomass in the tailrace of Iron Gate dam (site KR19000) is dramatically lower than at a site above J.C. Boyle reservoir (site KR22822). Algal biomass only begins to increase below the Iron Gate Hatchery bridge (site KR18973), a likely consequence of abundant benthic algal growth between Iron Gate dam and the hatchery bridge.

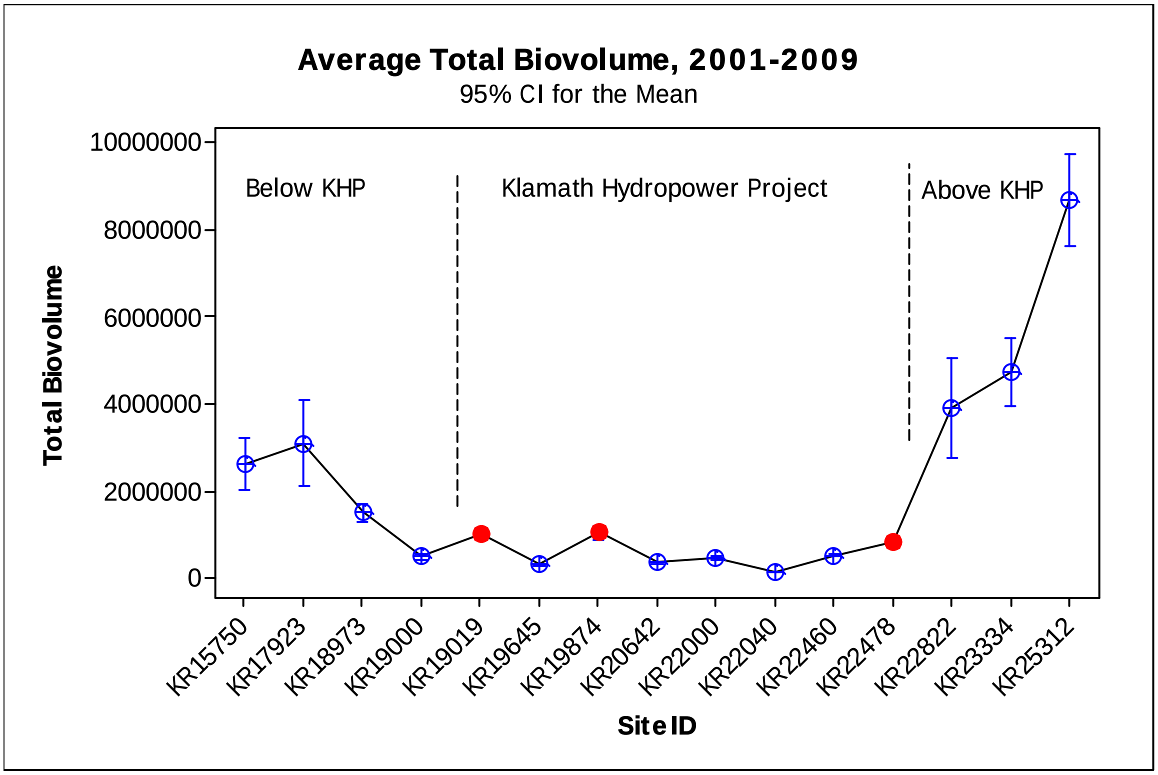

Figure A5. Average total biovolume (µm3/cm3) at various sites in the Klamath River measured in 2001-2009. Red symbols denote project reservoirs, J.C. Boyle (KR22478), Copco (KR19874), and Iron Gate (KR19019).

Page 2-73, Paragraph 2, Line 3. The Revised Draft TMDL states, "The consistent presence of high concentrations of *Microcystis aeruginosa*…." (MSAE). The assumption of a "consistent presence of high concentrations" of MSAE is not supported by data. MSAE is highly variable in both time and space and is not consistently high (or even consistently present) throughout the Klamath River and within Project reservoirs. Results of monitoring since 2005 have shown *Microcystis* to be present at high abundance at some sites in some years, and absent or present at different sites in other years. The Revised Draft TMDL must clarify its use of "consistent" with regard to the summertime presence of *Microcystis* in the Klamath River. From a year-to-year perspective, *Microcystis* blooms have been documented only during the last 4 or 5 years, with no evidence that supports the assumption of the existence of consistent *Microcystis* blooms before that. Data collected in the Klamath River and reservoirs prior to approximately 2003 (EPA 1978, City of Klamath Falls 1986, PacifiCorp website) do not indicate that *Microcystis* blooms were occurring, although *Microcystis* has been reported in Upper Klamath Lake since at least 1999 (Gilroy et al. 2000). Blooms of potentially harmful cyanobacteria, such as *Microcystis,* are known to be increasing worldwide (Hudnell 2009). Because the Project reservoirs have been in place for 50 years, it is reasonable to infer that recent increases in *Microcystis* are a part of the worldwide trend and may have some cause other than the mere presence of the Project reservoirs. Assertions to the contrary are not supported by data.

Page 2-73, Paragraph 4, Line 1. The first sentence, "Every year since 2004 *Microcystis aeruginosa* counts have exceeded…" is incorrect and clearly contradicts Table 2.11. Such contradiction notwithstanding, it is not possible to assess the severity of the supposed problem because Table 2.11 provides no information about the total number of samples for microcystin collected in each reach.

Page 2-92, Paragraph 2. The Revised Draft TMDL presents an incomplete and unbalanced discussion of the available data and information on the presence of microcystin in tissues and fish and mussels from the Klamath River. Key sources of available data and information on the topic, including from PacifiCorp, are absent (e.g., PacifiCorp 2008c, CH2M HILL 2009a, CH2M HILL 2009b). Until such data are presented, this section of the Revised Draft TMDL is inadequate and misleading. For example, during three years (2006-2008) of bi-weekly sampling between the Trinity River and the estuary, there has been only one instance when a water sample exceeded the threshold value for microcystin (see Table 2.11 on page 2-75). During the same three years of biweekly sampling at multiple sites from Iron Gate dam to the mouth, there have been only seven samples, or less than two percent, that exceeded the threshold value for microcystin. There is no evidence that the Project was the cause of the microcystin observed downstream of the Trinity River.

COMMENTS: CHAPTER 3. ANALYTIC APPROACH

3.2 Modeling Approach

Page 3-1, Paragraph 1. In the Revised Draft TMDL, the language on "model calibration and corroboration" from the original Draft TMDL has been removed, and replaced with the term "testing". This is inappropriate if by "testing" the Revised Draft TMDL means something less than the necessary level of calibration and corroboration. Calibration is an essential model step for evaluation and discussion. EPA (2009) clearly identifies the need to calibrate models:

> "the Office of Water's standard practice is to calibrate well-established model frameworks such as CE-QUAL-W2 (a model for predicting temperature fluctuations in rivers) to a specific system (e.g., the Snake River). This calibration generates a site-specific tool (e.g., the "Snake River Temperature" model)."

The Revised Draft TMDL needs to explain here what is meant by "testing". If the model is neither calibrated nor corroborated, the model would not provide a reasonable basis for the TMDL.

Page 3-1, Paragraph 2. The PacifiCorp models used to support studies for the Federal Energy Regulatory Commission hydropower relicensing process are documented in PacifiCorp (2005), and reflect incorporation of comments from Wells et al (2004) with respect to the Watercourse (2004) document. Leading up to the 2005 document, collaboration on model updates between Tetra Tech and Watercourse was fairly continuous, and the models were quite comparable at that time.

Page 3-2, Paragraph 2. PacifiCorp did not have sufficient time to review the estuary application of EFDC, and reserves the right to submit comments at a later date.

Page 3-5, Paragraph 3, Line 10. The Revised Draft TMDL needs to explain the "corroboration" process and the results of the process. Greater transparency in this regard is needed to ensure confidence in the TMDL model. Corroboration is not a formal modeling term and does not replace validation of the model for an independent time period. If the Revised Draft TMDL is using corroboration as a replacement for validation, then the applicability of the model and confidence in model results are in doubt for this TMDL.

Page 3-6, Paragraph 2, Line 1 and elsewhere. The Klamath River TMDL model above the estuary is divided into eight parts or reaches, which includes river and reservoir reaches. To call these reaches "segments" is confusing and misleading. Further, modeled reservoirs are divided into "segments" in the language of CE-QUAL-W2.

Page 3-7, Second paragraph. In this paragraph, the Revised Draft TMSL suggests that modifications were made on the modeling grid and framework. If so, the Revised Draft TMDL needs to document the reasons for the changes, and what changes were made. If changes have been made to the grid, then the hydrodynamic calibration noted in the last paragraph on this page is no longer valid.

Page 3-7, Bullets. Why were the terms "boundary conditions" removed from these bullets?

Page 3-7, Paragraph following bullets. The Revised Draft TMDL includes a brief discussion of calibration, but the terminology regarding calibration was removed on page 3-1. Also, if the TMDL model parameters are changed to provide a "best fit", then summary statistics have to be identified and a "best fit" defined for the purposes of calibration.

The last sentence states that calibrated model parameters were tested against field parameters. This cannot be correct for all parameters. Many model parameters used in calibration (e.g., Manning's roughness, rate constants, temperature coefficients, oxygen demands, reaeration rates) were not tested against field measurements. The model must compare simulations with field observations of state variables (e.g., nitrate concentration) or derived constituents (e.g., pH).

Page 3-8, Paragraph 2. Testing the model for the single year, 2000, does not test the model for a wide range of hydrologic conditions and water quality. The Revised Draft TMDL is clear that water quality conditions in the Klamath River vary seasonally. Coupled with highly variable meteorological conditions (intra-annually and inter-annually), variable hydrology from one summer (or spring, or fall) to another has considerable implications for water quality. Assessment of inter-annual variability is critical.

Page 3-8, Paragraph 2. The Revised Draft TMDL includes the following sentence: "The model was not run downstream (Segments 6 through 9) for 2002 primarily due to limited boundary data." The previous draft stated that the model was not run downstream in 2002 due to costs. In addition, there were meetings between PacifiCorp and the Regional Board and ODEQ regarding TMDL activities. Through these meetings the specific issue of not extending the model through segments 6 through 9 was raised. The TMDL team stated clearly that this was a resource and cost limitation. It is disappointing to see this transparency being removed from the Revised Draft TMDL. Further, review of data indicates that 2002 had a comparable set of data for downstream reaches, as USFWS had commenced a detailed sampling program below Iron Gate dam.

Page 3-8, Paragraph 2. Considering the availability of data and models from 2000 through 2004 that were provided to the Regional Board Staff early in the TMDL process, it is unfortunate that only data from one year are used to calibrate the TMDL model. As such, the TMDL model does not have a formal validation period. Thus, there is no reasonable assurance that the TMDL model downstream of the Bypass-Peaking Reach is reliable for setting TMDL load allocations or other purposes. As it stands, one can only have confidence for model applicability for 2000, and yet the TMDL model is relied upon to set load criteria for many years to come. Specifically, using only a single year on which to base the TMDL analysis provides no information on inter-annual variability – a considerable omission in a system with the size, complexity, and degree of inter-annual variability of the Klamath River.

Page 3-8, Paragraph 3. Review of Appendix 6 of the Revised Draft TMDL indicates that sensitivity analyses were limited and only applied to areas where problems were perceived. No systematic approach assessing individual parameters was completed. No uncertainty analysis is included in Appendix 6.

Page 3-8, Paragraph 3. The peer reviews of the TMDL modeling brought up a host of comments regarding uncertainty, lack of calibration, and sensitivity analysis, yet little of this critical review is reflected in the Revised Draft TMDL. Uncertainty analyses or even model performance metrics that allow model uncertainty to be quantified are absent from this analyses. Models are only representations of physical systems and, although powerful and useful, are by their nature imperfect. Without a quantification and incorporation of model uncertainty into analyses, the models are insufficient to develop the TMDL, including TMDL load allocations. EPA (1997) states, "[T]he question of model accuracy is often crucial in situations where a given allocation is being negotiated or contested" (page 4-27). Further, "uncertainty analysis should be included as an integral component of water quality modeling. One of the primary purposes is to quantify the error in predicting water quality and evaluate the effect of input parameters on model output. Better management decisions can be made by quantifying this error. Such quantification also facilitates subsequent studies, such as risk assessments, to evaluate alternative allocations." (page 4-29) EPA (1997) identifies sensitivity analysis as a valid approach to defining uncertainty and dedicates a portion of an appendix (Appendix D) to this topic. The fact that sensitivity analysis is presented with reference to the EPA water quality model QUAL2E shows that, even in complex systems, quantification of uncertainty is feasible and necessary. As stated in the Revised Draft TMDL, "models are suitable tools for establishing Klamath River TMDL allocations and targets," but the tools must be appropriately developed, tested, and applied to carry out this task. The model used to develop this TMDL has not been.

Page 3-9, Paragraph 2, Lines 2-7. The Revised Draft TMDL notes that the "NNE approach is a risk based approach," but without identification and clear quantification of uncertainty, risk-based assessments are at best a challenge and at worst infeasible. Specifically, without sensitivity analysis, assessing interannual variability, defining uncertainty associated with field data, and quantifying model uncertainty (as well as other sources of uncertainty), the approach of developing multiple lines of evidence for response variables is infeasible.

COMMENTS: CHAPTER 4. POLLUTANT SOURCE ANALYSIS

4.1 Introduction

Page 4-1, Footnote. The calculation for conversion of organic matter to CBOD, and to CBOD ultimate is not presented in the analyses. Basic stoichiometric considerations and decay rates are not provided to convert among these parameters. As such the reader of the technical TMDL cannot interpret what has been used to calculate load allocations for CBOD.

Page 4-1, Paragraph 4, Bullet 1. Please show how the UKL TMDL compliance target for TP of 0.11 mg/L was converted to nutrient boundary conditions used in scenarios.

Page 4-2, Paragraph 2, Bullet point 2. It is not valid to treat Copco No. 1 and Copco No. 2 "as a single source" simply because there is no data for Copco No. 2. Copco No. 2 has fundamentally different water quality response than Copco No. 1. For example, because the reservoir is small, it does not stratify and does not have hypolimnetic anoxia (because it does not stratify). The TMDL is silent on whether processes and water quality impairments identified for Copco No. 1 are automatically applied to Copco No. 2, where they may not be applicable.

Page 4-3, Paragraph 2. The Revised Draft TMDL does not specify the relative magnitudes of the point and non-point sources or the current nutrient contributions from UKL. Such specifics are needed to quantify UKL contributions, so that water quality improvement actions can be determined and prioritized.

Page 4-4, Table 4.1. Are these source categories for Oregon, California, or both? Other comments include: (a) wetland conversion can affect water temperature under certain conditions, (b) if roads contribute to nutrients, then they can contribute to both organic matter and dissolved oxygen impairment (as explained in the paragraph immediately above the table), and (c) urban land use not included.

Page 4-4, Paragraph 1, Line 1. Regarding the Upper Klamath Lake TMDL, the National Research Council (2004) recognized that "[c]urrent proposals for improvement of water quality in Upper Klamath Lake, even if implemented fully, cannot be counted on to achieve the desired improvements in water quality." Thus, the Revised Draft TMDL's use of natural, "pre-disturbance" conditions as the "starting point" for the Klamath River TMDL is unrealistic. The TMDL should provide justification for this position based on actual data, and needs to discuss the uncertainties inherent with such a starting point.

Page 4-4, Paragraph 3, Line 1. Volcanic geology is identified as a source of natural phosphorous and may suggest the Upper Klamath Lake is nitrogen limited, which may also explain why *Aphanizomenon flos aquae*, a nitrogen fixer, dominates in UKL. Regardless of the limiting nutrient, there is no discussion in the TMDL of what nutrient management strategies are available to implement reductions in nutrient loads from UKL. The lack of a clear nutrient management strategy (e.g., N:P ratios and seeking a limiting nutrient to manage) provides little direction for successfully attaining water quality improvements within a TMDL framework or for demonstrating that the assumed nutrient reductions are achievable or otherwise a reasonable basis for the TMDL.

Page 4-4, Paragraph 3, Lines 6-7. The Revised Draft TMDL states that "the upper Klamath basin was characterized by high levels of nitrogen and phosphorus demonstrating the high natural background loading of nutrients." Here the Revised Draft TMDL clearly acknowledges that the upper Klamath Basin and Upper Klamath Lake have long been known for natural eutrophic conditions and high levels of organic matter. Upper Klamath Lake is the source of the Klamath River and provides those eutrophic conditions and high loads to the Klamath River. Therefore, the Revised Draft TMDL's recognition of this high natural background loading of nutrients fundamentally contradicts the Revised Draft TMDL's allocations that assume and set "natural" conditions in the Klamath River for nutrient concentrations that are in the oligotrophic to mesotrophic range. See section 5.3.

Page 4-4, Paragraph 4, bottom of page. The Revised Draft TMDL includes new text that "Eilers et al. (2004) have identified a clear shift in UKL productivity and species composition in the past 100 years, consistent with large scale land disturbance activities, which can be strongly implicated as the cause of the lake's current hypereutrophic character". The Revised Draft TMDL goes on to state, "These changes also include increased export of nutrients and organic matter from UKL to the downstream waters of Klamath River, contributing to the pollutant loading and water quality conditions that are present today". The inclusion of these statements is a much stronger recognition than in the original Draft TMDL of the naturally-eutrophic and currently-hypereutrophic conditions of the source waters to the Klamath River. However, the Revised Draft TMDL continues to repeat the error of the original Draft TMDL in assigning water quality targets and load allocations that would require huge nutrient reductions that are unachievable, unenforceable, or both.

Page 4-5, Paragraph 4. The Revised Draft TMDL states that:

> "Further exacerbating the effect of the naturally productive and weakly buffered system is the presence of regionally high ambient summer air temperatures, and the resulting high heat load to the shallow and predominantly un-shaded Upper Klamath Lake. These naturally warm waters are the source of the Klamath River. In addition, the east-west aspect of much of the Klamath River also makes it prone to heating, even within the steep gorges of some reaches of the river."

This paragraph suggests that heat loading at Upper Klamath Lake is a source for heat in downstream reaches. First, the temperature of Upper Klamath Lake is in dynamic equilibrium with meteorological conditions, i.e., at equilibrium temperature, much of the year (ice cover is a deviation from this condition). Much of the Klamath River is at or near equilibrium temperature (this is not a static value in space or time). To suggest that warm waters are a source of elevated temperatures in downstream reaches (i.e., in California) would be erroneous.

Page 4-5, Paragraph 5, and 4-6, Paragraph 1. The Revised Draft TMDL correctly identifies that natural background water quality:

- is naturally productive/biologically productive
- produces large seasonal volumes of organic matter

- results in subsaturated dissolved oxygen
- is weakly buffered (prone to elevated pH)
- includes high seasonal water temperatures

However, these statements are largely in conflict with the defined natural baseline conditions outlined in Chapter 2 of the Revised Draft TMDL. The natural conditions baseline total N and total P concentrations presented in Chapter 2, Figures 2.16 and 2.17 would occur in a system with low natural productivity (low nutrients), with low volumes of inorganic nutrients, and with high concentrations of dissolved oxygen.

Further, the last sentence, "These natural background heat, nutrient, and organic matter loads to the Klamath River underscore the very limited capacity of the river to assimilate anthropogenic pollutant sources, and ***the necessity for establishing load allocations that will result in attainment of water quality standards***" (emphasis added), shows that the load allocations in the Revised Draft TMDL are based on desired water quality outcomes rather than on an assessment of what load allocations are reasonably achievable and enforceable.

Page 4-6, Paragraph 2, Lines 12-17. Please include the flows at Stateline and the Mouth, or at minimum approximate flow volumes. At Iron Gate Dam the mean annual flow is on the order of 1.4 million acre-feet (MAF), while for the Klamath River near Turwar, the flow is on the order of 11 MAF – nearly 8 times greater (in drier years mean annual flows at Iron Gate and Turwar are on the order of 1 MAF and 6 MAF, respectively). So, in normal years when flow at Stateline is about 10-12 percent of the flow at the mouth, the total load (as identified in the draft TMDL) is approximately 40 percent of the load at the mouth. This clearly identifies the disproportionate load from the upper basin and the challenges that face both California and Oregon in improving water quality conditions.

Pages 4-10 to 4-12, Figures 4.1 to 4.3. The derivation and calculation of the loadings presented in these figures are not explained. It is therefore difficult to review these loadings to determine if they are appropriate.

Pages 4-10 to 4-12, Figures 4.1 to 4.3. Only loads from 2000 are taken into consideration, while loads change from year to year. The lack of assessment of inter-annual variability in the Revised Draft TMDL precludes it from addressing more than a narrow range of potential conditions. The Revised Draft TMDL lacks the technical rigor in the categories of inter-annual variability, sensitivity analysis of numerical tools, and overall uncertainty analysis to establish a reasonable TMDL and load allocations.

Pages 4-10 to 4-12, Figures 4.1 to 4.3. Without the associated flow data in the Klamath River, Figures 4.1 through 4.3 lack a basis for identifying the value of tributary contributions in the form of direct dilution. That is, representing pollutant loading in terms of total annual mass is misleading. As the arrows get bigger moving downstream, it suggests that the river water quality is getting worse. However, the opposite is true. It would be useful to present the pollutant loads in terms of concentrations, as well.

Pages 4-10 to 4-12, Figures 4.1 to 4.3. The figures report data to single pounds and single kilograms. This is misleading to the reader that the analysis is accurate to this level. Because there is no uncertainty analysis in the draft TMDL, there is no method for determining the appropriate significant figures in these figures or in Table 4.2.

Pages 4-10 to 4-16, Figures 4.1 to 4.3 and Table 4.2. The load values shown in Figure 4.1 through Figure 4.3 and Table 4.2, respectively, do not balance along the river. Annual nutrient and CBOD loads in the Klamath River TMDL do not add up, and significant losses and sources are unaccounted for. Because of discrepancies in loads along the river, the Revised Draft TMDL fails to put in-river sources and sinks in proper perspective, and thereby improperly considers appropriate load allocations. In every reach of the river, there are significant, unaccounted losses or gains, indicating that processes at work in the river and reservoirs are not properly addressed. These unaccounted losses and gains should be fully identified, and the processes that produce these significant losses or gains should be discussed in detail, especially with respect to the relative magnitude of regulated sources.

Also, load balances could not be checked for the "natural" baseline condition because load diagrams are presented only for current conditions, and in-stream loadings for "natural" baseline conditions are not listed. Because TMDL "natural" conditions load diagrams are not listed, and the supporting table does not list instream loads below Iron Gate dam, the relative magnitude of unaccounted "natural" sources and sinks along the river cannot be determined. Therefore, the analysis leaves the reader unable to compare TMDL "natural" baseline and estimated current conditions nutrient and CBOD sources along the river or to understand the relative importance of sources and sinks in these two scenarios. These omissions frustrate meaningful public review and result in an incomplete and misleading presentation of constituent loading in the Klamath River and need to be corrected. Furthermore, the magnitude of unaccounted loads that can be calculated from information that is provided in the Revised Draft TMDL represents a flawed analysis and a serious shortcoming of the Revised Draft TMDL.

As presented in the Revised Draft TMDL load diagrams, nutrient and CBOD loads do not balance in any reach of the river. A simple mass balance on any reach of the river follows the form:

$$Load_{in} + Load_{internal} - Load_{out} = 0$$

Where:

$Load_{in}$ = total constituent load at the upstream boundary of a reach

$Load_{out}$ = total constituent load at the downstream boundary of the reach

$Load_{internal}$ = total constituent load added to the reach by tributaries or riverine processes

This relationship does not hold for the loads listed for any reach in the Revised Draft TMDL load diagrams. The sum of loads is never zero; there are unaccounted loads in every reach. These unaccounted loads are significant and often far greater than, for example, the upward benthic flux attributed to either Copco or Iron Gate reservoirs.

Unaccounted loads of total phosphorus, total nitrogen and carbonaceous biochemical oxygen demand (CBOD) in the Revised Draft TMDL load diagrams are listed by river reach in Table A1 through Table A6 below. A negative value indicates that a loss has been neglected, and a positive value indicates that a source has not been taken into account in the listed reach.

Significant digits are always a concern when presenting modeling or field data. Because of uncertainties associated with modeling processes and the data underlying them, only as many significant digits should be used as would give the results meaning. Following this well-accepted guideline, annual loads from the modeling effort undertaken for the Revised Draft TMDL should reasonably be rounded to the nearest hundred pounds. Instead, for consistency with the TMDL, load values appear here as they are listed in the Revised Draft TMDL, to the nearest pound.

Table A1. Klamath River Revised Draft TMDL phosphorus load balance, "current conditions"

Reach	Current Conditions Phosphorus Load (lbs/yr)			
	$Load_{in}$	$Load_{out}$	$Load_{internal}$	Unaccounted Load
Stateline to Iron Gate	717,523	772,016	94,675	-40,182
Iron Gate to Shasta River	772,016	Not given	18,055	Unknown
Shasta River to Scott River	Not given	Not given	104,846	Unknown
Scott River to Salmon River	Not given	Not given	206,780	Unknown
Salmon River to Trinity River	Not given	Not given	103,015	Unknown
Trinity River to Estuary	Not given	Not given	367,401	Unknown

Table A2. Klamath River Revised Draft TMDL phosphorus load balance, "natural" baseline

Reach	"Natural" Baseline Phosphorus Load (lbs/yr)			
	$Load_{in}$	$Load_{out}$	$Load_{internal}$	Unaccounted Load
Stateline to Iron Gate	86,737	95,493	10,157	-1,401
Iron Gate to Shasta River	95,493	Not given	17,690	Unknown
Shasta River to Scott River	Not given	Not given	58,653	Unknown
Scott River to Salmon River	Not given	Not given	206,780	Unknown
Salmon River to Trinity River	Not given	Not given	103015	Unknown
Trinity River to Estuary	Not given	Not given	425,410	Unknown

Table A3. Klamath River Revised Draft TMDL nitrogen load balance, "current conditions"

Reach	Current Conditions Nitrogen Load (lbs/yr)			
	$Load_{in}$	**$Load_{out}$**	**$Load_{internal}$**	**Unaccounted Load**
Stateline to Iron Gate	3,020,913	2,819,510	381,647	-583,050
Iron Gate to Shasta River	2,819,510	3,084,413	116,978	147,925
Shasta River to Scott River	3,084,413	3,258,247	231,080	-57,246
Scott River to Salmon River	3,258,247	4,522,128	1,113,982	149,899
Salmon River to Trinity River	4,522,128	5,463,502	761,780	179,594
Trinity River to Estuary	5,463,502	8,072,118	2,641,224	-32,608

Table A4. Klamath River Revised Draft TMDL nitrogen load balance, "natural" baseline

Reach	"Natural" Baseline Nitrogen Load (lbs/yr)			
	$Load_{in}$	**$Load_{out}$**	**$Load_{internal}$**	**Unaccounted Load**
Stateline to Iron Gate	866,423	950,527	94,355	-10,251
Iron Gate to Shasta River	950,527	Not given	115,617	Unknown
Shasta River to Scott River	Not given	Not given	189,820	Unknown
Scott River to Salmon River	Not given	Not given	1,113,982	Unknown
Salmon River to Trinity River	Not given	Not given	761,780	Unknown
Trinity River to Estuary	Not given	Not given	3,086,366	Unknown

Table A5. Klamath River Revised Draft TMDL CBOD load balance, "current conditions"

Reach	Current Conditions CBOD Load (lbs/yr)			
	$Load_{in}$	**$Load_{out}$**	**$Load_{internal}$**	**Unaccounted Load**
Stateline to Iron Gate	17,492,704	11,295,995	1,807,322	-8,004,031
Iron Gate to Shasta River	11,295,995	12,879,105	1,109,290	473,820
Shasta River to Scott River	12,879,105	13,812,364	1,387,237	-453,978
Scott River to Salmon River	13,812,364	19,212,688	4,785,678	614,646
Salmon River to Trinity River	19,212,688	29,908,129	8,375,798	2,319,643
Trinity River to Estuary	29,908,129	55,969,233	29,820,283	-3,759,179

Table A6. Klamath River Revised Draft TMDL CBOD load balance, "natural" baseline

Reach	"Natural" Baseline CBOD Load (lbs/yr)			
	$Load_{in}$	$Load_{out}$	$Load_{internal}$	Unaccounted Load
Stateline to Iron Gate	6,498,082	7,077,933	690,994	-111,143
Iron Gate to Shasta River	7,077,933	Not given	1,109,290	Unknown
Shasta River to Scott River	Not given	Not given	2,008,839	Unknown
Scott River to Salmon River	Not given	Not given	4,785,678	Unknown
Salmon River to Trinity River	Not given	Not given	8,375,798	Unknown
Trinity River to Estuary	Not given	Not given	34,915,178	Unknown

Calculations to balance loads, as illustrated in these tables, show unaccounted losses in the Revised Draft TMDL that range as high as -40,000 lbs/yr phosphorus, -583,000 lbs/yr nitrogen, and -8 million lbs/yr CBOD. Unaccounted loads range as high as 179,000 lbs/yr nitrogen, and 2.3 million lbs/yr CBOD. Most of these unaccounted loads, and all of the highest values, occur in the Stateline to Iron Gate reach. Copco and Iron Gate reservoirs lie within this reach and represent loss due to deposition and nutrient processing, but this loss is not specifically accounted. Reaches upstream of Scott River always show unaccounted load loss. The Scott River to Salmon River reach and the Salmon River to Trinity River reach always show unaccounted load gain. The Trinity River to Estuary reach shows a gain in phosphorus and loss of nitrogen and CBOD.

Even though insufficient information is provided in the Revised Draft TMDL load diagrams and table to calculate load balances for "natural" baseline conditions along most reaches of the river, large losses are apparent under this scenario in the Stateline to Iron Gate reach, where sufficient information is provided. All of these unaccounted loads suggest processes that are poorly documented in the Revised Draft TMDL.

In sum, the Revised Draft TMDL leaves significant nutrient and CBOD loads unaccounted for in its presentation of loading in support of numerical targets and load allocations. Much load information for "natural" baseline conditions is missing, so load balances could not be completed for most reaches under this scenario. But, given the data presented in the TMDL, significant unaccounted loads must exist for the "natural" baseline conditions as they do for the current conditions scenario. Unaccounted loads are significantly greater than loads that are accounted for. The failure to include data describing "natural" baseline loads needs to be addressed. Without these data, "natural" baseline and current condition loads cannot be evaluated. The magnitude of unaccounted loads that can be calculated from information provided in the Revised Draft TMDL represents an incomplete analysis and is a serious shortcoming.

Page 4-14, Table 4.2. This table suffers from the same problem as the previous figures. The numbers don't add up. It is not possible to get the total phosphorus load shown on the table by summing any logical combination of values from the table rows above. It also has mysterious disappearing phosphorus between Stateline and Copco. See the Table A7 below for examples (using values for Table 4.2 of the Revised Draft TMDL).

Table A7. Klamath River Revised Draft TMDL load balance by sources

Source	PT load	% of calculated total	% of table total
Klamath River	717,523	47	45
Copco Reservoir Outlet	703,047	46	44
Copco Reservoirs sed flux	3,331	0	0
Stateline to Iron Gate	90,979	6	6
Iron Gate Reservoir outlet	772,016	50	48
Iron Gate Reservoir sed flux	365	0	0
Iron Gate Fish Hatchery	365	0	0
Iron Gate to Shasta	17,690	1	1
Shasta River	98,544	6	6
Shasta to Scott	6,302	0	0
Scott River	13,856	1	1
Scott to Salmon	68,217	4	4
Salmon River	70,302	5	4
Salmon to Trinity	32,713	2	2
Trinity River	302,196	20	19
Trinity River to Turwar	65,205	4	4
Total calculated	1,542,081	100	96
Total from table	1,612,295		100

Page 4-14, Table 4.2. The annual source loads of phosphorus for Iron Gate to Shasta Tributaries, Scott River, Scott to Salmon tributaries, Salmon River, Salmon to Trinity tributaries, and Trinity River to Turwar tributaries are all set equal to the natural background, and the Trinity River is set below natural background. This is unrealistic given the anthropogenic alterations that have occurred in these watersheds. This needs to be explained and justified using actual data or citations to relevant reports. Similar comments apply with respect to the numbers for nitrogen and CBOD.

Page 4-14 to 4-16, Table 4.2. As noted above, the data presented in Table 4.2 (and Figures 4.1-4.3) suggests accuracy to single pounds, which is greater accuracy in the analysis than can possibly exist. As with Figures 4.1 to 4.3, the Revised Draft TMDL also is missing any discussion of how the values in Table 4.2 were derived. Such discussion is necessary in the TMDL documentation to effectively interpret these figures and table.

Page 4-17 Section 4.2.1.1 Temperature. The Revised Draft TMDL states "The results, summarized in Figure 4.4, indicate that the sum of all sources upstream of California leads to significant temperature increases, possibly as much as 6.9°F (3.35°C), from approximately April to December." This statement is erroneous, and neglects the fundamental fact that this is an open system, and the aquatic environment can readily gain or lose heat across the surface (as well as the bed). Thus, all sources of heat energy cannot be simply summed, because heat energy can enter and leave the system, and the system is always seeking equilibrium with meteorological conditions. Further, in the Revised Draft TMDL modeling, J.C. Boyle reservoir receives 100 percent solar radiation input in the "existing conditions" scenario, while the solar radiation is reduced by some 20 percent in the "natural conditions" (no dam) riverine reach model (as discussed further below in comments on Appendix 7).

4.2 Pollutant Source Area Loads

Page 4-17 and 4-18, discussion under 4.2.1.1 Temperature. Water temperature is one of the least conservative constituents because of the constant heat exchange across the air-water interface. There is no discussion of whether the river is at or near equilibrium temperature for this assessment (i.e., Figure 4.4), although presumably it is. There is no discussion of whether the return flows from irrigation are at or near equilibrium, although presumably they are. There also is no discussion of the volume of irrigation return flows compared to the receiving water, and the notable distance from Stateline to these return flow points. The river will seek equilibrium temperature and may make any difference in irrigation return flow negligible. A more complete and accurate discussion is necessary to interpret these results.

Page 4-18 and 4-19, Figures 4.4 and 4.5. These graphs show only the difference between two model runs, with no reference to the actual temperatures. Without knowing the actual temperatures, it is impossible to adequately evaluate the statements in the text. Secondly, these are comparisons of the output of two model runs. If the expected accuracy of the models is +/- 2 ºC, then a difference of 4 ºC might be due to fluctuations in the model only. This error and associated uncertainty should be provided to the reader.

Page 4-18 and 4-19, Figures 4.4 and 4.5. An exceedance curve of deviations would be a valuable addition to assess these data. For example, in Figure 4.5, although positive differences of as much as 1.5°C occur, this is only one day in 365. All other differences are less than 1°C. Further, an exceedance plot would also illustrate the number of days when deviations were positive (warmer) and negative (cooler). However, without a quantification of uncertainty, data interpretation is challenging. Using information from Watercourse (2006) for temperature model simulations on the Klamath River below Iron Gate Dam, model uncertainty is probably on the order of 1°C (a function of time of year and location).

Page 4-19, Paragraph 1, Line 2. The Revised Draft TMDL should explain whether or not TP and TN loads include algae-bound, and particulate organic-matter bound P and N.

Page 4-20, Figure 4.6. There is no supporting data or detailed documentation in the Revised Draft TMDL document for the derivation of "natural conditions" baseline presented in these graphs. What are the flows and concentrations that make up these loads? It is especially confusing that the total phosphorus load is presumed to have increased nearly six-fold when the difference between "current" conditions (based on actual data) and "natural" conditions (based on groundwater and tributary streams) is only about two-fold. For example, the current average total phosphorus concentration in the Klamath River in the vicinity of the Project is about 0.18 mg/L. Assuming 0.18 mg/L is six-fold greater than "natural" conditions would require a "natural" concentration of 0.03 mg/L (assuming the same flows). A total phosphorus concentration of 0.03 mg/L is unrealistically low for the Klamath River, even substantially lower than the current total phosphorus concentration in "natural" groundwater (at the J.C. Boyle bypass reach) of 0.07 to 0.08 mg/L as well as the natural baseline phosphorus concentration in water flowing to Upper Klamath Lake of approximately 0.06 mg/L (NRC 2004). See comments above related to Page 2-66, Figures 2.16 and 2.17.

A range of years would provide considerable insight into the potential variability and ranges of loads. Also, should a simulation from 2000 be used for a TMDL that will be completed a decade later? Have UKL TMDL implementation actions improved water quality in the six years since adoption of that TMDL? At a minimum, an assessment of available data should be carried out to assess current conditions at UKL and determine if indeed improvements have been observed. Such information would be useful to include in the Klamath River TMDL because if loads have been reduced (or increased, or stayed the same…or simply experienced a range of conditions) at Link River Dam this would provide some evidence regarding the reasonableness of the Revised Draft TMDL's assumptions about the loading from UKL to the Klamath River.

Page 4-22, Paragraph 1, last sentence. Mayer (2002) found that in 1999-2000 the Klamath Straits Drain contributed 25-75 percent of the nitrogen and 25-50 percent of the soluble reactive phosphorus load to the river below the Klamath Straits Drain.

Page 4-25, Paragraph 3, Lines 5-6. The Revised Draft TMDL states that "the presence of Copco Reservoir can increase Klamath River water temperatures as much as 6.8°F". This is a misstatement of the facts. There is no "increase" in temperature; there is a change (of a week or two) in the time of year that a given temperature occurs in the river. The TMDL must be clear about this because an actual increase in temperature of 6.8°F could have a substantially different effect than a change in the timing of existing temperatures. The Revised Draft TMDL presents no empirical evidence that a shift in the timing of certain temperatures has had an adverse effect on beneficial uses.

Page 4-25, Paragraph 3, Lines 6-8. Same comment as the previous comment. The maximum temperature does not increase. Instead, the timing of the maximum temperature shifts.

Page 4-25 to 4-28, Section 4.2.2.1 Temperature. Throughout the section of the Revised Draft TMDL, only temperature *differences* are shown. This is the case for the entire chapter for all applicable graphs – only the differences in constituent concentrations are shown. Thus, the actual concentration or temperature is not available to the reader. The Revised Draft TMDL needs to include the actual concentrations and temperatures. Although conditions may deviate from natural conditions, such a deviation is not inherently harmful to beneficial uses.

Page 4-25, Paragraph 2, Lines 3-4. The draft TMDL states that the analysis isolated the effects of each reservoir. However, the difference calculations do not isolate the reservoirs but include the effects of the reservoir and any upstream reservoirs. Thus, the results for Copco reservoir (Figure 4.10) include those for J.C. Boyle reservoir, and the results for Iron Gate Reservoir include those for Copco reservoir and J.C. Boyle reservoir. This makes it difficult to assess if the effects presented are correct.

Page 4-26, Figure 4.10 and elsewhere. Presenting only differences and not actual model simulated temperatures (or other constituents presented in this manner in Chapter 4) provides limited insight into the relative impact of the difference given the actual temperature or concentrations in the aquatic system. With no knowledge of the actual temperature range involved it is not possible to make properly informed decisions about the "significance" of the temperature differences. The Revised Draft TMDL needs to include the actual temperature plots of the two scenarios in addition to the differences between scenarios.

Page 4-28, discussion under Dissolved Oxygen. Providing a chart of the dissolved oxygen conditions in Copco 1 and 2 and Iron Gate reservoirs throughout the year with associated volumes is needed. Labeled on the chart should also be the applicable water quality standards. This discussion should be supported by field data to supplement the model results, which are limited to the year 2000. Such data would also illustrate the inter-annual variability in volumes of water where dissolved oxygen conditions are undesirable.

Temperature and dissolved oxygen conditions under existing and natural conditions scenarios are not presented for critical summer periods in the Copco and Iron Gate dam reaches, nor are associated standards. Presentation of this information is required to support the statement that co-occurring dissolved oxygen and temperatures would meet targets under natural conditions. It should be made clear whether or not the reference to a "natural free flowing condition" is the same as the TMDL's assumed natural conditions baseline.

Page 4-28, Paragraph 2, last sentence. It is not clear what aspects of the reservoirs the Revised Draft TMDL is referring to that "require" that the reservoirs be considered a contributing source and assigned allocations and numeric targets. Earlier in Chapter 4 (see page 4-3), the Revised Draft TMDL states, "Precise quantification of individual source categories within source areas is not critical because the primary mitigation for nonpoint source loads is not a specific permit limit; rather mitigation is generally based on the use of best management practices that have demonstrated effectiveness to reduce pollutant loads through their application." Since the reservoirs are a net sink for nutrients from upstream, thus protecting the lower river from even higher loading than currently exists, the Revised Draft TMDL needs to support and justify (with data or reference to relevant reports) why it is "required" that the reservoirs be considered a contributing source.

Page 4-28, discussion under Dissolved Oxygen, Paragraph 3 of page, Lines 1-4. Internal nutrient loading in stratified reservoirs does little to exacerbate dissolved oxygen conditions because for internal loading to occur, anoxia must be present. Anoxia occurs primarily because of seasonal stratification and is largely driven by organic matter loading and sediment oxygen demand. Resulting loading from the sediments is generally limited to the hypolimnion. When the reservoir attains an isothermal condition in the fall, dissolved oxygen conditions are typically no longer of concern. Likewise, any available nutrients that were contributed from the hypolimnetic volume during turnover are of minimal consequence because the shorter days and cooler temperatures limit algal growth. Copco and Iron Gate reservoirs have very short residence times in the winter due to the relatively small storage, large inflows, and isothermal condition, so carryover of hypolimnetic nutrients from one season to the next is most likely insignificant.

Page 4-28, Paragraph 3, Line 12. The 18.7°C maximum weekly maximum temperature under natural conditions referenced in the Revised Draft TMDL is not valid due to the inappropriate 20 percent reduction in solar radiation in the TMDL's river models.

Page 4-29, Table 4.3. The table refers to the period from May 2004 - May 2005, while the text refers to May 2005 - May 2006. Likewise, annual values in the table do not correspond to annual values in the text, and it would be helpful to present all data in days or years, or both. Please clarify that these are "compromise" values (Appendix 2, section 3.2) used in analysis. How any of these values for residence time were determined is not described here or in Appendix 2. Residence time information is readily available from the CE-QUAL-W2 models of the reservoirs in model output.

Page 4-29, Paragraph 4, Lines 1-4. The Revised Draft TMDL accurately states that Copco and Iron Gate reservoirs "promote the settling of particulate material, including nutrient-bearing organic material and algae, and nutrient sorbed to inorganic sediment". This statement contradicts conclusions made elsewhere in the Revised Draft TMDL that the reservoirs export "high levels" of organic matter (for example, see page 2-37), and that the level of nutrient retention by the reservoirs is small and insignificant (for example, see page 2-42).

Pages 4-29 and 4-30, five bullet points on these pages. The listed bullet points are a description of processes that largely are not applicable to Iron Gate and Copco reservoirs. They are not significant processes that drive water quality conditions in Copco and Iron Gate reservoirs.

- Bullet 1 – Resuspension of sediments is unlikely to be a source of nutrients to Copco and Iron Gate reservoirs. The fact that both Iron Gate and Copco reservoirs experience stable stratification in the summer with a thermal gradient developing as shallow as 5 m indicates that there is relatively little wind generated turbulence and little likelihood of resuspension of anoxic sediment. It is theoretically possible that sediments shallower than 5 m could be resuspended, but no evidence of it has been observed during frequent visits over 10 years. Copco and Iron Gate reservoirs are impoundments located in steep canyon areas and thus are deep with sloping sides. Because they are maintained at stable levels for hydropower purposes, macrophytes tend to ring these reservoirs, dissipating wind energy and minimizing resuspension of sediment. This process (along with degassing and bioturbation) is probably small in the reservoirs. Bubbles rising to the surface of the reservoirs, suggesting degassing, have been observed on at least one occasion (Eilers pers. comm.). There was no evidence to suggest that the gasses came from the sediment. In any event, even if degassing were a regular phenomenon it would have little effect on the nutrient budget of the reservoir because it happens during the fall when stratification breaks down and biological activity is low. Any nutrients that might be released would be quickly washed out of the system during the winter.

- Bullet 2 – Low redox potential is not likely to be a source of phosphorus to the Klamath River. Available data does not show phosphorus releases from the sediment in Iron Gate reservoir (see extensive water quality data for Iron Gate reservoir posted on PacifiCorp's website, and previously available to the Regional Board). Available data shows that phosphorus can increase in Copco reservoir during the summer below about 24 m (see extensive water quality data for Copco reservoir posted on PacifiCorp's website). However, the volume of Copco reservoir contained below 24 m is less than 5 percent of the volume of the reservoir (Eilers and Gubala 2003). An increase in such a small volume of the reservoir would be undetectable when mixed into the total volume. A similar situation exists with respect to ammonia. Figures 4.1 to 4.3 in the Revised Draft TMDL show that loading from the Iron Gate and Copco reservoir sediments is less than one percent of influent loads.

- Bullet 3 – "High" pH is not defined. Elevated pH near the bulk of the sediments (in deeper waters) is atypical during summer when anoxia is present (and pH is actually quite low near the sediments under these conditions where fermentation is occurring). Both Copco and Iron Gate bottom waters during summer have pH values typically below 7.5 and sometimes below 6.0. This may occur in shallow margin areas of the reservoir, but likely is not a dominant process.
- Bullet 4 – The Revised Draft TMDL claims that Figure 4.13 demonstrates the transport of phosphorus from "below the thermocline" to the surface via migrating cyanobacteria. This is a misrepresentation of the data found in Figure 4.13, which illustrates vertical migration of *Microcystis* in Copco reservoir, but it in no way demonstrates that there is translocation of phosphorus from deeper water "below the thermocline" to the surface. Figure 4.13 shows that *Microcystis* migrates between approximately 7 m to the surface, but it does not reach as deep as 10 m. This is well above the thermocline. The summertime concentration of phosphorus in Copco reservoir does not change until depths greater than 20 m. The migrating cyanobacteria never move below the thermocline, and there is no greater concentration of phosphorus at 7 m than there is near the surface, so there can be no translocation of phosphorus from an area of higher concentration to an area of lower concentration. The Revised Draft TMDL needs to be modified to accurately represent the facts.
- Bullet 5 – Nitrogen fixation does require energy, and there has been no analysis to date if this process is occurring. The mere presence of heterocysts is not conclusive of actual nitrogen fixation. In addition, both Copco and Iron Gate reservoirs experience the presence of both non-nitrogen fixing BGA (e.g., *Microcystis*) and nitrogen fixing BGA (e.g., *Aphanizomenon*), and the presence of ample soluble nitrogen in the water indicates that nitrogen fixation is not a substantive process in the Project reservoirs. There is no empirical evidence that nitrogen fixation is occurring in Iron Gate or Copco reservoir, and the Revised Draft TMDL presents none. The empirical information that is available using nitrogen isotopes (Moisander 2009, Deas pers. comm.) suggests that the nitrogen in the reservoirs comes from sources other than nitrogen fixation.

Page 4-30, Paragraph 2. The Revised Draft TMDL hypothesizes several mechanisms by which nutrients might move from the reservoirs and constitute an additional load to the downstream reaches. However, the Revised Draft TMDL provides no actual empirical evidence, and cites no studies that demonstrate that such movement occurs. In fact, the evidence that does exist (based on PacifiCorp's extensive water quality monitoring data from 2001- 2008 , available on its website) suggests that the mechanisms hypothesized by the Revised Draft TMDL do not occur, and that no such loading from the reservoirs occurs (PacifiCorp 2006). The Revised Draft TMDL explicitly recognizes that the reservoirs are a net nutrient sink.

Page 4-30, Paragraph 2, last sentence. The Revised Draft TMDL expresses concern about export of nutrients "when occurring within the window of the critical growth period for periphyton", but the Revised Draft TMDL provides no empirical evidence that such export occurs. The Revised Draft TMDL also provides no empirical evidence that periphyton growth in the river is the result of anything other than nutrients transported from upstream. In fact, on page 2-42, the Revised Draft TMDL asserts that the river is saturated with nutrients so that small changes in nutrients caused by the reservoirs would have no effect on periphyton growth.

Page 4-32, Paragraph 1. The Revised Draft TMDL cites analysis and results from "Asarian et al. 2009". This citation is not available for public review. The use of documents still "in press" or otherwise unavailable does not allow a thorough review of this TMDL by the public. The Revised Draft TMDL should delete reference to this information unless and until a report has been made available for public review. There have been substantial flaws with previous nutrient loading analyses by these authors (i.e., Kann and Asarian 2005, Asarian and Kann 2006, Kann and Asarian 2007) as described in PacifiCorp (2006), PacifiCorp (2008b), and Butcher (2008).

Page 4-32, Paragraph 2, under Role of Copco and Iron Gate Reservoirs in Klamath River Nutrient Dynamics. To reiterate earlier comments, the Revised Draft TMDL definition of the critical growth period from May through October masks critical intra-seasonal dynamics in the Klamath River. Discussions in the Revised Draft TMDL focus on annual or six-month loading assessments and miss critical within-season dynamics during which reservoir nutrient retention is even more important. The fundamental flaw in this analysis is the failure to carefully examine TMDL model outputs, which show that the reservoirs dramatically reduce large nutrient pulses emanating from Oregon (in response to bloom conditions in UKL) and provide substantial reductions during the critical summer season.

PacifiCorp's water quality modeling consultant (Watercourse Engineering) performed model runs (using the Revised Draft TMDL models recently obtained from Tetra Tech for review) that show that TP and TN loads at Iron Gate dam are substantially lower under current conditions than under conditions assuming the dams are absent. This is due to the significant retention and loss of inflowing organic matter in the reservoirs that would not occur without the reservoirs.

The peak nutrient loads coming from upstream sources are also shifted later into the fall than would occur without the reservoirs. This shift into the fall is important because, with dams in place, nutrients tend to leave the reservoirs later in the season after the benthic algae standing crop in the river has started to diminish.

Page 4-33, Paragraph 1, under Table 4.4. The Revised Draft TMDL includes new text on the matter of net annual retention of nutrients in Copco and Iron Gate reservoirs. The Revised Draft TMDL states, "Within the critical summer growth period (May – October), the TMDL model estimates a combined reservoir retention of TP of 7.6% annually and 6.0% during the period May to October. For nitrogen the annual retention is 14.9% and 30% during the summer growing period (May to October)." The Revised Draft TMDL goes on to state, "Asarian and Kann have estimated the combined effect of the reservoirs to be 15% retention of TN and 10% retention for TP on an annual basis and seasonally TP 8% and TN 31%". Despite these appreciable levels of nutrient retention, the Revised Draft TMDL consistently downplays these levels as "small" (see page 4-35, second bullet), "not large" (see page 2-42, under second bullet), and "not significant" (see page 2-42, under second bullet). Retention of the inflowing load of TP at a rate of 10 percent annually equates to a reduction of about 71,000 pounds of total phosphorus, and retention of the inflowing load of total nitrogen at a rate of 15 percent annually equates to a reduction of about 453,000 pounds of TN. The Revised Draft TMDL's characterization of these reductions as "small", "not large", and "not significant" is misleading and discounts the very reduction in nutrients levels that the TMDL seeks to achieve.

Page 4-34. The net retention values presented in the Revised Draft TMDL are actually considerable – especially the critical May-September period: 31 percent for total N and 8 percent for total P (Table 4.5). Table 4.4 in the Revised Draft TMDL is misleading. It only states Klamath River inflows and outflows from reservoirs, underestimates retention for the reservoirs, and even suggests that Iron Gate reservoir is a source of TN and TP. Tributary inflows and associated loads to the reservoirs need to be listed. The retention estimated by the TMDL model appears to under-predict estimated annual and seasonal TP retention compared to Asarian et al (2009) by some 24 percent and 25 percent, respectively (acknowledging that the averaging periods on seasonal values are slightly different). This significant deviation needs to be explained.

Page 4-35, first half of page. The net retention benefits of Copco and Iron Gate reservoirs are clearly presented in Table 4.5 (page 4-34). Nevertheless, on page 4-35, the Revised Draft TMDL tries to argue that such retention is unimportant and perhaps even undesirable. The fact is that, if the reservoirs were absent, there would be considerably more nutrients in the Klamath River below Iron Gate dam. Again, the downplaying of reservoir retention in the Revised Draft TMDL puts the Regional Board in the position of discounting the reduction in nutrient levels that the TMDL seeks to achieve.

Page 4-35, first bullet. Retention within the reservoirs is largely the result of settling to the bottom, where the nutrients do not participate in biological activity within the reservoir. Retention therefore has little to do with the algal conditions in the reservoirs, which are driven by the concentration of nutrients imported from upstream.

Page 4-35, second bullet. The Revised Draft TMDL states that "net retention amounts are small relative to the nutrient-rich conditions downstream of Iron Gate dam". Given that retention involves the very biostimulatory constituents (i.e., nutrient and organic matter) that the TMDL is aimed at reducing, the Revised Draft TMDL should explain why it considers these substantial reductions in nutrients to be unimportant.

Page 4-35, fourth bullet. The Revised Draft TMDL provides no data concerning particulate and dissolved partitioning. This Revised Draft TMDL needs to provide the supporting information on particulate and dissolved forms of inorganic and organic phosphorus, including the stoichiometry of the particulate forms (i.e., C, N, and P fractions). In fact, available data shows that most of the phosphorus in the system is in the dissolved fraction (see data posted on PacifiCorp's website, and as previously available to the Regional Board).

Page 4-35, fourth bullet. The Revised Draft TMDL includes new text that states, "For phosphorus, it is inappropriate to assess retention only at an annual time step, as the majority of the retention occurs in Winter-Spring, when more of the phosphorus is in particulate form and water quality conditions (i.e., flow, light, temperature) are not subject to biostimulatory conditions". Such a conclusion fundamentally contradicts the *year-round* or *annual* nutrient targets and allocations required in the Revised Draft TMDL (see Chapter 5).

Page 4-35, fifth bullet. The section addresses nutrients, but this fifth bullet discusses oxygen allocations and implications for fisheries. This point is out of place or needs additional information to make it relevant to this section. Further, the draft TMDL is vague about where and when oxygen depletion occurs and which fishery (COLD or WARM) is affected.

Page 4-35, sixth bullet. The Revised Draft TMDL states that "Chlorophyll-a and blue-green algal related targets are achieved above the reservoir but not within the reservoirs." This statement is irrelevant and should be deleted. These chlorophyll *a* and blue-green algal related targets are not applicable or relevant to the river reaches. The tendency for the Revised Draft TMDL to examine river data in light of these targets recurs elsewhere in the document (e.g., see pages 2-70 and 2-71), and indicates a fundamental misunderstanding of the applicability of these particular targets. It is an inappropriate comparison. It is as inappropriate as it would be to apply the river-related benthic chlorophyll *a* target to the reservoirs.

Page 4-35, seventh bullet. The Revised Draft TMDL has deleted text here from the original Draft TMDL that reservoir nutrient "retention plays an important…role". The Revised Draft TMDL replaces the deleted text with text indicating that "negative water quality affects [*sic*] associated with changes in nutrient dynamics". These edits indicate the Revised Draft TMDL's bias toward making interpretations that emphasize reservoir detriments and downplay reservoir benefits, such as with regard to nutrient and organic matter loading. The Revised Draft TMDL's own analysis indicates that the reservoirs provide substantial levels of nutrient retention (e.g., 6-10% retention of TP and 15-31% retention of TN as shown in Table 4.5). The Revised Draft TMDL discounts and downplays the very reduction in nutrients levels that the TMDL seeks to achieve. The implications of increased nutrient loads under the "without dams" condition on river reaches and the estuary needs to be more comprehensively and accurately assessed to determine implications on implementation of TMDL actions. Further, a more balanced and objective assessment of system nutrient dynamics in the TMDL would allow better assessment of potential implementation actions and key intermediate milestones en route to compliance.

Page 4-36, Paragraph 1 (before section 4.2.3), Line 3. Oxygen deficits are presented here as if they occur throughout the reservoir during summer months. The Revised Draft TMDL should identify the location where deficits occur, e.g., hypolimnion.

Page 4-38, under 4.2.4.1 <u>Temperature</u>. The Revised Draft TMDL's analysis is invalid because the mainstem temperature model used for the TMDL under-predicts water temperature due to an inappropriate reduction of solar radiation by 20 percent in the river models.

Pages 4-40 and 4-41, Figures 4.14 and 4.15. These plots of temperature "changes" (and others like these elsewhere in the Revised Draft TMDL) provide little analytical value, particularly because: (1) there are no tabular statistics on the "changes" or differences; (2) the scales are such that quantitative interpretation is difficult; and (3) the data sets used to calculate the "changes" or differences are not provided. Identifying a metric, most usefully based on model uncertainty, and examining results in a more rigorous manner (e.g., a basic exceedance plot), would provide considerably more information and form a more robust assessment. For example, if uncertainty analysis identified that the model was accurate to within 0.5°C, then an exceedance plot of the differences could be constructed and the probability of differences over 0.5°C could readily be presented consistently throughout the entire document.

Because model uncertainty was not quantified in the Revised Draft TMDL, the results in Figures 4.14 and 4.15 cannot be interpreted in a meaningful manner. Further, when notable discrepancies occur, such as in November, some discussion in the text should follow. Why would fall temperatures be so much warmer under a TMDL compliance condition than under existing conditions? Lack of interpretation and investigation of model output throughout the draft TMDL, i.e., why discrepancies occur, suggests that the models may have been used as "black boxes" with emphasis on the final model output and minimal regard to why the values are what they are.

Page 4-41, Paragraph 1, Lines 1-3. The Revised Draft TMDL states that daily average temperatures "regularly exceed" 20 °C in the Klamath River. No figure is provided, no data presented. What does the term "regularly" mean?

Page 4-42, Paragraph 1, Line 7. Please provide the Revised Draft TMDL's definition of a thermal refugia. This paragraph suggests that the Regional Board staff have simply made a determination that a temperature condition below 20°C defines a thermal refugia. This is based on the statement that "temperatures above 20°C (68°F) do not adequately support adult Chinook migration and holding". Referring to work by Strange (2006), "[R]esults from 2005 supported the conclusion from previous study years that the thermal threshold for migration inhibition for KRB adult Chinook occurs at mean daily water temperatures (MDTs) of 23.5°C during falling water temperature trends, at MDTs of 21.0°C during rising water temperature trends, and at MDTs of 22.0°C during stable temperature trends". (See page 5 of Strange [2006]). Further, is the TMDL's definition of a thermal refugia based on adult migration and holding, and not over-summering juveniles?

Because the conditions of thermal refugia are not defined in the draft TMDL, a quantitative approach to assessing refugial areas cannot be completed. There is considerable literature specific to the Klamath River available to draw from, but these sources were not considered in the TMDL analysis. For example, the Revised Draft TMDL does not mention the Reclamation-funded four-year study of thermal refugia in the Klamath River below Iron Gate dam. All of the documentation associated with this work, as well as other associated literature, was supplied to Regional Board staff in April in response to a request for information. This work was guided by a technical committee (USFWS, DFG, Yurok Tribe, Karuk Tribe, and others) which met each year prior to field season to provide review of study methods and results and input on study plans and flow schedules. The work was carried out cooperatively with the Yurok and Karuk Tribes, Watercourse Engineering, and Reclamation. Multiple thermal refugia were investigated representing upper river (Beaver Creek), middle river (Elk Creek) and lower river (Red Cap Creek). Intensive field surveys included mapping bed forms and fish counting polygons, collecting local velocities, extended period temperature monitoring, meteorological observations, exploring water temperatures in regions of upwelling, and extensive fish counts. In addition, many other creeks and areas were explored to further an understanding of refugial areas. Aerial FLIR was also implemented to capture a snapshot of a large number of potential refugial areas.

Based on the available work of thermal refugia in the Klamath River, considerable thought has been given to the definition of thermal refugia, and the single temperature approach suggested in the Revised Draft TMDL is insufficient. Refugial areas in the Klamath River require several key attributes:

- persistence and stability (at a minimum these features must be continuously functional during the late spring through summer period).
- fish utilization (habitat, which may differ among species).
- appropriate temperatures for species present (each species may have a different thermal tolerance).
- appropriate flow (this may or may not include connectivity to the mainstem, but this is determined on a case-by-case basis. Protection of the watershed baseflow is critical).
- meteorological considerations (affects tributary stream temperatures as well as mainstem Klamath River)

Page 4-42, Figure 4.16. Please provide the year of the data (presumably 2000). Providing a range of years will also be useful for comparison. A more comprehensive presentation of the Shasta River analysis is required. This figure presents information, but there is no technical appendix outlining approach, assumptions, or presentation of data. There is no quantitative discussion of uncertainty. Further, recent work in the Upper Shasta River (Jeffres et al 2008, Jeffres et al 2009) should be considered in the TMDL for natural conditions baseline. Jeffres et al (2009) concludes that assumptions basic to the cold water determination on the Shasta River were overstated. More recent studies indicate that spring temperatures in Big Springs Creek are probably between 2 and 4°C warmer than assumptions in the Shasta River TMDL. Further, these studies have identified severe limitations to riparian shading for extended reaches of the Shasta River due to soils conditions. These important findings indicate the Shasta River TMDL temperature analysis should be revisited. Available data suggest that water temperature reductions that are assumed to be achievable in the Shasta River under an implemented TMDL for the Shasta River are too optimistic. Thus, the Shasta River water temperatures assumed in the Klamath River TMDL analysis are colder than can likely be achieved.

Page 4-51, under <u>Effects of Sediment Loads on Klamath River Tributaries</u>. Excessive sediment loads create unique dynamics in the Klamath River thermal refugia. In the upper system – above the Scott River – where annual flow ranges are modest, most tributaries enter at elevations that match that of the river, which essentially provides access to the creek (e.g., Bogus, Cottonwood, Beaver, Horse Creeks…Humbug Creek is an exception). As one progresses downstream and the river flow range increases dramatically, tributary mouths are often located well above the river, with the tributary crossing alluvium to reach the main stem. In certain cases these creek mouths are several feet above the Klamath River summer flow stage and become disconnected. Longitudinal location and complex geomorphology conditions have direct implications on thermal refugia formation. For example, the timing of winter floods and subsequent snowmelt hydrographs in tributary streams play an important role in the alluvial conditions at the mouth of tributaries because the flows (and thus sediment delivery) are often not coincident. These dynamics are discussed in USBR (2005). In sum, this is a complex issue and unique to each tributary. This paragraph is speculative and adds little to the technical TMDL regarding temperature impacts associated with sediments and approaches to managing these unique and valuable resources.

Page 4-51, Paragraph 4. Although floods have occurred, the riparian vegetation shading conditions, and associated temperature conditions, have recovered in many tributary situations. Using post-1997 flood conditions is not necessarily conservative – those conditions represent an element of natural disturbance regimes and need to be accounted for in the Revised Draft TMDL.

Page 4-51, last paragraph. The Revised Draft TMDL states, "Furthermore, because the downstream endpoints of the modeled reaches are near the mouths of the streams where streams are already near equilibrium…" Equilibrium with what conditions? Are they in equilibrium with the Klamath River? The discussions in the Revised Draft TMDL have not incorporated findings from four years of thermal refugia study completed by the U.S. Bureau of Reclamation in cooperation with the Karuk and Yurok Tribes.

Page 4-52, under Effects of Suction Dredging on Thermal Refugia. Comments herein are not wholly related to suction dredging, but rather to thermal refugia. The draft TMDL does not define a thermal refugia. There are no thermal characteristics, sizes, habitat, fish use (number, species, period, lifestage), period of thermal protection, persistence (inter- and intra-annual). There is no formal discussion of how they are modified by natural conditions or by man made activities. Appendix 9 includes maps of known thermal refugia, but no specifics are provided; rather it simply looks as if the Revised Draft TMDL assumes that nearly every named tributary below the Shasta River is a refugia. Some of these are not persistent through the summer or perhaps year-to-year, some are not notably colder than the Klamath River, some are inaccessible to anadromous fish, and others enter the river where the benefit of cold water is minimal due to limited habitat. The restriction of 1,500 feet above and below the refugial areas (defined in Appendix 8) adds up to nearly 50 miles of river, or approximately 25 percent of the main stem below Iron Gate Dam (and this does not include the physical size of the refugia). What resources are available to manage this considerable length of river? A rapid assessment of all refugia, as per USBR (2006) is recommended to define the functional value of these unique areas.

Page 4-53, Section 4.2.4.3 Nutrients and Organic Matter. The Revised Draft TMDL states: "These loads were calculated based on the best available quality assured concentration data from 2000 through 2007 and flows from the 2000 calendar year." The Revised Draft TMDL needs to clarify whether all data used in the TMDL has undergone such quality assurance. For example, has all of this CBOD data undergone quality assurance? Further, this data covers multiple years, yet the Revised Draft TMDL does not indicate the range of values.

Page 4-55, Figure 4.23. A fundamental flaw with Figure 4.23 is the fact that the natural conditions baseline is unattainable at a minimum for phosphorus. Year-round data from Jeffres et al (2008, 2009) throughout the Shasta Valley show that total phosphorous concentrations on the order of 0.15 mg/L are typical background river concentrations. These background concentrations in spring contributions (e.g., Big Springs, Carrick Spring, Boles Creek spring, Beaughan Creek spring, Hole in the Ground spring) to the Shasta River typically range from 0.15 mg/L to 0.20 mg/L. With a mean annual flow of 180 cfs, and an average background total phosphorous concentration of 0.15 mg/L (with winter season averages being similar when biological activity is at an annual minima) – largely derived from geologic sources – the load to the Klamath River is over 100,000 lbs/yr for the Big Springs Complex alone. Given that much of the base flow of the Shasta River above Big Springs Creek (and including Little Springs) originates as spring flow, and that the baseflow for the Little Shasta River also derives considerable base flow from similar geology, a natural conditions baseline load of roughly 100,000 lbs/yr is unachievable. Further, annual average concentrations of total N are on the order of 0.5 mg/L (with winter season averages being similar when biological activity is at an annual minima), leading to a load of approximately 300,000 lbs per year – well above the estimate of approximately 200,000 lbs/yr included in Figure 4.23. Winter concentrations are similar to annual values, which suggests that a reasonable background concentration is also on the order of 0.5 mg/L, indicating that the natural conditions baseline load of approximately 80,000 lbs/yr background is probably unachievable. To the extent that the Jeffres et al (2008, 2009) data disagree with the Shasta River TMDL assumptions, the more recent, extensive, and detailed year-round monitoring work of Jeffres et al (2008, 2009) is probably more appropriate as a starting point for TMDL analysis, and suggests that the Shasta River TMDL should be reexamined and load allocations reviewed in light of more recent data.

Page 4-55, Last Paragraph. There is no presentation of dissolved oxygen data. At a minimum a description of data used, methods for filling data gaps and other assumptions outlined, and graphical and tabular presentation of dissolved oxygen data along with corresponding dissolved oxygen saturation percentage should be provided. Without such information, review of assumptions is not possible. Review of the model input files shows that all minor tributaries to the Klamath River are placed at 90 percent of saturation under current conditions and 100 percent of saturation under natural baseline condition. This important assumption is undocumented in the TMDL. What is the basis for this assumption? Limited grab sample and water quality probe data suggest many of these tributaries are oligotrophic and, with perhaps the exception of sediment and in some cases temperature, have dissolved oxygen concentrations at saturation. Why assume dissolved oxygen impairment in these tributaries where none may exist? At a minimum, a sensitivity analysis should be completed and clear documentation of the conditions and results presented.

COMMENTS: CHAPTER 5. KLAMATH RIVER TMDLS – ALLOCATIONS AND NUMERIC TARGETS

In PacifiCorp's August 2009 comments on the previous draft of the TMDL document, PacifiCorp described at length its fundamental legal concerns about the approach taken to establish the TMDLs and load allocations. These fundamental concerns have been expanded upon and reiterated in this document and, as a preface to PacifiCorp's specific comments on Chapter 5, are summarized here:

1. For purposes of the Clean Water Act, thermal TMDLs must be based on, and only on, a waterbody-specific determination of the temperatures that are necessary to ensure the protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife (BIP). The Revised Draft TMDL is not based on a waterbody-specific determination of BIP but on temperature water quality objectives and recommended ideal or near-ideal temperatures for salmonids in the colder waters of the Pacific Northwest. The temperature effects of the Project are consistent with BIP. See Findings of Fact on USFWS/NMFS Issue 2(A) and at pages 14-19, 36, 68-69 in McKenna (2007). See also 401 Certification Application (2008) at pages 5-60 to 5-104.

2. Under the Clean Water Act and EPA's implementing regulations, TMDL load allocations must be addressed to a source's pollutant loadings. Water quality impairments that are not caused by pollutant loadings to the waterbody—and that, therefore, cannot be addressed by reducing those pollutant loadings—must be addressed through mechanisms other than a TMDL. To facilitate implementation, a TMDL may use surrogate measures to allocate loads, but those surrogate measures must have some relationship to a source's pollutant loadings to the waterbody. The Revised Draft TMDL's load allocations to the Project are improper to the extent that they are not addressed to pollutant loadings from the Project. These improper allocations include, for example, (1) the requirement to achieve a "compliance lens" of simultaneously achieved temperature and dissolved oxygen criteria in portions of the Project reservoirs and (2) negative nutrient "load allocations" upstream of Copco Reservoir. Neither of these allocations is addressed to pollutant loadings to the Klamath River from the Project.

3. Under EPA's regulations, load allocations must be "attributed" to sources that are not regulated by an NPDES permit, including natural sources. Moreover, the regulations require such an attribution to be based on a reasonable estimate of the pollutant loadings from the source. An estimated loading is not reasonable if it cannot be shown to be reasonably achievable (*e.g.*, because the source's pollutant loadings are not regulated or because the loading is technically or economically impracticable). The Revised Draft TMDL is based on load allocations that are improper because they have not been demonstrated to be reasonably achievable and are not achievable. These include load allocations that would require reductions from actual natural loadings (in contrast to the loadings from the Revised Draft TMDL's "natural conditions" modeling scenario, which are based on water quality targets rather than a plausible description of actual natural conditions); reductions that cannot be enforced because the source is not regulated or, in

some cases, such as sources in Oregon, cannot be regulated by California; and reductions that are not technically or economically practicable.

5.1 Introduction

Page 5-1, Paragraph 2. The Revised Draft TMDL includes new text that states the general goals of the TMDL, such as "…allocations and related targets are designed to reduce the impacts of advanced eutrophication…", and "the targets and allocations… are consistent with trophic classifications that are ecologically appropriate and supportive of Klamath basin beneficial uses". However, these goals are unrealistic and unachievable (as further described below). The Revised Draft TMDL must be based on a reasonable estimate of achievable pollutant load reductions given the limits of the Board's and state's legal authority and technical and economic feasibility of the reductions.

As PacifiCorp made clear in our August 2009 comments on the original Draft TMDL, the Regional Board must address in a realistic manner how the huge reductions of nutrient loads proposed in the Revised Draft TMDL would be achieved. To our knowledge, there have been no documented cases in which nutrient load reductions on such a large scale have been achieved elsewhere, or even determined to be feasible and achievable for planning and implementation purposes, particularly where nutrient sources are overwhelmingly nonpoint source-dominated and in an another, upstream state, as in the case of the Klamath Basin. Further, local geology, hydrology, meteorology, and land use need to be comprehensively assessed to identify what can feasibly and economically be achieved.

If a proposed TMDL is unachievable, then either (1) the water quality objectives or "targets" on which the TMDL is based are unnecessary to protect beneficial uses or (2) the beneficial uses are not attainable. In the former circumstance, the appropriate courses before establishing the TMDL are either to reconsider the water quality "targets" that interpret the water quality objectives or to adopt and obtain EPA approval of revised water quality objectives. In the latter circumstance, the appropriate course before establishing the TMDL is to conduct a use attainability analysis (UAA) to specify the attainable beneficial uses. But regardless whether the appropriate course is to revise water quality targets or objectives or to conduct a UAA, a TMDL that cannot be demonstrated to be achievable is inconsistent with both the CWA and a rational, intellectually honest public policy.

Page 5-1, Paragraph 2. The Revised Draft TMDL states, "The targets and allocations, as discussed in Chapter 2, are consistent with trophic classifications that are ecologically appropriate and supportive of Klamath basin beneficial uses". The Revised Draft TMDL has systematically separated the concept of "ecologically appropriate and supportive of Klamath basin beneficial uses" from actual attainable conditions in the Klamath basin. This also relates to the first sentence on page 5-2 regarding targets appropriate for "well functioning stream systems." Again, however, a TMDL must be based on reasonable estimates of technically and economically achievable pollutant load reductions considering, among other things, local geology, hydrology, meteorology, and land uses. The load allocations in the Revised Draft TMDL are not based on reasonable estimates but have merely been established at whatever level is believed necessary to achieve the proposed water quality targets.

Page 5-1, Paragraph 2, Last sentence. The Revised Draft TMDL wrongly assumes that water quality issues within the reservoirs are "inherent to their operation". There is nothing in the operation of the reservoirs, operated largely as run-of-river impoundments with only a few feet of change in surface elevation, that would inherently cause water quality problems. Even if the Revised Draft TMDL meant "inherent to their existence", the statement still would be in error because there is nothing inherent in the presence of reservoirs that causes water quality problems. In fact, it is the nutrients from upstream that are the cause of water quality impacts in the reservoirs.

Page 5-1, Paragraph 2, Lines 9-11. The Revised Draft TMDL misrepresents what Welch (2009) actually says. Welch (2009) does not say that strategies to address both phosphorus and nitrogen are essential. From the conclusion of Welch's paper:

> "The results of these observations clearly show that P reduction, either from external or internal sources, most cost-effectively controls eutrophication in fresh water lakes. The author is unaware of any published case that demonstrates the effectiveness of N-only reduction, or for the necessity of N reduction in addition to P reduction."

The Revised Draft TMDL needs to be corrected to accurately reflect the words of the author (Welch 2009).

Page 5-3, Table 5.1. Table 5.1 in the Revised Draft TMDL has several flaws:

1. Under Watershed Temperature, Table 5.1 states that allocations allow for natural disturbances, but no analysis is provided in the Revised Draft TMDL regarding frequencies, magnitudes, durations, etc. for such natural disturbances. Without such analyses, these allocations cannot be determined or targets applied.

2. In addition to not being based on a BIP determination, and unnecessary to ensure a BIP, see, e.g., Findings of Fact on USFWS/NMFS Issue 2(A) and at pages 14-19, 36, 68-69 in McKenna (2007) and PacifiCorp's 401 Certification Application (PacifiCorp 2008b) at pages 5-60 to 5-104, a temperature allocation of "zero increase above natural temperature" is not possible to meet – a "zero increase" is not measurable, and it makes no allowance for interannual variability or seasonality. No sensitivity analysis was completed to determine the range of potential "natural" temperatures. How will this be assessed by Regional Board staff: how will natural temperatures be defined for 2010 or any future year?

3. Apart from the technical and economic infeasibility of the Stateline monthly temperature targets and allocations, they are generally, and perhaps wholly, more stringent than the Oregon water quality standard for temperature just upstream of the state line, which is 20° C (expressed as a seven-day average of daily maximum temperatures) and includes a human use allowance when the temperature exceeds 20° C. *See* OAR 340-041-0028(4)(e), (12)(b). Although the Revised Draft TMDL asserts that the Stateline targets and allocations are consistent with the "Oregon allocation scenario," it is not clear how the Stateline targets and allocations are achievable given Oregon's temperature standard.

4. An allocation based on either a "compliance lens" of simultaneously achieved temperature and dissolved oxygen values or on "dissolved oxygen instantaneous mass" is improper because the allocation is not related to any pollutant loading from the Project.

5. The chlorophyll *a* target of 10 µg/L is unachievable and inappropriate for the nutrient-enriched system that exists, and has existed historically, in the Klamath River. The *Microcystis* target is too low because the WHO guideline is 20 µg/L chlorophyll *a*, and the biomass target is tied to the biomass of all cyanobacteria species, whereas only *Microcystis*, which sampling results indicate is of low abundance compared to other algal species in the reservoir (Raymond 2008b, 2009), produces the toxin microcystin. The TMDL provides no persuasive explanation for the logic of this target. The nutrient allocation for the hatchery of "zero net increase of nutrient and organic matter above …compliance scenario conditions" is not possible to meet – the compliance scenario assumes an unrealistically extreme reduction in nutrients in the system, a "zero increase" is not measurable, and it makes no allowance for interannual variability or seasonality.

6. As discussed above at the beginning of comments on this chapter, the "Annual loading reduction[s]" applied as an allocation to PacifiCorp are improper because the allocations do not apply to loadings from PacifiCorp. By making such allocations, the Revised Draft TMDL is allocating a "negative load", which in turn means that PacifiCorp would have to reduce the load of a pollutant that PacifiCorp neither contributes nor controls. Since PacifiCorp currently discharges no load to the Klamath River (see Figure 5-1), a negative load is not only legally improper but illogical and unreasonable.

Page 5-6, Paragraph 4. Applying a margin of safety (MOS) to periods of time during which beneficial uses (BUs) are not impaired or at risk from the pollutant is unnecessary and improper. There is a brief statement in the Revised Draft TMDL regarding periods when beneficial uses are not impaired and that the "timing of those periods changes from year to year and is difficult to predict," but there is no analysis to support this statement. Moreover, notwithstanding the availability of a "comprehensive, dynamic numerical model," no effort whatsoever has been made to identify the periods when there is sufficient uncertainty to require a margin of safety. The Clean Water Act's margin of safety requirement is not a justification for adopting the most conservative load allocation possible. The imposition of a margin of safety must be justified by facts and analysis.

Page 5-7, Paragraph 3, Lines 7-10. The Revised Draft TMDL states that "TP, TN, and CBOD allocations are assigned to PacifiCorp at the upstream end of Copco 1 Reservoir in order to meet the chlorophyll *a*, *Microcystis aeruginosa* cell density, and microcystin targets within the reservoirs". For the reasons discussed in the comments above and below, such allocations are legally improper, unprecedented, and unreasonable.

EPA's TMDL guidance states, "The process of calculating and documenting a TMDL typically involves a number of tasks, including characterizing the impaired waterbody and its watershed, *identifying sources*, setting targets, calculating the loading capacity using some analysis *to link loading to water quality*, identifying source allocations, preparing TMDL reports and coordinating with stakeholders." Draft Handbook for Developing Watershed TMDLs, U.S. EPA, December 2008, at 1 (emphasis added). Moreover, EPA's TMDL regulations define a "load allocation" as "[t]he portion of a receiving water's loading capacity that is *attributed* either to one of its existing or future nonpoint sources of pollution or to natural background sources." 40 CFR § 130.2(g) (emphasis added). To "attribute" a loading is "[t]o relate [it] to a particular cause or source." *American Heritage Dictionary of the English Language* 120 (3d ed. 1992).[3] A load allocation, then, is a statement of fact. Because PacifiCorp is not the cause or source of the nutrient loading upstream of Copco Reservoir, the Revised Draft TMDL cannot truthfully attribute that loading to PacifiCorp. As such, the Draft Revised TMDL cannot permissibly assign any nutrient load allocation—positive, zero, or negative[4]—to PacifiCorp upstream of Copco Reservoir.

Pages 5-12 to 5-14, Figures 5.1 to 5.3. There are substantial errors and flaws in Figures 5.1 to 5.3. To begin with, values in the figures don't add up (See Table A8 below). When the difference between the loads at each division of the watershed (column 4 in the table below) is compared to the sum of the loads shown on the table (column 5 in the table), none of them match. There is no explanation for these discrepancies provided in the Revised Draft TMDL. These errors call into question the Revised Draft TMDL's analysis and conclusions. These errors need to be corrected. It is not possible to adequately evaluate the TMDL with so many of the sources and sinks inaccurately represented.

[3] Compare EPA's definition of "wasteload allocation," which applies to point sources: "The portion of a receiving water's loading capacity that is *allocated* to one of its existing or future point sources of pollution." 40 C.F.R. § 130.2(h) (emphasis added). To "allocate" a loading is "[t]o distribute [it] according to a plan." *American Heritage Dictionary of the English Language* 49 (3d ed. 1992). Thus, whereas the "attribution" of a pollutant loading is a factual statement of its source, the "allocation" of a pollutant loading is the assignment of a pollutant loading *to* a source.

[4] Given what a load allocation is, of course, a negative load allocation is nonsensical.

Table A8. Klamath River Revised Draft TMDL total phosphorus load balance by locations (values from Figure 5.1)

Location	Figure Loads	Calculated Loads	Difference values	Summed values
Stateline	40,569	40,569		
PacifiCorp		-10,148		
Full flow	30,421	30,421		
input?			-2,334	30,421
Copco	28,087	30,421		
Benthic		0		
Tribs		3,709		
Benthic		0	973	3,709
Iron Gate	29,060	34,130		
Hatchery		0		
Tribs		8,026	8,120	8,026
	37,180	42,156		
Shasta		12,366		
Tribs		6,302	13,484	18,668
	50,664	60,824		
Scott		62,851		
Tribs		30,951	46,484	93,802
	97,148	154,626		
Salmon		31,898		
Tribs		14,843	0	46,741
	97,148	201,367		
Trinity		126,167		
Tribs		29,585	206,902	155,752
Total	304,050	357,119	273,629	357,119

Pages 5-12 to 5-14, Figures 5.1 to 5.3. These figures misrepresent the facts (at least the "facts" as they are presented in the figure) by manipulating the widths of the arrows, which are clearly meant to be understood as representing the magnitude of the loads. The figures mislead the viewer as to the relative loads. For example, the load arrow for Iron Gate reservoir is nearly four times as wide as the arrow for Copco reservoir, but the load is only 3 percent greater. Similarly, the load arrow for the Scott River is approximately 15 percent of the width of the Iron Gate arrow, but the Scott River load is more than twice as large as the Iron Gate load. These figures need to be redrawn to accurately represent the relative magnitudes of the loads, or it should be clearly stated for these figures that the arrows are purely decorative and intended to have no quantitative meaning.

Pages 5-12 to 5-14, Figures 5.1 to 5.3. The Introduction of the Revised Draft TMDL indicated that analysis of TMDL compliance in California is based on compliance conditions being achieved in Oregon, including compliance with the Upper Klamath River TMDL and the Lost River TMDL. Figure 5-1 reinforces that by showing the load allocation from Oregon at Stateline equal to compliance conditions with the Oregon TMDLs with Keno dam and J.C. Boyle in place. However, as the Klamath River crosses the state border, the load allocation is suddenly reduced by approximately 25 percent, ostensibly to represent the Revised Draft TMDL's inappropriate negative "annual nutrient loading reduction" applied to PacifiCorp. In reality, there is no PacifiCorp facility at Stateline that could account for this difference, and PacifiCorp neither contributes to nor controls Stateline nutrient loads. Because the TMDL states that this negative load reduction is necessary to meet the unrealistic and unachievable target of 10 µg/L chlorophyll *a*, it is clear that the California TMDL targets cannot be met under Oregon TMDL compliance conditions.

Pages 5-12 to 5-14, Figures 5.1 to 5.3. On each of these diagrams, "Benthic load" should clearly be identified as "Net Benthic Load" or otherwise re-labeled. Any such benthic load is only from sediments to water column, and does not account for the load lost from water column to sediments.

Page 5-15, Paragraph 2, Line 2-4. The Revised Draft TMDL states that uncertainty in the analysis was reduced "by applying a comprehensive, dynamic numerical model." It does not state, however, how uncertainty was reduced by the model or by how much. Models may increase precision of results (even to a ridiculous level, e.g. "load = 2,253,542 kg), but accuracy is not necessarily increased (Deas and Lowney 2000). As discussed in our comments on Appendix 7, the TMDL modeling did not incorporate enough data in model calibration and validation. Also, there was not enough evaluation of model uncertainty to make the statement that "uncertainty was reduced … by applying (this) model."

Page 5-15, Paragraph 2, Line 5. The Revised Draft TMDL claims that the model takes advantage of "data collected over multiple years," but the model was only calibrated based on 2000 data. It is true that data from multiple years was used to form certain boundary conditions where limited data were available, but the hydrology and meteorology – two principal drivers – were taken from the year 2000 only. Using multiple years of data may improve certain elements of model inputs, but it may also lead to increased uncertainty by mismatching in time hydrology and meteorological conditions with actual water quality responses. This is not discussed in the draft TMDL.

Page 5-15, Paragraph 2, Line 9-11. What is the basis for the statement that "the largest source of uncertainty in this system is the highly variable and dominant loading from Upper Klamath Lake"? There is no analysis, no documentation, no citation, no quantification, or other description of this issue. Further, how does this relate to downstream reaches all the way to the estuary? This statement suggests that UKL boundary conditions have a larger impact on the estuary than other factors, such as Trinity River flows, lack of detailed estuary geometry, lack of detailed estuary data, etc. This line of questioning can be applied to all river reaches downstream.

Page 5-15, four bullets summarizing "Conservative assumptions". Klamath River water quality dynamics are complex, varying considerably in space and time. Even though the numerical model included a wide range of parameters, constants, and coefficients, the model does not include all relevant processes. For example, the model has the following limitations affecting uncertainty:

- The model includes only a single algae group on the mainstem reservoirs,
- The model includes only a simple sediment model in both the river and reservoirs,
- The model includes incorrect partitioning of organic matter at Link dam
- The two-group algae model for Keno reservoir is completely untested and parameter values have no basis,
- The model's representation of Iron Gate outlet works has been specified instead of simulated,
- The available data for modeling are limited in winter throughout the system, and
- Only a single year is modeled.

Comments on the individual bullet points listed on page 5-15 follow.

Bullet point 1. Without a presentation of the current SOD and its impact on oxygen levels in the river, this bullet point cannot be interpreted. Further, SOD is a small player in the overall dissolved oxygen conditions in the river reaches because of the limited deposition of organic matter (high shear environment) and the near continual mechanical reaeration in the Klamath River due to the high gradient (and once the river gradient diminishes below Orleans, dissolved oxygen is much less of an issue). SOD is an insubstantial factor and, although this is a conservative assumption, it is also negligible.

Bullet point 2. "Timing of allocations" is based on the scenario with greatest loads from UKL and has no stated basis, explanation, or citation. "[M]agnitudes of allocations are based on median loading conditions from UKL," would mean that 50 percent of the time loads are greater than those upon which allocations are based. This is incorrect. Loads are based on the 1995 conditions – one of seven years of data (1992-98) used in formulating the UKL TMDL load allocation. Further, 1995 is the second lowest year of the seven years, and less than 50 percent of the 7-year mean conditions. Thus, if the UKL is accepted as "representative" of a range of conditions from 1992-98, the majority of years (5 out of 7, or 71.4 percent of the time), TMDL compliant conditions as defined in the California TMDL will not be met. The representation of this in the California TMDL is erroneous, misleading, and presented with such brevity that without considerable data and information requests from Regional Board staff, ODEQ, and EPA, such a condition would never have been identified. This is another example of the critical nature of uncertainty analysis and a clear limitation of modeling only a single year for TMDL load allocations in a complex basin such as the Klamath River.

Table A9. Upper Klamath Lake TMDL model output for 40% reduction case. Highlighted row (1995) is the information used in the California TMDL (ODEQ, 2002).

Year	Outflow (kg/yr)	Percent of 7-yr Average
1992	13,854	21.6%
1993	114,637	178.5%
1994	50,860	79.2%
1995	30,237	47.1%
1996	103,839	161.7%
1997	83,970	130.8%
1998	52,057	81.1%
Mean	64,208	100.0%

Bullet point 3. This bullet point describes a simplistic approach that reduces all nutrients to low levels. There is no nutrient reduction strategy that targets one (N or P) – an approach that is fundamental to water quality management. In retrospect, this is not a surprise because no assessment of trophic status or nutrient limitation was completed for the Klamath River under an existing or a TMDL compliant condition. Without a clear nutrient limiting strategy (even if that strategy is co-limitation), implementation actions will be severely hampered and valuable resources will be wasted. It is important to reduce both nutrients, but it is also important to identify a limiting nutrient so effective water quality improvement actions can be identified, prioritized, and implemented at an appropriate time. This may also be a conservative assumption, but it is also too simplistic and could ultimately hamper the effective implementation of the TMDL.

Bullet point 4. Basing analyses on low flow conditions is not necessarily conservative. Higher flow does not mean less WQ impact as higher flows can result in higher loadings for similar in-stream concentrations. In short, this is not conservative, particularly if dam removal occurs prior to effective implementation of nutrient and organic matter reductions in Oregon.

Page 5-17, Table 5.2. The Revised Draft TMDL includes Table 5.2 specifying TMDLs for TP, TN, and CBOD (in pounds) by source area. It is noteworthy that the values in Table 5.2 for the "Upstream of Copco 1", and "Stateline to Iron Gate inputs" source areas are about one-tenth to one-third of the TMDL values for TP, TN, and CBOD for these source areas given in the original Draft TMDL. Such a large disparity and apparent correction made for these TMDL values in the Revised Draft TMDL suggests potential issues with the analysis used to derive these values. See comments on Appendix 7 presented later in this document.

5.2 Temperature-Related Numeric Targets and Allocations

Page 5-18, 5.2.1.1 and associated figures. The Revised Draft TMDL states "Accordingly, the temperature load allocations for shade are equal to: the shade provided by topography and full potential vegetation conditions at a site, with an allowance for natural disturbances such as floods, wind throw, disease, landslides, and fire." This should include local geology, geomorphology, and some level of vegetation potential. Full vegetation potential is not defined. In the subsequent paragraph effective shade is defined as that which is "blocked by vegetation or topography before reaching the ground or stream surface, and takes into account the differences in solar intensity that occur throughout a day." Vegetation setback is a critical element of this analysis – how far from the water's edge (on July 21st) is the vegetation located—because shading a point bar or other land features offers few benefits. What is the presumed setback for each vegetation type in this analysis? Also, is wetted depth always the same: 0.25 meters? What does this represent and how does this play into the analysis? What is buffer width? Also, the text mentions that the 1/3 of bankfull width was assumed, but the graphs identify 100 percent of bankfull width as the x-axis. What was the channel form if 1/3 of bankfull width was applied? Were different channel forms explored? Please explain the legend and an interpretation for the four lines. Which aspect will be applied for a specific application of these criteria, the average, or one of the directions? What does density refer to? As presented, the effective shade information is not readily interpreted, and a complete comment cannot be submitted.

Topographic shading is mentioned in this section, but little is said how this is included into the "effective shade" graphs. Topographic shading is due to local terrain and can include mountains, hills, stream banks, boulders, and other land features that cast shade. In fact, there is no real way to include topographic shading in the manner presented in the Revised Draft TMDL because topographic shading is a function of stream aspect, local topography and time of year. Small topographic shade elements (e.g., banks, in stream rocks and boulders) can have profound effects on small streams and should be defined on a stream-by-stream basis.

Time of year is not addressed in Figures 5.4 through 5.9. However, day length and solar altitude are critical elements in assessing solar radiation reductions for aquatic systems and how they impact local temperatures. Summer solstice provides the longest day length and highest solar altitude in the Klamath Basin, but maximum temperatures do not occur until approximately August 1. The Revised Draft TMDL needs to clarify the date that these figures apply, or whether they are seasonally averaged. If they are a seasonal average, the period used for the average needs to be clarified. Finally, the Revised Draft TMDL needs to describe the analysis, source of data, assumptions (setback from bank, density, solar transmittance), including supporting documentation.

Page 5-23, Paragraph 1 under Excess Sediment. The temperature load allocation for human-caused discharges, "zero temperature increase," is not defined, and is therefore impractical and unachievable. Regarding the definition of "substantial human-caused sediment related channel alteration", it is unclear how an action that "increases channel width, decreases depth, or removes riparian vegetation to a degree that alters stream temperature dynamics and is caused by an increased sediment loading" can be measured against natural processes in the system. What is the baseline? What is the metric for sediment loading? How and where is this measured? How are legacy activities incorporated? Who is responsible for monitoring and assessing potential changes, let alone defining what fraction of the impact is due to natural processes or human-caused actions? Without such guidance, regulatory oversight will be vague and implementation of actions ineffective.

Page 5-25, Table 5.3 (and Tables 5.4 and 5.6). Presenting a range for the temperature numeric targets would be more beneficial. The TMDL should describe exactly how the values in the table were derived. Do the values in the table account for climate change. If not, why not? Also, the TMDL should describe how monthly average temperatures were chosen as the applicable metric and time-step. Monthly averages represented in Table 5.3 (and Tables 5.4 and 5.6) have only limited biological value.

Page 5-26, under 5.2.3 *Temperature Numeric Targets and Load Allocations to Copco 2 and Iron Gate.* The targets present in this section need to be re-assessed with the 0.8 solar reduction factor removed from the riverine sections of the TMDL's RMA-11 models. The PacifiCorp (2005) models were reviewed by USGS and Risley and Rounds (2006), including calibration performance. These reviews suggested no reason for reduction of incoming solar radiation. Further, applying such a reduction globally to the entire Klamath River is inappropriate and unreasonable.

Page 5-26, first sentence on page. The temperature allocation at Stateline is "zero increase above natural". "Zero increase" is not measurable, and is therefore impractical and unachievable. How does this allocation specifically relate to the values listed in the previous Table 5.3? The values in Table 5.3 appear to be intended as monthly average temperatures at Stateline. However, these values do not account for inter-annual variability and simply reflect modeled temperatures under the "natural conditions" scenario for the year 2000. Increases above these monthly average temperatures at Stateline as a result of natural variability will make the achievement of downstream temperature allocations impossible, if they are not already so.

Page 5-26, Paragraph 2. The Revised Draft TMDL states that "Regional Water Board staff have determined that achievement of water quality standards is necessary to support a balanced indigenous population of fish and shellfish". See above comments on section 2.3.1 of the Revised Draft TMDL.

Page 5-27, Paragraph 1, Lines 6-8. The Revised Draft TMDL states "Because the upstream heat loads are outside of the control of the dam operators (PacifiCorp), the allocations apply to the condition of the water as it enters the reservoirs." This statement contradicts the Revised Draft TMDL's treatment of nutrients, in which allocations are assigned to PacifiCorp ***upstream*** of Copco reservoir. If the upstream heat loads are outside the control of PacifiCorp, by the same logic the upstream nutrient loads are outside the control of PacifiCorp.

Page 5-27, Paragraph 2, Lines 7-8. The appropriate scenario for determining "natural temperature increases" in California is the Oregon TMDL compliance conditions at Stateline and "natural conditions" downstream. Please clarify that this is the scenario to which the Revised Draft TMDL is referring. Without the Oregon TMDL available for public review, it is difficult to confirm how temperature compliance at Stateline would be achieved.

Page 5-27, Paragraph 3, Lines 5-10. Discussion states that "maximum temperatures periodically increase by approximately 0.5°C". But this analysis and accompanying Figure 5.10 have little relevance because 0.5°C is more resolution than the temperature model warrants. Without actual data to assess conditions within this reach, little can be said about the daily range of temperatures. Further, Copco reservoir occupies a more open terrain than upstream reaches that are in the canyon. Thus, a reduced daily range due to more topographic shading than in upstream reaches makes little sense.

Page 5-28, Paragraph 1 (and Figure 5.11). The Revised Draft TMDL states, "These results indicate that the daily average temperature would naturally increase by approximately 0.1°C (0.2°F) through the Iron Gate reach". This statement assumed that models can predict increases of 0.1°C, i.e., that the accuracy of these models is 0.1°C or better. This assumption is erroneous. PacifiCorp (2004) provides extensive calibration statistics that indicate the models are probably accurate to no more than about 1.0°C. Misapplication of the model in this manner points to a clear need for uncertainty quantification.

Page 5-30, Table 5.5. The Revised Draft TMDL's temperature load allocations in reservoir tailrace waters are substantially smaller than model accuracy. Given model accuracy and the accuracy of the data collected for model calibration, load allocations of 0.1°C are not supportable. Further, the Revised Draft TMDL should describe the specific method that the Regional Board would intend be used to measure the 0.1°C increases in Iron Gate daily average and maximum. Available temperature measuring devices (including the ones used to collect calibration data for the model) are accurate only to 0.2°C or more.

Moreover, the temperature load allocations to Copco and Iron Gate Reservoirs in Table 5.5 are expressed as tailrace temperatures, *viz.*, daily average and daily maximum temperature increases above inflow temperatures, not as thermal loads. EPA's TMDL regulations define "load" or "loading" as "[a]n amount of matter or thermal energy that is *introduced into a receiving water*." 40 C.F.R. § 130.2(e) (emphasis added). Similarly, the regulations define "load allocation" as the "portion of a receiving water's loading capacity" that is attributed or allocated to a source. *See* 40 C.F.R. § 130.2(g). The "load allocations" to the Copco and Iron Gate Reservoir tailraces are improper because they are not addressed to thermal energy introduced into the Klamath River by the reservoirs but to the daily difference in temperature of the river as it enters and leaves the reservoirs. That temperature difference may not reflect, and generally will not reflect, the daily amount of thermal energy introduced into the river by the reservoirs. Instead, the temperature differences may be attributable to the travel time between the inlet and outlet of the reservoir (which greatly exceeds one day), measurement error, and other factors that do not reflect the amount of thermal energy introduced into the river by the reservoirs.

Page 5-30, Paragraph 2, Lines 3-6. The Revised Draft TMDL states "there is no allowable temperature increase that can be allocated to Iron Gate Hatchery", and "[a]ccordingly, the temperature load allocation for the Hatchery equals zero temperature increase above natural temperatures (see Table 5.6)". "Zero increase", or any deviation from the temperature targets, is not measurable, and is therefore impractical and unachievable. It is unclear how this load allocation specifically relates to the values listed in Table 5.6. If Table 5.6 is intended to present temperatures that may not be exceeded by discharges from Iron Gate Hatchery, then these temperature targets are impractical and unachievable since they do not recognize influent water temperature to the hatchery, which would be the proper parameter against which to assess whether the hatchery resulted in increases in temperature. Indeed, the concept of a "natural temperature" against which to judge Iron Gate Hatchery discharges is meaningless since the cold water supply provided to the hatchery by Iron Gate reservoir did not exist naturally.

5.3 Dissolved Oxygen and Nutrient-Related Numeric Targets and Allocations

Page 5-31, Paragraph 3. The Revised Draft TMDL states, “The dissolved oxygen targets at Stateline are expressed as monthly average and monthly minimum DO concentrations (Table 5.7)”, and further states, “These dissolved oxygen targets are consistent with the DO concentrations at Stateline under the Oregon and California allocation compliance scenarios”. The DO target values in Table 5.7 match the model outputs from the Oregon and California allocation compliance scenario almost exactly (See Table A10 below). These numeric targets do not account for model uncertainty, data uncertainty, or any deviation in conditions (hydrology, meteorology, etc.) from those assumed in the Revised Draft TMDL.

Table A10. DO target values in Table 5.7 compared to model output values.

Location	Month	Chapter 5 Mean DO Numeric Targets	Monthly Mean DO From Model Output		
			Natural Baseline Scenario	No Dam Compliance Scenario	With Dam Compliance Scenario
Stateline	January	11.5	11.5	11.5	11.6
	February	10.5	10.5	10.5	10.6
	March	9.7	9.7	9.7	9.8
	April	9.1	9.1	9.1	9.3
	May	8.8	8.8	8.8	8.9
	June	8.2	8.2	8.2	8.2
	July	8.2	8.2	8.3	8.0
	August	8.2	8.2	8.2	8.1
	September	8.8	8.8	8.8	8.7
	October	9.6	9.6	9.6	9.6
	November	11.5	11.5	11.5	11.3
	December	11.8	11.9	11.8	11.4
Copco 2 Tailrace	January	11.6	11.7	11.6	11.8
	February	10.6	10.6	10.6	11.0
	March	9.8	9.8	9.8	9.9
	April	9.3	9.3	9.3	9.3
	May	8.8	8.8	8.8	8.4
	June	8.2	8.2	8.2	7.6
	July	8.2	8.1	8.2	6.5
	August	8.2	8.2	8.2	5.9
	September	8.8	8.8	8.8	6.6
	October	9.7	9.7	9.7	8.0
	November	11.6	11.6	11.6	10.5

Location	Month	Chapter 5 Mean DO Numeric Targets	Monthly Mean DO From Model Output		
			Natural Baseline Scenario	No Dam Compliance Scenario	With Dam Compliance Scenario
	December	12.0	12.0	12.0	11.5
Iron Gate Tailrace	January	11.7	11.7	11.7	12.1
	February	10.7	10.7	10.7	11.4
	March	9.8	9.8	9.8	10.2
	April	9.3	9.3	9.3	9.4
	May	8.8	8.8	8.8	8.6
	June	8.2	8.2	8.2	7.9
	July	8.1	8.1	8.2	7.1
	August	8.1	8.1	8.2	6.8
	September	8.8	8.8	8.8	7.1
	October	9.7	9.7	9.7	7.9
	November	11.7	11.7	11.6	9.5
	December	12.1	12.1	12.0	11.7

Page 5-31, Paragraph 3, Line 4. The Revised Draft TMDL needs to specify the pressure and air temperature at which the 85% saturation would be calculated.

Pages 5-31 to 5-34, Tables 5.8 and 5.10. The Revised Draft TMDL allocations at Stateline and for Copco and Iron Gate tailraces present a clear disconnect with the 2002 Upper Klamath Lake TMDL (ODEQ 2002). The Upper Klamath Lake TMDL seeks TP targets of 0.066 mg/L for inflows to the lake and 0.11 mg/L for the in-lake concentration, while the expectation in Tables 5.8 and 5.10 is to achieve 0.024 to 0.030 mg/L TP at Stateline (as listed in Table 5.8), 0.015 to 0.023 mg/L TP at the Copco tailrace, and 0.013 to 0.019 mg/L TP at the Iron Gate tailrace (as listed in Table 5.10). (Table 5.10 reverses the TP and TN rows for Iron Gate tailrace.) Even the allowable without-dams and natural conditions load capacities (as shown in Figure 5.12) would require nearly a 90 percent TP reduction from existing loads (compared to 95 percent for the with-dams capacity).

The concentration targets in Tables 5.8 and 5.10 are unrealistically low – so low, in fact, as to be substantially less than naturally-occurring groundwater concentrations that discharge to the Klamath River in the J.C. Boyle diversion reach just above Stateline. As with the original Draft TMDL, the Revised Draft TMDL is based on a huge nutrient reduction goal that is simply unrealistic and unachievable, particularly given that hypereutrophic Upper Klamath Lake is the primary source of water for the Klamath River. As a result, the proposed targets and load allocations in the Revised Draft TMDL are not achievable, practicable, or enforceable. As such, they do not comply with the Clean Water Act or EPA's implementing regulations.

As PacifiCorp made clear in our August 2009 comments on the original Draft TMDL, the Regional Board must provide a reasonable explanation of how the huge reductions of nutrient loads proposed in the Revised Draft TMDL would be achieved. Otherwise, the proposed load allocations are not reasonable estimates of the loading from existing and future nonpoint sources, including natural sources. To our knowledge, there have been no documented cases in which nutrient load reductions on such a large scale have been achieved elsewhere, or even determined to be feasible and achievable for planning and implementation purposes, particularly where nutrient sources are overwhelmingly nonpoint source-dominated as in the case of the Klamath Basin. Given the unrealistic and unattainable nutrient reductions needed to meet the Revised Draft TMDL's goals, a UAA or reassessment of water quality targets and objectives should have preceded the TMDL.

Page 5-32, Table 5.8. The total phosphorus allocation at Stateline is unrealistic and unachievable. It is unlikely or impossible to be met under the best of conditions because it is approximately three-fold lower than the actual natural background concentration in Klamath basin groundwater. Even if it were to be met, it would be unlikely that compliance could be measured because the allocation value is lower than the commonly achieved laboratory method reporting limit for total phosphorus.

Page 5-32, Table 5.8. The CBOD allocation is unrealistic and unachievable, because it is based on concentrations that are below the commonly achieved laboratory method reporting limit (1 mg/L) and could not be even measured for most of the year. In a naturally eutrophic system such as the Klamath, natural background levels during certain periods of the year (later spring through early fall) would be higher than the allocation value. See comments above on natural conditions background values (specific to Page 2-66, Figures 2.16 and 2.17).

Page 5-35, Paragraph 1. PacifiCorp is assigned an allocation that requires reduction of nutrients ***upstream*** of its facility. Assigning such an "upstream" allocation is legally improper, inappropriate and unprecedented. See PacifiCorp's previous comments.

Further, the assignment of nutrient allocations to the Project is inappropriate given that the Project does not contribute nutrients, but instead currently contributes to nutrient reductions (via annual net retention of nutrients in the reservoirs). The Project also has no control over upstream nutrient sources and no means of practicably achieving the allocation. In addition, this "upstream" or negative allocation contradicts the Revised Draft TMDL's allocation for temperature, which expressly does not make PacifiCorp responsible for upstream thermal loading.

Pages 5-36 to 5-39, Figures 5.12 to 5.14. The Revised Draft TMDL states "These figures demonstrate that larger nutrient reductions are needed in order to achieve water quality standards with the Klamath Hydroelectric Project facilities in California in place". The nutrient reductions called for, however, are inconsequential compared to the huge reductions called for in the Revised Draft TMDL with or without the Project. For example, the Revised Draft TMDL concludes that an 87 percent reduction in TP is necessary to achieve compliance in California even if the Project is removed, compared to a 92 percent reduction with the Project in place. Thus, in any case, the Revised Draft TMDL calls for huge, unachievable reductions that dwarf the asserted Project-related differences.

Page 5-39, Figure 5.14. This figure shows the Revised Draft TMDL's estimated CBOD loadings for the Klamath River below Iron Gate dam. It is noteworthy that the values in Figure 5.14 are substantially different from this figure in the original Draft TMDL. Such a large disparity and apparent correction made for these TMDL values in the Revised Draft TMDL suggests potential issues with the analysis used to derive these values. Details are discussed in our comments on Appendix 7, presented later in this document.

Page 5-40, Paragraph 1 and Figure 5.15. As discussed above, the proposed "compliance lens" is improper because it is neither an allocation of a pollutant load nor based on any attribution of a pollutant load to PacifiCorp. In addition, the basis for the compliance lens is not well defined, and it cannot feasibly be achieved. Defining the compliance lens as a fixed volume where temperature and dissolved oxygen are both acceptable based on the reach average depth of a free-flowing river makes no physical sense: lentic and lotic systems are fundamentally different environments. The average reach depth (the Revised Draft TMDL is unclear if this is average depth or average hydraulic depth) for a free flowing river channel is not stated, but based on modeling efforts is probably on the order of 1.0 meter. Even if the average depth were 2.0 meters, the expectation that such a lens would persist is unrealistic given thermal stratification, wind mixing, and seasonal thermal loading.

Further, the Revised Draft TMDL states that the compliance lens applies to the width and length of the reservoir. This is an unrealistic expectation for any reservoir, particularly under stratified conditions. By definition, the thermocline within Copco and Iron Gate reservoirs does not extend the entire length of the reservoir. In shallower headwater areas, the hypolimnion pinches out and there are no cold, deeper waters in the upper reaches of both reservoirs for considerable distances. Similarly, the thermocline does not extend the full width of the reservoirs. Based on fundamental stratification dynamics and the morphology of reservoir systems, the compliance lens defined in the draft TMLD is unrealistic and cannot be achieved.

Page 5-43, Table 5.14. The nutrient and organic matter targets in this table for the Klamath River below the Salmon River will be a function of assumptions throughout upstream river reaches, including tributaries. Previous comments regarding the upstream boundary conditions (including the Shasta River boundary conditions) assumed in the modeling for the Revised Draft TMDL, as well as other comments addressing the TMDL analysis, will have to be reassessed in the TMDL.

Page 5-44, Table 5.15. No data are provided to support the values for these major tributaries. A comprehensive analysis of assumptions, approach, limitations, and uncertainty needs to be presented in the Revised Draft TMDL. Naturally occurring phosphorus levels from the spring complexes in the Shasta River are on the order of 0.15 mg/L. Because these springs form the predominant fraction of the baseflow for the system, a TMDL target of 0.071 mg/L of total phosphorus is unachievable. In addition, tables 5-15 and 5-16 are expressed as concentrations rather than as pollutant loads, which, as discussed in the comments above, is inconsistent with TMDL requirements. This issue has important environmental consequences. For example, if tributary baseflows are increased, the concentration could remain the same, but the load could increase dramatically.

Page 5-44, Table 5.16. CBOD values included in this table are below both the method detection limit and the method reporting limit for standard production laboratories. A minimum value of 2.0 mg/L would be appropriate. Bogus Creek, another cascade stream supported by spring baseflow, will also have elevated phosphorus concentrations and a mean concentration allocation of 0.014 mg/L will be unachievable.

COMMENTS: CHAPTER 6. IMPLEMENTATION PLAN

6.1 Introduction

A crucial element of TMDL implementation that is only briefly mentioned in the Draft Implementation Plan is the timeline or schedule for compliance with proposed TMDL allocations and targets. The timeline or schedule for compliance is a particularly important element of the TMDL implementation process for the Klamath River. On page 6-3, the Revised Draft TMDL states, "The regulatory process will accommodate short-term measures working in concert with longer-term programs to achieve full compliance over a longer time frame". The specific time frames associated with the Draft Implementation Plan's use of "short-term", "longer-term", and "longer time frame" are not defined.

6.2 Implementation of Allocations and Targets – Stateline

Page 6-8, Paragraph 2, Lines 13-17. The Revised Draft TMDL states that allocations and targets presented in the Revised Draft TMDL assume water quality at Stateline (and by extension other downstream Klamath River locations in California) "once the Oregon TMDLs are fully implemented". The Revised Draft TMDL further states that full implementation of the Oregon TMDLs is a "critical part of the solution in meeting water quality objectives in California". The Revised Draft TMDL therefore assumes, and its success depends upon, substantial load reductions upstream in Oregon (over which California has no control) to meet California's draft TMDL objectives at Stateline. Even if these load reductions were achievable, which they are not (see the comments above), the need for substantial upstream load reductions demonstrates that the timeline or schedule for obtaining load reductions in California is particularly important in evaluating the feasibility of a trading program and other implementation actions that would be necessary in an effort to obtain the nutrient reductions proposed in the Revised Draft TMDL.

Also, because the Revised Draft TMDL fundamentally links its success to the Oregon TMDLs, it is premature for the Regional Board to seek comments on TMDLs for California before the draft Klamath River TMDL in Oregon has been completed and available for review.

6.3 Implementation of Allocations and Targets - Klamath Hydroelectric Project and Iron Gate Hatchery

Page 6-11 to 6-18. With respect to the Klamath Hydroelectric Project, PacifiCorp will work with the Regional Board on a timeline for submitting an Implementation Plan that makes sense within the broader framework of TMDL and settlement agreements. A TMDL Implementation Plan submitted to the Regional Board pursuant to the KHSA may first require adoption of

Oregon's TMDL such that TMDL implementation actions under the KHSA can be harmonized with both California and Oregon's TMDLs, as adopted.

Page 6-12, first bullet. It is inaccurate and inappropriate to say that the Revised Draft TMDL "found" that the Project contributed to the impairment by "altering the nutrient dynamics of the river". The Revised Draft TMDL does not provide any evidence to support this claim. The Revised Draft TMDL does find, however, that the Project is a significant sink for nutrients, thus removing them from the river. This reduces the impairment of the river rather than contributes to it. PacifiCorp disagrees with all four bulleted conclusions for the reasons discussed elsewhere in these comments.

On page 6-18, the Revised Draft TMDL discusses implementation for allocations associated with the Iron Gate Hatchery. On September 14, 2007 PacifiCorp and the California Department of Fish and Game (CDFG), the operator of the hatchery, submitted a revised Monitoring and Reporting Plan (MRP) per Water Code Section 13267(b) Order issued by the Regional Board. PacifiCorp and CDFG have been following the requirements of this proposed MRP since January 2008 per the terms of the Settlement Agreement with the Klamath Riverkeeper. In addition, PacifiCorp and CDFG submitted the results of the 2007 chemical pollutant scan to the Regional Board per the 13267(b) Order referenced above. PacifiCorp considers these submittals to the Regional Board as steps towards the issuance of a renewed NPDES permit for the hatchery. PacifiCorp will continue working with the CDFG and the Regional Board to assess discharge from the Iron Gate Hatchery through the NPDES renewal process addressing the need for additional measures, if necessary.

6.5.2 Prohibition of Discharges in Violation of Water Quality Objectives in the Klamath River Basin

The Revised Draft TMDL includes a prohibition against unauthorized discharges of waste. The Revised Draft TMDL states: "This prohibition is a restatement of existing law and is not intended to provide a nonpoint source program…" First, it is unclear who the responsible parties are since the prohibition is stated so broadly. Second, if the prohibition is merely a restatement of existing law it is duplicative and unnecessary. If it is not, then the Regional Board should explain exactly what additional requirements are or may be imposed.

6.7 Klamath River Water Quality Accounting and Tracking Program

Pages 6-61 to 6-62. The discussion about watershed trading/offsets is good to have, but vague regarding program components and responsibilities, other than mention of the KlamTrack program. The Revised Draft TMDL recognizes that substantial reductions in nutrient and organic matter loads in the Klamath River will be needed to improve water quality to any substantial degree, and these reduction efforts should target the largest sources of nutrient loads – Upper Klamath Lake and the Lost River basin. PacifiCorp believes that water quality trading could be an important programmatic "tool" to be incorporated as part of the TMDL implementation processes in the Klamath River basin for the variety of stakeholders that will be affected by TMDL allocations and targets. PacifiCorp proposes to commit resources under AIP Interim Measure 11 (Nutrient Reduction Measures) to evaluate and, if warranted, design and implement a water quality trading program. Such a program would be developed cooperatively with the Regional Board within the framework of the Draft Implementation Plan, as well as considering TMDL implementation actions in Oregon through ODEQ

COMMENTS: CHAPTER 7. MONITORING PROGRAM

Page 7-1. Paragraph 4. Please expand on the program identified in NRC (2004) and identify similarities and differences.

Page 7-3. Paragraph 4. The goals outlined by the Regional Board and ODEQ are not echoed in the Preliminary Review Draft: Klamath River Basin Water Quality Monitoring Plan (KBWQMCG), but rather drawn from KBWQMCG (Royer and Stubblefield 2009). Admittedly (and contrary to the statement on Page 7-5 under section 7.2.2 that states the plan is done), the plan is still in draft form, but much of the direction for the TMDL has been drawn from the KBWQMCG. Tables 7.3, 7.4, and 7.7 are drawn directly from processes involving the KBWQMCG and not properly referenced. Many participants have worked tirelessly on KBWQMCG issues and not properly referencing the sources of this information is inappropriate. Much of this chapter has been drawn from the Blue-Green algae working group and the KBWQQMCG, but these contributions are not properly cited.

Page 7-4, Table 7.1, Row 6. The chlorophyll *a* target units are wrong (mg vs. µg).

Page 7-6, Fifth bullet. Both of the examples given for project effectiveness monitoring appear to apply to projects that would occur mostly in Oregon. How does the Regional Board propose to provide grant funding and project monitoring to projects outside of its jurisdiction?

Page 7-10, Table 7.3. Differences between the use of terms "trend monitoring" and "trend compliance monitoring" should be explained.

Page 7-14, Paragraph 3, Lines 7-10. The statement is made that, "the results should be applied to determine whether microcystin exposures are a contributing factor to ecological impacts such as fish disease and fish health both within the reservoirs and below Iron Gate Dam". Explain how this determination would be made.

Page 7-14, First Bullet. This bullet indicates that public health monitoring in the reservoirs would occur at four shoreline sites in coves. Open water sites are not mentioned, but should be sampled also, since the open water areas are used by the public also.

Page 7-18, Paragraph 5, Line 2. The Revised Draft TMDL describes sampling that "will occur in 2009". This sentence, and other sentences in this section, should be revised to reflect the correct timing of sampling.

Page 7-19, Paragraph 2, Line 3. The 26 ng/g value listed here should be specified as ng/g wet weight.

Page 7-23, Section 7.7. The Revised Draft TMDL's proposed compliance monitoring program suffers from a lack of objectives, lack of rationale for the constituents chosen, lack of clear decision criteria, lack of congruence between the targets and the sampling sites, dates, and frequency, and lack of any apparent consideration of cost.

Page 7-24. Section 7.6.1 Comprehensive Water Quality Monitoring. This program of parcel tracking to assess water quality conditions is misleading and inappropriate for application in the Klamath River. This was tried by the Regional Board below Iron Gate dam and provided little useful information (in fact, there is no mention of this work in the Revised Draft TMDL). This is an inappropriate method to develop a system wide mass balance (which is stated as a desired outcome). The ability to track a parcel of water through the system requires a very clear understanding of travel time, which is not addressed in any way in this section. The approach does not speak to dilution and the role of tributary inputs at any sufficient level to understand the approach. The more prudent approach would be to reduce the system to a reach-by-reach basis and complete information on individual reaches multiple times per year. For example, a small study of Keno reservoir over a two week period, two or three times a year, would provide dramatically more information than this proposed approach. In the Keno dam to J.C. Boyle reach, which has a short transit time, a shorter study may be required, saving additional monies and resources. The constituents seem well represented, but the timing issue of this program will result in little useful data.

Folded into this are several studies that appear to be part of this “comprehensive” parcel tracking program, but do not seem directly related. This is a confusing presentation of important matters. For example:

- The estuary sampling does not seem related to the parcel tracking program (nor should it necessarily be related)
- The open ocean boundary condition is in a very dynamic environment and trying to tie it into the parcel tracking will not provide sufficient information to form confident and robust decisions
- New flow gages and flow analyses may be useful, but where is such work needed? This does not appear to tie in with the parcel tracking. How long of a record is necessary before a comprehensive understanding of the flow records can be confidently stated?
- Water monitoring for accretions is a great topic, but what defines “significant accretions” is unknown. This would vary by season, year type, and location in the system
- A bathymetric survey for the estuary is important for two reasons. The stated reason is that the initial survey may not have characterized important elements. An equally important reason is that the estuary is not static and will change, probably frequently. Thus relatively frequent surveys would be valuable to ascertain the variability in the estuary and accommodate that in modeling (sensitivity analysis) to quantify uncertainty.

These tasks require considerable resources, funding, and ideally a level of cooperation and coordination. A framework, ideally developed with considerable public input, is required to identify rank and prioritize monitoring actions to ensure effective and responsible use of funds and resources.

Page 7-27, Third Bullet. This bullet is titled “Below channelized section of Iron Gate Dam”. Please specify what is being referred to here. What “channelized section” is this? Also, the statement is made “This station has recently been demonstrated to have the highest rate of parasite infection of fish within the Klamath system". This statement is wrong and should be deleted. The higher rates occur downstream below the Shasta River near the confluence with Beaver Creek.

Page 7-29, Section 7.6.2. Second bullet point pertains to the Scott River and does not appear to be related to the Klamath River TMDL. Refugia temperatures are localized areas that probably do not have a broader effect on mainstem temperatures far from the refugia. Though groundwater in the Scott Valley may play a broader role, the valley is located well over 20 river miles upstream from the Klamath River and probably has little effect on Klamath River temperatures.

Page 7-29, Paragraph 3, Line 3. With nearly 10 years of data and two highly developed water quality models for the Klamath system, a reasonable mass balance for nutrients can be developed without extensive and costly additional data collection. In fact, it has already been done, and is referenced several times earlier in the Revised Draft TMDL (Asarian et al. 2009). What has not been accomplished, and apparently what is referred to in this paragraph, is an instantaneous mass balance to determine, for example, for a specific day whether more nutrients are leaving the Project than are coming in. However, this is an impossible, and meaningless, task because the indeterminate delay, mixing, and dilution of a particular parcel of water as it passes through the Project reservoirs makes it impossible to say with confidence how the discharge from Iron Gate dam on any particular day is related to the inflow above J. C. Boyle reservoir, or Copco reservoir, on any particular prior day. Knowledge of the instantaneous mass balance of the Project will do nothing to implement or monitor TMDL activities.

Page 7-30, Section 7.6.5. Bullet point identifies a "Periphyton Advisory Committee." Does such a committee exist? If it does exist it is so poorly communicated in the basin that key water quality analysts are unaware of its existence.

COMMENTS: CHAPTER 9. CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) ENVIRONMENTAL ANALYSIS

1. **<u>The Regional Board failed to clarify which portions of the CEQA analysis were revised and available for recirculation</u>**

It is unclear whether the Regional Board intends the revised Chapter 9 to be considered a "recirculated" environmental document pursuant to CEQA. Pub. Res. Code § 21092.1; 14 CCR § 15088.5. The "Summary of Revisions" states that Chapter 9 has been revised. In addition, the Public Notice of the availability of the December draft states that it is issued in accordance with CEQA Guidelines section 15087. NCRWQCB, Public Notice (Dec. 23, 2009), at p. 3. Indeed, recirculated environmental impact reports (EIRs) must be noticed in accordance with this section. 14 CCR § 15088.5(d).

The Public Notice states that the Regional Board and the Environmental Protection Agency (EPA) "are soliciting comments on the revised text and substantive changes only. Previously submitted comments need not be resubmitted." NCRWQCB, Public Notice (Dec. 23, 2009), at p. 2. This is permissible when the lead agency only revises and recirculates portions of the environmental document. 14 CCR § 15088.5(f). However, the Regional Board recirculated the entire CEQA environmental analysis as well as all other chapters of the Staff Report. At the same time, the Regional Board failed to provide a redline showing the revisions to Chapter 9, making public comment on the revised portions difficult. It is unclear why these revisions could not be shown in readable format since they are simple additions or changes to the previous text.

2. **The Regional Board failed to discuss feasible alternatives to the "project"**

As discussed elsewhere in PacifiCorp's comments, the load allocations assigned by this TMDL are impossible to meet due to a flawed natural conditions analysis and because the load allocations at Stateline are infeasible. The Revised Draft TMDL, or the "recommended alternative," is based on a huge nutrient reduction goal that is simply unrealistic and unachievable.

The nutrient targets are unrealistic because they are far below the Klamath River's naturally eutrophic condition. In addition, the Revised Draft TMDL's modeling results for natural conditions include a 20 percent reduction in solar radiation. The natural conditions scenario does not reflect water quality conditions that are attainable. Therefore, load allocations to achieve these "natural conditions" are infeasible.

The Revised Draft TMDL assumes water quality at Stateline (and by extension other downstream Klamath River locations in California) "once the Oregon TMDLs are fully implemented." (p. 6-8). In addition, the Oregon compliance conditions at Stateline determine natural temperature increases in California although it is unclear how temperature compliance at Stateline would be achieved. Chapter 9 contains no discussion of the feasibility of achieving the large nutrient reductions or the uncertainty that Oregon will otherwise meet the allocations at Stateline. Rather it simply states: "Improvements in water quality in Oregon represent a critical part of the solution in meeting water quality objectives in California." (p. 9-17) A legally adequate alternatives analysis includes a reasonable range of alternatives that may be feasibly accomplished in a successful manner considering the economic, environmental, social, and technological factors involved. *Citizens of Goleta Valley v. Board of Supervisors* (1990) 52 Cal.3d 553, 566.

The Regional Board must discuss the possibility that Stateline load allocations will not be achieved and that therefore, the downstream load allocations will be impossible to meet. One alternative should be considered that accounts for the likelihood that higher nutrient loading will occur at Stateline than is assumed under the recommended approach. Otherwise, there is no opportunity for public comment on the comparative merit of alternatives or to evaluate and respond to agency conclusions. 14 CCR § 15126.6(a). "The range of feasible alternatives shall be selected and discussed in a manner to foster meaningful public participation." 14 CCR § 15126.6(b).

3. **The Regional Board failed to analyze impacts from the load allocations set in the Revised Draft TMDL or to consider alternatives that would avoid these impacts**

The Regional Board failed to analyze potentially significant adverse environmental impacts from the load allocations proposed in the Revised Draft TMDL. The Regional Board chose a drastically reduced nutrient level to establish the load allocations. By choosing such a reduced nutrient level, the Revised Draft TMDL has potentially significant adverse environmental impacts that could have been avoided. As discussed elsewhere in these comments, sufficient nutrient levels are actually important in high temperature environments to support, among other things, salmonid species, particularly in juvenile rearing. The Regional Board failed to discuss this interaction within the environmental analysis in Chapter 9 or anywhere else. The drastic nutrient reduction proposal has potential to significantly alter food webs in the river which could adversely impact both the quantity and quality of salmonids in the Klamath River. The Regional Board also failed to consider alternatives that would reduce or avoid these impacts.

4. **The Regional Board's discussion of impacts and mitigation measures for dam removal or dam alteration was inadequate**

PacifiCorp appreciates the discussion in the December draft of the environmental impacts of dam removal. As PacifiCorp stated in its August comments, the June draft identified dam removal as the measure by which compliance with the TMDL load allocations would be achieved yet failed to identify associated environmental impacts, mitigation measures or alternatives. The December draft partially corrected this deficiency by including a discussion of potential environmental impacts from dam removal and possible mitigation measures.

However, the December draft now recognizes "[b]oth dam alteration/modifications and dam removal … as possible strategies by which final compliance with the TMDL load allocations may be accomplished." (p. 9-20) Yet the methods or actions involved for dam alteration or modification are not specified or discussed further. Instead, the analysis addresses only interim compliance measures and dam removal. A CEQA document is inadequate where it "sets forth various compliance methods, the general impacts of which are reasonably foreseeable but not discussed." *City of Arcadia v. State Water Res. Control Bd.* (2006) 135 Cal.App.4th 1392, 1425-1426. By identifying dam alteration/modification as a compliance method, the Regional Board staff should have discussed what actions may be involved, the reasonably foreseeable environmental impacts, and potential mitigation measures or alternatives.

In addition, the Revised Draft TMDL does not identify several reasonably foreseeable potentially adverse environmental effects of dam removal, including the loss of electricity generated by hydropower and the potential replacement by thermal generation resources, and the loss of the Iron Gate reservoir cold water supply to Iron Gate Hatchery, which provides successful year-round fish rearing and a hatchery water supply that is free of fish disease.

Moreover, the analysis of environmental impacts from dam removal and potential mitigation measures concludes: "Although potentially significant adverse impacts from dam removal were identified, it is impossible without further study to know whether those impacts may be able to be mitigated to less than significant levels." (p. 9-39) It also suggests that the Regional Board, "when required to take a discretionary action for approval of dam removal as a final TMDL compliance measure" will adopt a statement of overriding consideration. *Id.* Although this CEQA analysis may be at the programmatic level, and additional environmental review will occur prior to removal of the dams, the Regional Board is adopting a regulation that effectively requires dam removal to achieve compliance. Therefore, the potentially significant adverse impacts from dam removal identified are not speculative. The Regional Board cannot adopt a project with potentially significant adverse environmental impacts and hope that an agency or PacifiCorp can find a solution later. At the least, the Regional Board should have identified criteria for later mitigation measures that could mitigate the adverse impacts identified. *Sundstrom v. County of Mendocino* (1988) 202 Cal.App.3d 296, 308-309 (holding that by approving the project without data showing that a solution was possible, the county evaded its duty to engage in comprehensive environmental review.).

5. **The Regional Board failed to analyze alternative compliance methods, ignoring PacifiCorp's previous comments**

As part of the environmental analysis of methods of compliance, the agency is required to analyze "reasonably foreseeable alternative means of compliance with the rule or regulation." Pub. Res. Code § 21159(a)(3). In its August comments, PacifiCorp stated that the June draft did not discuss any alternative means of compliance. The Regional Board did not make any changes to Chapter 9 in response to this comment and PacifiCorp continues to believe that the discussion of alternative compliance methods is inadequate for the reasons already stated.

6. **The Regional Board failed to analyze the environmental impacts from the additions to the implementation plan**

The Revised Draft TMDL includes a "Prohibition of Discharges in Violation of Water Quality Objectives in the Klamath River Basin" that was not included in the June draft. Although section 9.2, "Description of the Proposed Activity," was revised to include this change, no other revisions were made to describe how this change might change the impacts of the project, including the analysis of alternatives, the analysis of compliance measures, and the description of possible mitigation measures or alternatives to the compliance measures. As discussed elsewhere in these comments, it is unclear what compliance measures will be required as a result of including this prohibition, even if it is a "restatement of existing law." Therefore, potential impacts of the reasonably foreseeable compliance measures should have been discussed to facilitate public comment. The inclusion of the prohibition was not a clarifying change in the environmental document. Rather, it was a change in the project with uncertain consequences.

Similarly, the Revised Draft TMDL adopts a Thermal Refugia Protection Policy in place of the thermal discharge prohibition in the June draft and replaces a sediment discharge prohibition with the adoption of Guidance to Control Sediment Discharges. Although section 9.2, "Description of the Proposed Activity," was revised to include these changes, no other revisions were made in the environmental analysis. The Regional Board should have analyzed reasonably foreseeable compliance measures for this policy and guidance.

7. **As a result of the omissions discussed above, the Regional Board must add the missing information and recirculate the CEQA analysis for additional public comment**

The omissions in critical information for adequate environmental review, discussed above, require the Regional Board to revise Chapter 9 to include missing information and to recirculate the CEQA analysis for additional public comment. Pub. Res. Code § 21092.1; 14 CCR § 15088.5. Currently, the draft environmental document is "so fundamentally flawed and basically inadequate and conclusory in nature that meaningful public review and comment were precluded." 14 CCR § 15088.5(a)(4); *See also Cadiz Land Co. v. Rail Cycle* (2000) 83 Cal.App.4th 74, 87 (holding that depriving the public of critical information during public comment period resulted in public and decision-makers lack of sufficient information to make an informed decision that intelligently takes account of environmental consequences.). If the Regional Board revises the environmental analysis to appropriately discuss the missing information, the revised chapter will likely include "significant new information" showing new significant environmental impacts or new mitigation measures that may have impacts or a substantial increase in the severity of environmental impacts. 14 CCR § 15088.5(a).

PUBLIC PARTICIPATION AND PROCEDURAL ISSUES

1. <u>The Regional Board violates principles of fairness by failing to make criteria for and information supporting its decisions publicly available</u>

The Regional Board staff continues to rely on information and studies that have not been made publicly available to support its decisions. Such extra-record evidence frustrates public participation and effective judicial review. *California Assoc. of Nursing Homes, etc. v. Williams* (1970) 4 Cal.App.3d 800, 811; *California Optometric Ass'n v. Lackner* (1976) 60 Cal.App.3d 500, 510-511. For example, as stated in PacifiCorp's comments on chapter 2, the Revised Draft TMDL cites "Ward and Armstrong 2009 in press" as the support for the benthic chlorophyll *a* target and cites the analysis and results from "Asarian et al. (2009)", neither of which have been made available for public review. (Page 2-18, paragraph 4; Page 2-41, Paragraph 4). In another example, the Revised Draft TMDL indicates the CA NNE boundary target is based on review of studies and recommendations of experts without indicating which studies or which experts and without documenting the recommendations. (Page 2-18, Paragraph 3). The Revised Draft TMDL also provides that personal communications with Richard Stocking support the Regional Board's conceptual model assumption that high levels of FPOM exported from the reservoirs are a critical factor in determining *M. speciosa* distribution and abundance. (Page 2-36-2-37). Without making this supporting evidence available for public comment, the Regional Board unlawfully relies on privately acquired data outside the record.

As discussed elsewhere in these comments and in its August comments, PacifiCorp showed that the modeling and technical analysis supporting the load allocations assigned to the Project are designed so that compliance is not expected without dam removal. In fact, the modeling is inaccurate and intended to overstate the case that compliance with the TMDL targets will be achieved with dam removal. Providing inaccurate and misleading modeling inputs frustrates effective public consideration of the actual consequences and outcomes of the regulation.

Further, as noted elsewhere in these comments, the TMDL "natural" conditions load diagrams are not listed, and the supporting table does not list instream loads below Iron Gate dam; therefore, the relative magnitude of unaccounted "natural" sources and sinks along the river cannot be determined. (page 4-10-4-16). The analysis leaves the reader unable to compare TMDL "natural" baseline and estimated current conditions nutrient and CBOD sources along the river or to understand the relative importance of sources and sinks in these two scenarios. These omissions frustrate meaningful public review and result in an incomplete and misleading presentation of constituent loading in the Klamath River.

2. <u>The Regional Board is required to respond to written public comments received 15 days prior to the hearing and to oral comments made at the hearing</u>

The boards' regulations implementing CEQA provide that the Regional Board shall prepare written responses to written public comments raising significant environmental points that are received at least 15 days prior to the date on which the Regional Board intends to take action. 23 CCR § 3779(a). However, the Public Notice on the availability of the December draft states that the public comment period will close on February 9, 2010 and the Board will only accept late comments in its discretion. NCRWQCB, Public Notice (Dec. 2009), at p. 4.

The Public Notice also states that the Board intends to provide written responses to public comments prior to the Board meeting on March 24-25 during which the Board intends to consider adoption of the TMDL. NCRWQCB, Public Notice (Dec. 2009), at p. 4. Indeed, "[c]opies of such written responses shall be available at the board meeting for any person to review." 23 CCR § 3779(a). The Regional Board should not complete the written responses before March 9 when written public comments raising significant environmental points may be made to which the Board must respond but should provide the responses as far in advance as possible to provide an adequate amount of time to allow meaningful review of the responses.

In addition, the Regional Board must prepare written responses to any late written comments, if feasible, or orally respond to the significant environmental points raised in late comments at the board meeting. 23 CCR § 3779(b). The Regional Board must also respond orally to any oral comments made at the meeting. *Id.* However, the Public Notice requires that all those who plan to testify at the meeting submit written statements by February 9, 2010 and that new evidence shall not be added at the meeting. While the Regional Board may require testimony to be submitted in writing in advance, the boards' CEQA regulations require that the board respond to significant environmental points raised at a board meeting. Therefore, if the term "evidence" includes such significant environmental points, the Regional Board must accept such statements during the meeting.

3. <u>The Regional Board provided insufficient time for review of the model applications and other revised portions of the Revised Draft TMDL</u>

The time period provided by the Regional Board for public comment on the Revised Draft TMDL was insufficient for complete review of the revised model applications. Public consultation must be preceded by timely distribution of information, sufficiently in advance of agency decision-making to allow the agency to assimilate public views into agency action. 40 C.F.F. § 25.4(d). PacifiCorp did not have sufficient time to provide constructive comments on several revised model applications, including the estuary application of EFDC and plans to submit comments on this topic later. Should PacifiCorp identify any significant issues within supplemental comments, PacifiCorp trusts that the Regional Board will consider these comments to the extent required, as described above, or pursuant to its exercise of discretion to do so.

COMMENTS: APPENDICES

Appendix 1: Proposed Site-Specific Dissolved Oxygen Objective for the Klamath River in California.

Executive Summary, Paragraph 1. Note that the DO fluctuations, weekly averages, peaks, etc. are variable from year to year. And yet the comparisons are being made to the natural baseline scenario model output (T1BSR), which is only based on one year (2000) of data. This indicates that the Klamath River TMDL model is lacking as a tool in TMDL development because it does not adequately address annual variability.

Executive Summary, Paragraph 2, Line 4. The Revised Draft TMDL states "The proposed recalculated SSOs for DO are achievable under natural conditions…". However, "natural conditions" as identified in the Revised Draft TMDL will not likely be achieved. As noted elsewhere in the comments, the assumptions for natural conditions suggest extraordinary reductions that, given the geology, hydrology, meteorology, and land use, are unrealistic.

Page 4-7 to 4-10, Section 4.4. What is the significance of discussing the CADDIS model? This model was not applied to the Klamath Basin, and so the points made in this section are just general ideas that may or may not apply to the Klamath River system. Discussion of an additional model that is not relevant misleads the reader and causes confusion about the role of the CADDIS model in the TMDL.

Page 5-8, last paragraph. The Revised Draft TMDL states:

> "Altering the shape of the hydrograph through anthropogenic manipulation simultaneously alters the seasonal pattern of DO availability. For example, lower flows from April to September likely result in lower DO concentrations by increasing the rate at which the river heats during the summer months, thereby reducing the concentration of DO at saturation. Further, the warm and slow moving conditions behind the dams promote the excess growth of algae which simultaneously promotes wider fluctuations in DO, including much lower night concentrations than occur naturally."

While it is correct that elevated temperatures lead to a decrease in dissolved oxygen saturation concentration, this argument completely ignores mechanical reaeration dynamics and local conditions in the river. Mechanical reaeration is typically represented as proportional to velocity and inversely proportional to depth (Bowie et al. 1985). So it is true that, while decreased flows lead to decreased velocity, reduced flows also lead to decreases in depth. Further, reaeration is a local phenomenon in the river which changes considerably under various flow regimes. In short, one cannot simply state that lower flows result in decreases in DO saturation without a more comprehensive assessment. Again, there is no quantification of these statements: would this assumed reduction be 0.01% or 10 percent? Simply stating that it is "lower" is not constructive.

Page 5-9, Paragraph 1, Line 1 (Section 5.3.1.6). The Revised Draft TMDL states "Chapter 4.0 presents a USEPA's CADDIS generic conceptual model of the effects on DO expected from activities such as…" Why should the CADDIS model be relied upon? Though the CADDIS model could possibly be a very useful tool in water quality analyses, there is nothing to suggest that the results of CADDIS are applicable to the Klamath Basin.

Page 5-11, Paragraph 1, Lines 2-10. The Revised Draft TMDL states "The phosphorus-rich volcanic geology and organic wetland soils of the upper basin naturally feed episodic algae blooms downstream in the Klamath River mainstem leading to diurnal fluctuations in DO, particularly during the summer months. These natural conditions originate in the reaches downstream of Upper Klamath Lake in Oregon. Under natural conditions, they dissipate slowly in the downstream direction. Under existing conditions, though, *the fluctuation of DO is exacerbated and perpetuated further downstream by impoundments, agricultural return flows, water diversions, reduction in stream bank stability, reduction in stream side shade, and increase in sediment delivery* – conditions which were present when the SSOs for DO were first established" (emphasis added). How were dissolved oxygen conditions assessed to determine that impoundments perpetuate exacerbated DO fluctuations – was an existing conditions without dams scenario simulated to compare to baseline, and if so, are these results available? What are the specific diversions and agricultural return flows along the Klamath River being referred to in this statement? Where has stream bank instability in the mainstem occurred (e.g., how many miles, and what is the natural instability of banks in the main stem)? To support this statement, the Revised Draft TMDL needs to quantify the reduction in stream shade on the Klamath River mainstem and provide estimates of what changes have occurred over the past 50, 100, and 150 years. What was the disturbance regime of mainstem riparian vegetation, i.e., how often was it removed by fire, flood, beaver, disease, etc.). What quantitative impact does increased sediment delivery have on DO?

Page 5-12, last paragraph. The Revised Draft TMDL states:

> "Staff concludes that the SSOs for DO in the Klamath River mainstem must be updated to: a) accurately depict daily minima conditions and b) deliberately define background conditions. As they are currently set, the SSOs for DO in the Klamath River mainstem are outdated with respect to the monitoring tools currently available. And, they erroneously establish as background, conditions which very likely reflect significant anthropogenic influence. More accurate and protective SSOs for DO would reflect the actual daily minima expected during the early morning hours and would be based on natural background conditions."

The goal of the SSOs for DO are not to protect fish populations, but to achieve hypothesized "pre-disturbance" conditions. Such conditions and SSOs have been set with little regard to attainable water quality standards or on-the-ground conditions in the Klamath River basin.

Page 6-6, last paragraph. The Revised Draft TMDL states:

> "In 2005, peer reviews of the Klamath TMDL model were completed by Dr. Scott Wells (developer of CE-QUAL-W2 model), Portland State University; Brown & Caldwell (under contract to the City of Klamath Falls, Oregon); and the U.S. Bureau of Reclamation (Technical Services Center – Environmental Applications and Research Group, Denver). Peer review materials were also sent to Dr. Michael Deas, Watercourse Engineering, Inc., developer of the PacifiCorp Model. Dr. Deas did not submit any comments at that time."

Please note that neither the Regional Board nor EPA issued a contract that would allow Dr. Deas the means to provide peer review comments. Thus, no comments were submitted.

Page 6-10, end of section 6.2.3. The Revised Draft TMDL states "The model simulation was run for the year 2000." The model run was only done for one year. In contrast, the existing SSOs from the 1950s and 1960s were based on monitoring data from multiple years. This suggests that the existing SSOs were based on a more comprehensive data set.

Appendix 2: Nutrient Numeric Endpoint Analysis for the Klamath River, CA.

Page 2, Paragraph 2, Lines 2-4. Calibration was neither precise nor based on much data, and results of calibration probably do not suggest "that some of the original criticisms of the model are correct". In fact, other studies cited in the Revised Draft TMDL suggest that original model results as presented by PacifiCorp were correct. Use of more data in a more rigorous calibration and validation is necessary to make any such statements.

Page 2, Paragraph 3, Line 1. Models were designed to enhance analysis of systems characterized by sparse data. Given the lack of data, an appropriately applied model can provide more useful insight than relying only on limited data such as the scoping-level analyses described later in this appendix.

Page 3, Paragraph 1, Lines 2-6. The Revised Draft TMDL states that "model predictions are strongly influenced by the boundary conditions (upstream load and relative dilution provided by downstream tributaries." As noted, this is especially true in the Klamath River. A major flaw in this Revised Draft TMDL is the failure to use all available data and the misrepresentation of organic matter partitioning at the upstream boundary. A greater fraction of OM as refractory (as suggested by recent studies in the upper Klamath River) translates to even less retention in river reaches. In the dams-out scenario, the Klamath River system as modeled is all river reaches.

Page 3, Paragraph 2, Line 1. Simulations of more years to quantify this "year-to-year" variation are needed.

Page 3, Paragraph 4, Line 2. Usefulness of the models would be greatly improved by simulating several years, not just one.

Page 3, Paragraph 2, Lines 4-5. Here the Revised Draft TMDL appropriately acknowledges the uncertainty associated with data and its consideration in interpreting model results.

Page 4, Paragraph 2, Lines 1-2. Will denitrification occur in a river running at 85% saturation? It seems like denitrification and fixation are equally unlikely in river reaches as major factors.

Page 5, Paragraph 2. The unstated implication here is that the Asarian and Kann study cited should be discarded.

Page 7, Figure 1 and 2. These figures show no relationship between either TN or TP and flow. Why include these?

Page 7, Paragraph 1, Line 3-4. The SPARROW model of removal is very coarse and based on rivers throughout the U.S. Most of these rivers are of quite different conditions than the

Klamath River system. We question the relevance of the SPAROW model in the Klamath. Also, because the SPARROW model is non-linear (exponential decay), using a median value of flow is inappropriate. It would be easy to apply the model to hourly flows and average results for a more accurate representation of removal.

Page 9, Paragraph 1, Line 5-7. The model being reviewed is not PacifiCorp's model, it is TetraTech's model, and TetraTech should document "other relevant rate constants."

Page 9, Paragraph 3, Line 1-2. Nutrient cycling may not be accurate but that doesn't mean annual net retention (loss) is not. A reasonably calibrated RMA-11 can accurately represent annual net loss.

Page 9, Bullet point 1. Denitrification likely is not important in Klamath River reaches. Some simple estimates could put quantitative bounds on the contribution of denitrification to provide more context.

Page 9, Bullet points 2 and 3. These processes would not affect annual retention or loss.

Page 9, Bullet point 4. How significant is riparian vegetation in long-term sequestration on the Klamath River? It is probably not very significant, but some estimates could put quantitative bounds on this process to provide more context.

Page 9, Paragraph 2. There are few ultimate sinks for nutrients in RMA-11 representation because there are few ultimate sinks in a fast free-flowing river like the Klamath River.

Page 11, Paragraph 3, Line 3-6. As noted above, the relevance of SPARROW to the Klamath River system is questionable. SPARROW is based on an average across the U.S. with many Eastern rivers. RMA11 is physics-based with significant detail, but SPARROW takes into account nothing except flow and travel time –and those coarsely.

Page 11, Paragraph 3, Line 13-15. The important point here is annual loss, so the seasonal estimates cited are of marginal value. Plus, of the two seasonal estimates, RMA11 matches one of them.

Page 14, Paragraph 2, Line 8-9. Given that the other studies are of marginal relevance in estimating annual loss of nutrients on the Klamath River system, the Revised Draft TMDL needs to substantiate the statement that RMA-11 "may have some tendency to underestimate nutrient losses in the free-flowing reaches of the Klamath".

Page 14, Paragraph 4, Line 4-5. The Revised Draft TMDL needs to clarify whether and why deeper reservoirs are equated with shorter retention times.

Page 15, Paragraph 2. Another study of Kann and Asarian is considered of questionable value. Here, 2002 estimates are described as not reliable.

Page 15, Paragraph 3. Why should there be "large uncertainties" in flow measurements? Detailed flow data should be readily available.

Page 15, Paragraph 4, Line 5-8. What is the use of measures like "standard error" in this analysis? Field data have natural variation. How does that cast doubt on results?

Page 16, Paragraph 2, Title. Are these estimates of retention or loss?

Page 16, Last paragraph, Line 6-8. Where do these estimates of hydraulic residence time come from? Are these from the model or flow-volume calculations?

Page 17, Table 5. Kann and Asarian's work is not peer-reviewed. It would be useful to include W2 results in this table, as directly below:

Parameter	Method	Copco	Iron Gate
TP	W2	1.2%	6.1%
TN	W2	3.6%	17.6%

Page 18, paragraph 3. How was retention (loss?) calculated? Was this done hourly? For this analysis, only beginning and ending storage volumes were used with concentration. Why not just use Loss = $Q_iC_i - Q_oC_o$ (where subscripts *i* and *o* refer to inflow and outflow, respectively)? What concentration was used – was it taken from somewhere in the reservoir?

Page 19-20, Table 6-9. Please explain how the 'Whole Year Retention" was "corrected for change in storage."

Page 23, Paragraph 1, Line 1-2. The Revised Draft TMDL states, "Available monitoring data (are) insufficient to produce good estimates of nutrient retention and loss." However, more recent data will provide much better estimates.

Page 23, Paragraph 1, Line 1-2. As noted above, denitrification is probably not an important loss pathway in river reaches.

Page 23, Paragraph 5, Line 2-4. The Revised Draft TMDL needs to clarify the basis for Asarian and Kann's contention that "there is significant retention of TN between Iron Gate and Seiad".

Appendix 6: Model Configuration and Results: Klamath River Model for TMDL Development – December 23, 2009

General Comments.

The number of parameters and re-specification of key boundary conditions between the original Draft TMDL and the Revised Draft TMDL are remarkable. Although some of the parameter changes were apparently in response to comments about model representation being inconsistent among reaches, other changes have also been made for reasons that are not clear. Some of these other changes appear to be attempts to further calibrate the model, and others in response to specific applications or scenarios. Specific examples include:

- Natural Conditions at Link Dam. Modification of the Link Dam boundary condition for algae and organic matter under natural conditions. Algae concentration was increased globally by a factor of approximately 1.6 and organic matter was set to negligible values in the late spring and summer period when annual concentrations would naturally be the highest.

- Light Extinction. Light extinction was set uniform in all CE-QUAL-W2 simulations (calibration and application). Higher light extinction values in the upper basin would be expected, at a minimum in existing conditions and probably in natural conditions as well, given the wetlands that would presumably continue to surround UKL under a restored condition. This is an important distinction because refractory organic matter (ROM) has been completely ignored in the TMDL model, while seasonal (summer) ROM concentrations are currently on the order of 20 mg/l, with higher values occurring on occasion. Although refractory, this is a considerable load and will have implications throughout the river system.

- Organic Matter Partitioning. Partitioning of organic matter in the natural conditions case is the inverse of the existing conditions case. Existing conditions organic matter partitioning is 80 percent particulate and 20 percent dissolved. All this is assumed to be labile (as noted above, refractory material is neglected in the model). In previous PacifiCorp comments, concern has been raised about the partitioning given information from 2006-2008 studies by USGS (see Sullivan et al, 2008; Sullivan et al 2009). In an interesting modification, the Revised Draft TMDL partitions organic matter into 10 percent particulate and 90 percent dissolved. A single reference is cited as a reason, without any site specific argument provided.

- Particulate Organic Matter. Related to the previous point, comparison of 2007 and 2008 particulate organic matter at Keno from USGS studies versus TMDL model output at Keno Dam (approximately 2 miles downstream), suggests that the TMDL model systematically under-predicts particulate organic matter (model results are for 2000 and field data are from 2007 and 2008), particularly in critical summer periods (see Figure B1 below). For this comparison, particulate organic matter is assumed in the TMDL model to be labile (as assumed in Appendix 6), and that the fraction of carbon in organic matter is 0.45 (consistent with the CE-QUAL-W2 input file in the TMDL model for the Lake Ewauna to Keno Dam reach). These results suggest that organic matter partitioning, organic matter settling rates, organic matter decay rates, algal settling rates, algal dynamics, and possibly other factors are not set to values that reproduce field observations. The implications are that less organic matter at Keno Dam translates to less nutrients and oxygen demand in downstream river reaches. The TMDL model should be recalibrated to properly represent organic matter and associated nutrient loads.

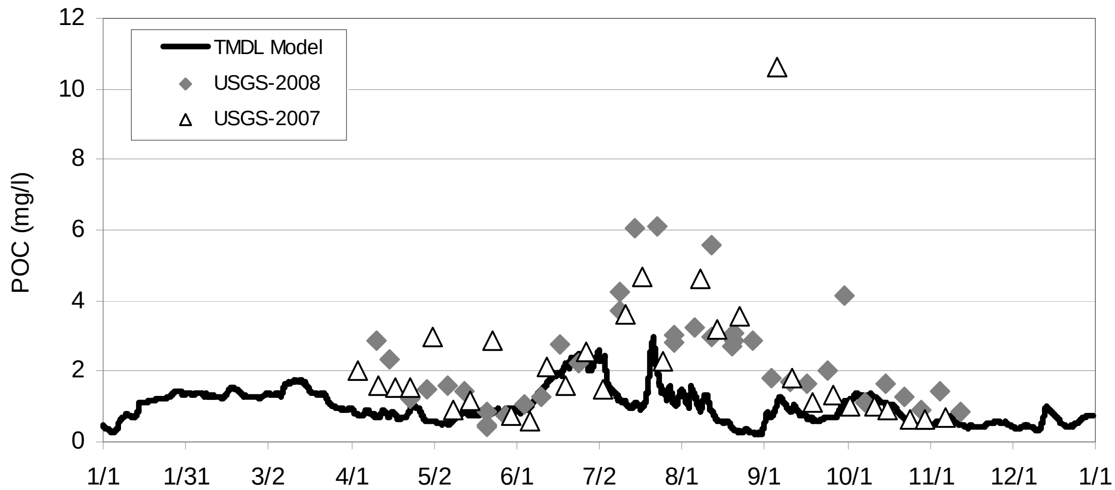

Figure B1. Particulate organic carbon: TMDL existing conditions simulations (TMDL Model, year 2000) at Keno Dam and USGS data from Klamath River at Keno fro 2007 and 2008.

- Temperature Logic – Solar Radiation Reduction. Previous comments by PacifiCorp identified that the RMA-11 model had undocumented code reducing solar radiation by 20 percent globally in the riverine reaches. In the Revised Draft TMDL, model documentation states that this was corrected for Keno Reservoir, but the solar radiation reduction remains in the river reaches. The reason provided in the Revised Draft TMDL was that when calibrating the model for the Klamath River above Copco Reservoir (near Shovel Creek), the model was too “warm” at that particular point and the analyst reduced solar radiation to improve model performance. For a specific reach this may be acceptable, but to subsequently apply this to the entire river – both upstream and downstream – has no basis. To ascertain the implications of solar radiation reduction, the PacifiCorp model (PacifiCorp, 2005) was used to simulate temperature conditions with and without the reduction from Iron Gate Dam to Turwar. The boundary conditions at Iron Gate Dam were identical in both runs – they were taken from the Iron Gate Reservoir reach simulated output of the existing conditions model where there was no solar reduction. Model performance was compared with observed data at Seiad Valley and Turwar where data were readily available (due to the limited comment period, not all data could be acquired and prepared for comparison, e.g., 2006, and in certain cases data were unavailable, e.g., 2000). Comparing model performance (see Table B1 below), the model with reduced solar radiation consistently showed a greater bias by approximately 0.5 to 0.75ºC, with mean absolute error and root mean squared error higher than the model without the reduction. This illustrates that carrying a calibration strategy derived for a single point (Klamath River at Shovel Creek) throughout the river basin resulted in poorer model performance. Table B2 illustrates that reducing solar radiation over the entire Iron Gate to Turwar reach almost uniformly results in lower average simulated monthly water temperatures. Further, average simulated temperatures in July, August, and September can be over 1ºC cooler with the reduced solar radiation logic. Because these are average monthly temperatures, there are times during particular summer months (e.g., individual days) when temperatures may be reduced even further under the reduced solar regime.

Table B1. Effects of 20 percent reduction in solar radiation over the entire Iron Gate to Turwar reach

A. No Solar Radiation Reduction

Statistic	2001		2002		2003	
	Seiad	Turwar	Seiad	Turwar	Seiad	Turwar
Mean bias	-0.45	0.27	-0.74	-0.98	-0.48	-0.58
Mean absolute error	1.38	1.60	1.02	1.75	0.91	1.58
Root mean squared error	1.76	2.03	1.35	2.20	1.18	1.97
n	3491	2981	5313	3420	6515	3420
Statistic	**2004**		**2005**		**2007**	
	Seiad	**Turwar**	**Seiad**	**Turwar**	**Seiad**	**Turwar**
Mean bias	-0.87	-1.25	-1.02	-0.83	-0.96	-0.99
Mean absolute error	1.20	1.56	1.27	1.35	1.05	1.19
Root mean squared error	1.56	1.79	1.48	1.64	1.32	1.59
n	3888	135	8759	8574	6638	6473

B. Solar Radiation Reduction (TMDL model)

Statistic	2001		2002		2003	
	Seiad	Turwar	Seiad	Turwar	Seiad	Turwar
Mean bias	-1.21	-0.57	-1.39	-1.83	-0.94	-1.29
Mean absolute error	1.63	1.57	1.47	2.07	1.14	1.78
Root mean squared error	2.07	1.87	1.83	2.58	1.47	2.21
n	3491	2981	5313	3420	6515	3420
Statistic	**2004**		**2005**		**2007**	
	Seiad	**Turwar**	**Seiad**	**Turwar**	**Seiad**	**Turwar**
Mean bias	-1.62	-2.05	-1.60	-1.37	-1.61	-1.68
Mean absolute error	1.71	2.08	1.72	1.64	1.63	1.71
Root mean squared error	2.11	2.33	1.99	1.96	1.92	2.15
n	3888	135	8759	8574	6638	6473

These findings illustrate that there is a consistent bias in reducing solar radiation globally in the riverine models. It is important to note that reservoir reaches modeled with CE-QUAL-W2 receive 100 percent of solar radiation (no reduction). Thus, when comparing cases where dams are in and dams are out, the solar radiation applied over a particular reach is not equivalent. For example, for a case where Iron Gate and Copco Reservoirs are included in an analysis, 100 percent solar radiation is applied. For the same reach under a no-dams analysis, 80 percent solar radiation is applied. The implication have not been fully explored due to limited review time, but the global reduction of solar radiation by 20 percent presents a clear bias for lower simulated temperatures that can be in excess of 1°C on a monthly average during the warmer periods of the year. The uncertainty associated with this error and the implications for thermal criteria should be fully explored.

Table B2. Difference between full solar radiation and 80 percent solar radiation (positive numbers indicate that reduced solar radiation simulated results are cooler).

	2000		2001		2002		2003	
	Seiad	Turwar	Seiad	Turwar	Seiad	Turwar	Seiad	Turwar
January	-0.02	-0.04	0.19	0.29	0.14	0.09	0.09	0.05
February	0.04	0.01	0.31	0.36	0.24	0.17	0.24	0.17
March	0.05	-0.08	0.48	0.40	0.33	0.26	0.28	0.19
April	0.06	0.03	0.49	0.54	0.41	0.38	0.30	0.25
May	0.10	0.17	0.61	0.50	0.56	0.53	0.38	0.33
June	0.40	0.55	0.70	0.83	0.76	0.75	0.58	0.56
July	0.72	0.70	1.00	1.00	0.91	0.89	0.84	0.77
August	0.86	0.77	0.92	0.93	1.00	0.95	0.80	0.82
September	0.63	0.77	0.81	0.87	0.84	0.90	0.69	0.82
October	0.41	0.54	0.54	0.64	0.59	0.80	0.50	0.69
November	0.17	0.35	0.28	0.24	0.35	0.37	0.30	0.37
December	0.17	0.21	0.14	0.07	0.12	0.08	0.14	0.08

	2004		2005		2006		2007	
	Seiad	Turwar	Seiad	Turwar	Seiad	Turwar	Seiad	Turwar
January	0.15	0.08	0.21	0.14	-	-	0.19	0.16
February	0.21	0.13	0.41	0.27	-	-	0.26	0.20
March	0.27	0.20	0.51	0.32	-	-	0.23	0.21
April	0.40	0.37	0.57	0.31	-	-	0.46	0.44
May	0.53	0.49	0.35	0.29	-	-	0.71	0.60
June	0.71	0.67	0.75	0.56	-	-	0.88	0.97
July	0.93	0.85	1.16	0.99	-	-	1.10	1.13
August	0.91	0.86	1.15	1.28	-	-	1.11	1.29
September	0.79	0.80	0.90	1.18	-	-	0.91	1.13
October	0.59	0.65	0.56	0.78	-	-	0.48	0.58
November	0.40	0.44	0.26	0.26	-	-	0.32	0.35
December	0.23	0.19	0.10	0.07	-	-	0.18	0.14

- Algae settling: In all cases algae settling rates have been set to 0.3 m/d. This rate ignored the fact that the blue-green algae that dominate UKL and main stem Klamath River reservoirs can control their buoyancy. This has considerable implications in Keno Reservoir where, under current model assumptions, loss rates of algae to settling are notable. However, blue-green algae settling rates may be negligible due to buoyancy regulation, resulting in considerably less loss. Overestimating loss rates of algae due to settling in Keno would have direct implications for transport of organic matter (algae – dead and alive) and associated nutrients to downstream reaches. The Revised Draft TMDL does not include a discussion of algal species composition under a natural baseline. The TMDL model should include multiple algal species representation in the main stem Klamath River reservoirs to assess species specific attributes.

PacifiCorp has multiple concerns with model assumptions and application of the models in the TMDL analysis. As stated in other comments, application of the models to additional years and formal sensitivity analysis could have potentially headed off some of these problems, and provided at least a minimum level of testing and uncertainty analysis so that decisions could be made using the modeling framework.

In sum, the Revised Draft TMDL contains boundary conditions and parameter values that are significantly different than the original Draft TMDL. These differences create significantly different water quality conditions in the Klamath River and algae and nutrient dynamics that are unusual and untested. Because of this, the model should be viewed as a new model and not just a revision of the previously released model.

Page 8, Section 2.2.2. Given the data provided, the value of this "two-state algae transformation" modification is questionable. A very limited number of data (3) seem to be the basis for this modification (please see discussion of Figure 2-1, below), and the data do not really support the scheme. The calibration plots for Miller Island and Hwy 66 in 2000, Figures E-6 and E-16, respectively, suggest that just about any function that reduces algae concentrations from Miller Island to Hwy 66 would work just as well. Furthermore, it doesn't look as if this "phenomenon" exists in the 2002 "validation" data. In 2002, there is no large drop in chlorophyll *a* concentrations, and the healthy-unhealthy hypothesis does not fit. At the very least, the TMDL should discuss the 2002 data that were used in "validation".

Page 8, Paragraph 3, last line. So many things can affect algal growth that it is hard to accept the statement in the Revised Draft TMDL that "available data show no other explanation for the observed phenomenon." What phenomenon is being referred to?

Page 9, Figure 2-1. There are three chlorophyll *a* concentrations above 50 μg/L at Miller Island, as shown in this figure. Is this the phenomenon referred to in the Revised Draft TMDL? Are these three data points representative of chlorophyll *a* at that time and in that location? These three data appear to be the basis of the entire healthy-unhealthy algae hypothesis and implementation. The eleven (11) other concentrations reported at Miller Island are all below 50 μg/L – similar in magnitude to chlorophyll *a* concentrations at Hwy 66. How does this low DO argument explain these data?

Page 10, Equation 3. This equation is not a "Monod-type function" in the rigorous sense.

Page 11, Last paragraph. Is "smoother" more accurate and more representative of natural processes? Does this modification improve the model?

Page 12, Section 2.2.4. Watercourse ran into some problems using the pH modifications. The numerical technique is not robust and can lead to errors.

Page 12, Paragraph 3, Equation (Ke). In this formula, is OM particulate or refractory or both (i.e., total)?

Page 13, Paragraph 2, Lines 13-19. The Revised Draft TMDL needs to clarify that the numbers given here are just an example and not values fixed for all simulations.

Page 13, Paragraph 2, Line 19. Both settling and decomposition affect the OM fractions.

Page 21, Paragraph 4, Lines 6-8. Sometimes, "it is preferable to use data collected during the modeling year", but only if the site is representative of boundary conditions.

Page 21 to 22, Paragraphs 1-4 of Section 2.3.3.1. Phosphorus data seem to come from Pelican Island, Fremont Bridge, and Miller Island, inconsistently.

Page 22, Paragraph 2. Boundary condition (BC) PO4 concentration is used as a calibration tool. This is not standard practice.

Page 22, Paragraph 3. PO4 BC is from Miller Island. But PO4 and TP used in OM BC are from Pelican Marina. This is inconsistent. The Revised Draft TMDL needs to clarify whether PO4 concentrations from Pelican Island are good or not.

Page 22, Paragraph 4. Boundary condition TIC and alkalinity concentrations are used as a calibration tool to get pH in Lake Ewauna. This is not standard practice.

Page 22, Paragraph 4. In 2002, Miller Island data were not used to estimate PO4. Again, we question this method. The Revised Draft TMDL needs to clarify why PO4 concentrations from UKL are good to use in 2002, but not in 2000.

Page 36, Bullet Point 1, Line 1. The Revised Draft TMDL states that "…OM in the boundary conditions is lumped (and thus not partitioned between labile and refractory components) due to lack of sufficient data for accurate OM partitioning." In fact, the assumption here is that ALL OM in the boundary condition is labile. Available data suggest that the majority of OM in the BC is not labile, but refractory. This incorrect assumption has large consequences for predicted water quality downstream and into the estuary.

Page 36, Bullet Point 1, Line 1. Denitrification in rivers is not significant, and thus should not be a concern in Appendix 3.

Page 36, Bullet Point 5, Line 3-6. We agree that the model is not good at predicting actual water quality concentration, but that it "can be used to represent the overall water quality trends in response to external loading and internal stream dynamics" as the Revised Draft TMDL states. This being the case, the Revised Draft TMDL needs to clarify the model's limitations for accurately setting target concentrations and load allocations. This inability to predict values is not well incorporated in the Revised Draft TMDL discussion.

Page 37, Paragraph 1 of Section 2.4.3, Lines 3-4. We agree that uncertainty is inherent in the model (especially with a limited observed data set) and that the model should only be relied upon to reproduce "general trends."

Page 44, Section 3.3. Some calibrated parameters were changed during "validation." The Revised Draft TMDL needs to confirm that calibrated values were unchanged for all TMDL scenarios.

Page 44, Last paragraph, Line 1-2. In calibration, algae and OM parameters changed from reservoir to reservoir. We question the validity of changing these values in light of the lack of data to support the changes. The Revised Draft TMDL needs to provide more justification for the actual changes made (e.g., "algae growth rates were reduced in Copco because…"). This is especially important because only one year of data was used in calibration and validation.

Page 45, Paragraph 2, Line 2-5. Lumping labile and refractory OM together and using an "average decay rate" does not accurately represent the separate decay rates of refractory and labile OM. Further, when an average value is used, the combination of both extreme labile and extreme refractory OM and their respective effects on the system are actually ignored.

Page 45, Table 3-3. The Revised Draft TMDL does not mention the fact that SOD parameters also change from reach-to-reach. The Revised Draft TMDL needs to explain the rationale for changing these parameters reach-to-reach.

Page 47, Table 3-5. The Revised Draft TMDL Table 3-5 implies that parameter values remain constant reach-to-reach and for each scenario. Also, some parameters are not listed in this table. For example, "bed algae carrying capacity" is a term added to the RMA-11 model. In earlier versions of the TMDL model, this important parameter was not kept constant. The Revised Draft TMDL needs to include all important parameters and confirm that they remain constant reach-to-reach and for each scenario.

Page 49, Paragraph 2, Line 1. The model does not appear to "reproduce the supersaturation of DO during early summer well." Simulated DO is always 4-6 mg/L low in comparison to observed values in May.

Page 49, Paragraph 3, Lines 6-10. There is SOD in W2. It is not clear that a fully dynamic interaction between bed and water column is necessary. Similar results might be obtained by specifying seasonal SOD.

Page 52, Paragraph 2, Last sentence. If "the model's overprediction of chlorophyll *a* …is likely caused by inaccurate boundary conditions from UKL", then why would this overprediction of chlorophyll *a* not show up in all upstream reaches? The Revised Draft TMDL suggests that the model simulates chlorophyll *a* "very well' in the Lake Ewauna to Keno Reach (page 49, paragraph 4, line 1). Or, is the Revised Draft TMDL suggesting that inaccuracies in boundary nutrients led to poor chlorophyll *a* simulation downstream? This needs to be clarified.

Page 53, Paragraph 1, Line 3. The Revised Draft TMDL states that the model "predicts concentrations within the range of observed data". This is misleading. Model results for NH4 and NO3 are not within any meaningful observed range.

Page 53, Paragraph 3. The Revised Draft TMDL states that calibrating a model to observed data "indicates that water quality dynamics … are reasonably represented." Calibrating at this level (one year of data) is simply a curve fitting exercise and doesn't indicate anything about the model's ability to represent the dynamic nature of surface water quality.

Page 54, Last Paragraph, Line 1-2. Apparently, 2004 data were used to calibrate the estuary model. Why weren't data through 2004 used for the rest of the river? Why weren't data gaps identified and filled for the rest of the river through at least 2004?

Page 55, Paragraph 1, Line 7-8. Uncertainty in lab data is shown in estuary calibration figures. Why should this be done only for the estuary? The Revised Draft TMDL needs to include error bars in the presentation of lab uncertainty throughout this TMDL.

Appendix 7: Modeling Scenarios: Klamath River Model for TMDL Development – December 23, 2009

The Revised Draft TMDL model scenarios and supporting numerical model simulations reviewed herein have several shortcomings that are not easily overcome without a revisiting of fundamental system conceptualization, interpretation of boundary conditions data, and basic model assumptions. Comments on Appendix 7 are presented as three overall sections to address these issues:

1. General comments on the model application:

   – Inconsistencies with UKL TMDL and neglect of inter-annual variability

   – Unexplained discrepancies with boundary conditions from the June 2009 TMDL draft release

   – Problematic approach in creating boundary conditions

   – Implications of altering Link Dam boundary conditions to Keno Reservoir water quality

   – Downstream effects of realistic boundary conditions at Link Dam

2. Specific Comments regarding the Revised Draft TMDL allocations above Copco Reservoir for California Compliance:

   – TMDL technical documentation inconsistent with TMDL target

   – Implicit condition of constant algae concentrations

   – Non-representative conceptual model

   – Unattainable targets

   – Alternative approaches in setting allocations

3. Other comments that pertain to Revised Draft TMDL language in Appendix 7.

1. General Comments

The boundary condition at Link Dam for the "natural" baseline conditions (T1BSR) in the Revised Draft TMDL was supposedly derived from the Upper Klamath Lake Phosphorus TMDL (ODEQ, 2002) analysis (henceforth known as UKL TMDL). Total phosphorus concentrations from the simulated outflow were supposedly used to create the boundary conditions for Link River. However, the total phosphorus concentrations used (and thus all other nutrients) are inconsistent with the UKL TMDL. The selected values represent neither the average value nor a range of values: they are too low and do not properly account for inter-annual variability at Link Dam. As such, the allocations and targets set by the Klamath River TMDL are likely to be both unattainable and unenforceable. Outlined below are several comments addressing:

– Inconsistencies with UKL TMDL and neglect of inter-annual variability

- Unexplained discrepancies with boundary conditions from the June 2009 TMDL draft release
- Problematic approach in creating boundary conditions
- Implications of altering Link Dam boundary conditions to Keno Reservoir water quality
- Downstream effects of realistic boundary conditions at Link Dam

Inconsistencies with UKL TMDL and Neglect of Inter-annual Variability

An approximate seasonal distribution of total phosphorus values for Klamath River "natural" conditions simulation (T1BSR), derived from the water quality input file used at Link River and the stoichiometric ratio of phosphorus in algae and organic matter as used in the Klamath River TMDL model, is shown in Figure C1 below. Total phosphorus (TP), the sum of orthophosphate-phosphorus (PO_4), algal phosphorus (Alg-P) and non-algal phosphorus or organic matter phosphorus (OM-P), at Link River varies over the year with a low of approximately 20 µg/L in winter and a high of about 40 µg/L in midsummer. As shown in the figure, the UKL TMDL target for spring of an average 30 µg/l matches the Link River boundary conditions. But the annual mean TP concentration used as Link River boundary conditions was only about 25 µg/L, far less than the UKL TMDL annual lake average target of 110 µg/L.

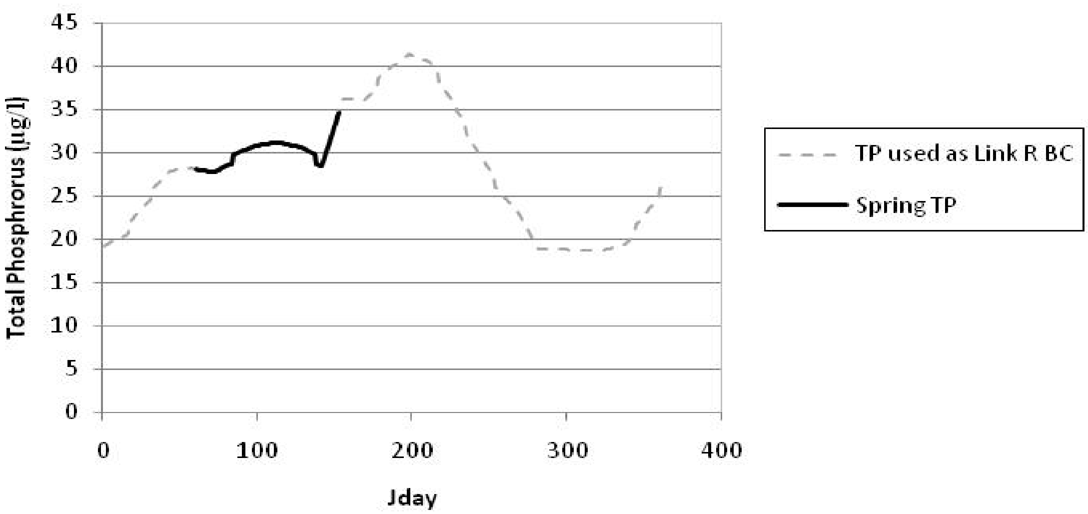

Figure C1: TP boundary conditions used at Link River for the "natural" baseline scenario (T1BSR) of the Klamath River TMDL model. Note that only the spring target specified in the UKL TMDL was matched by the T1BSR boundary conditions. Over the rest of the year, the water quality at the UKL outflow was assumed have concentrations notably lower than the UKL TMDL compliant conditions.

Communications provided with the UKL TMDL spreadsheet model indicate that a bi-weekly distribution of TP at the outflow of UKL was used to calculate T1BSR boundary conditions. The Revised Draft TMDL also indicates that these TP values for determining the T1BSR boundary conditions were based solely on one year (1995). Annual mean TP concentrations in UKL outflow for each of the seven years of these UKL simulations (Walker 2001) spanning 1992-1998 are shown in Figure C2 below. These concentrations are based on an assumed 40 percent reduction of external phosphorus load into UKL as per the UKL TMDL. As shown in the figure, the year chosen is the second lowest of the seven years. Annual mean TP for 1995 is only about 60 percent of the seven-year mean TP concentrations upon which the UKL TMDL was established.

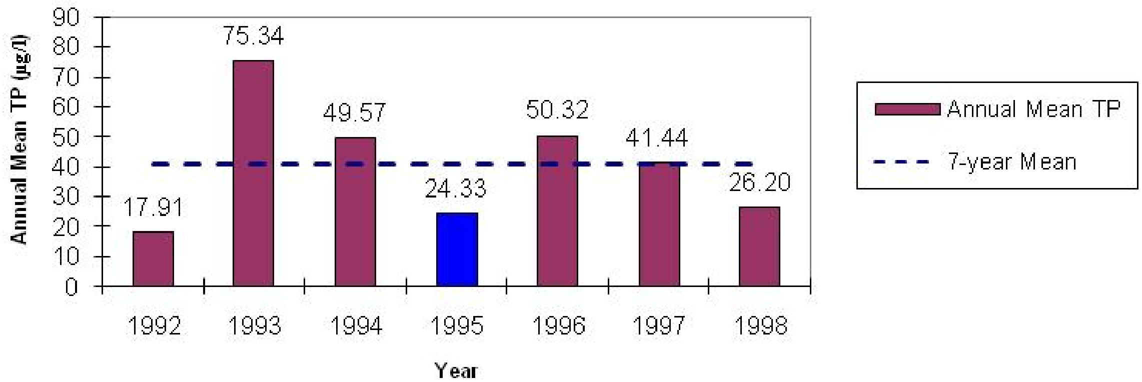

Figure C2: UKL model results of annual mean TP from 1992 to 1998. These annual mean TP concentrations in UKL outflow are based on an assumed 40 percent reduction of external phosphorus load into UKL. The blue dashed line indicates the 7-year mean TP, which is about 41 µg/l. The annual mean TP for 1995, which was the year used to formulate boundary conditions for T1BSR, is only 60 percent of this 7-year mean.

The Revised Draft TMDL claims that 1995 simulation results were used to create the boundary conditions for T1BSR because it represents the "median" conditions (Appendix 7, page 1). However, as mentioned above, the 1995 phosphorus concentrations are the second lowest of the 7-year period between 1992 and 1998. As such, 1995 is clearly not a representative condition. This is an important element in the UKL TMDL – there are times when the in-lake target will be met, but not in all years. Further, by selecting only a single year, natural variability from year to year is effectively unrepresented.

Historical data for TP loads in UKL outflow from 1992 through 1998 shows that 1995 is close to the median – although 1993 is the actual median year (see Figure C3 below). The 1995 scenario may have been chosen based on the historical data, but to do so would mean that historical data should also be used to create the boundary conditions for the Klamath River model, which would result in higher levels of water quality impairments for inputs to the model.

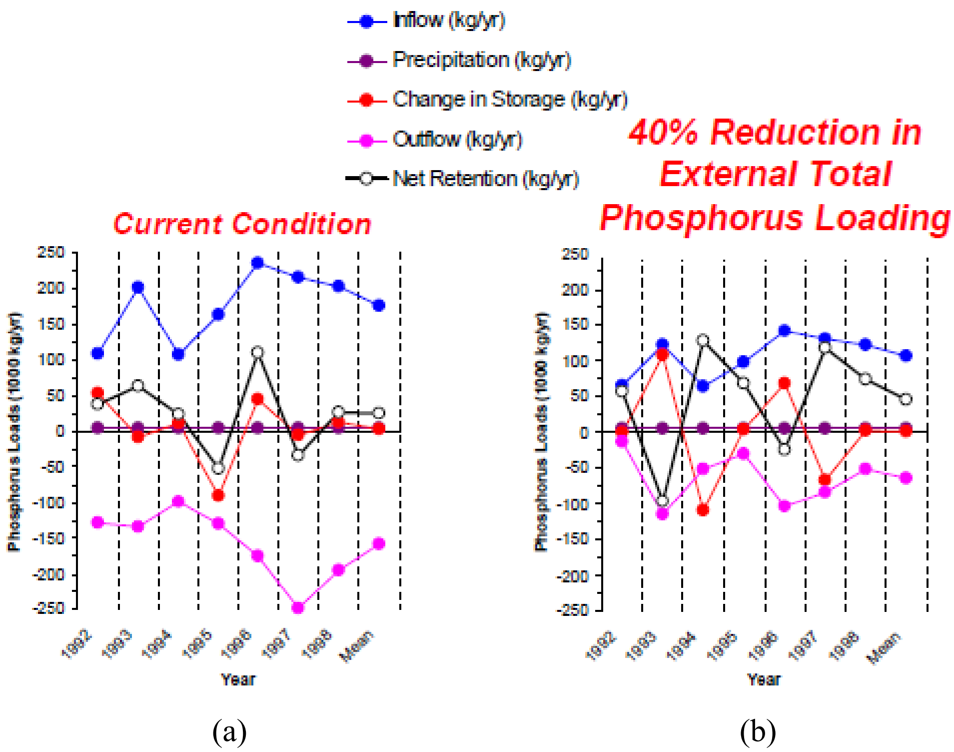

Figure C3. Link Dam phosphorous loads for (a) "current condition," and (b) the simulated phosphorus values based on the 40 percent reduction in external phosphorus loading as stipulated in the UKL TMDL. (Source: ODEQ, 2002)

Unexplained Discrepancies with Boundary Conditions from the June 2009 TMDL Draft Release

In addition to the above inconsistencies with the UKL TMDL, which the T1BSR boundary conditions at Link River were supposedly based on, changes were also made to the numbers between the original Draft TMDL and the Revised Draft TMDL. Specifically, organic matter and algae boundary conditions at Link River have been significantly changed.

In the previous public review comment period, PacifiCorp noted that boundary condition concentrations for nutrients were unrealistically low, thus making the downstream allocations and numeric targets unattainable. In the Revised Draft TMDL, changes were made to these boundary conditions without full explanation. Some of the details behind these changes were discovered upon examination of the spreadsheet used to create the Link River boundary conditions, which was provided by the Regional Board (and Tetra Tech) during the review period (January 19, 2010). Although review time was limited, several areas of concern were identified and are discussed below.

An important change is that, although nutrients remained at the same low levels identified in the original Draft TMDL, organic matter and algae concentrations were modified considerably. During peak growth periods, algae concentrations were increased by approximately 60 percent of the values used in the original Draft TMDL (see Figure C4 below). Concomitantly, organic matter reductions ranged from approximately 30 to 99 percent.

One unrealistic outcome of the assumptions made in creating the Link River boundary conditions is that organic matter is set to a negligible concentration during summer and early fall periods when concentrations are typically at annual maxima (see Figure C5 below) – a dramatic shift in assumptions occurred between the June and December TMDL draft. This has a direct effect on downstream nutrient concentrations because setting organic matter low removes a primary source of nutrients from the system. Overall total organic matter (organic matter plus living algae) was reduced between the June and December draft documents by up to 35 percent, or approximately 2.25 mg/l. Based on stoichiometry, associated reductions in nitrogen and phosphorus are approximately 0.15 mg/l and 0.012 mg/l, respectively. The magnitude of these concentrations are important to consider because they are roughly 50 percent of the Stateline total nitrogen and total phosphorus monthly allocations presented in Chapter 5 of the TMDL for summer periods. Overall, no explanations were given for this significant discrepancy between the June draft TMDL and December draft TMDL modifications.

Problematic Assumptions in Creating Boundary Conditions

As noted above, assumptions made in the determination of boundary conditions at Link Dam directly affect model results. The Revised Draft TMDL states that "average ratios…were calculated based on Pelican Marina, UKL monitoring data…(with a sample size of n=15)" (Appendix 7). These ratios were then used to generate the boundary conditions based on TP numbers from the implementation of the UKL TMDL. For example, an average ratio of 0.245 was calculated, based on a partial year of data, for soluble reactive phosphorus to total phosphorus ratio (SRP:TP). This ratio was then assumed to apply throughout the year. Following that estimation, SRP boundary conditions could be calculated as 24.5 percent of TP values based on the simulated UKL TMDL model results. However, the ratio of inorganic to total phosphorous is not constant across seasons (under existing conditions), nor would it be expected to remain constant under the posited trophic shifts (Wetzel, 2001), which are implicitly acknowledged in the Revised Draft TMDL as necessary to meet nutrient targets in California under compliance scenarios. Further, recent studies from USGS have shown that these pertinent ratios vary seasonally during any given year (Sullivan et al, 2008; Sullivan et al, 2009). During periods of algae bloom, the amounts of SRP in relation to TP may be very low due to uptake by primary production. Following a bloom crash and subsequent senescence, the inverse may occur.

Disregard for such seasonal variations in the nutrient ratios (not only the SRP:TP relationship, but all the other ratios which build upon this single ratio) is evident in the Tetra Tech spreadsheet that was used to create the Link River boundary conditions from the UKL TMDL model output: an analyst comment acknowledges that negative concentration can occur based on this assumption of a constant ratio. To circumvent this problem, an artificial minimum (the smallest calculated positive number, which is 0.239) is placed on the organic phosphorus whenever a negative concentration is calculated. This does not allow the mass balance to be closed at Link Dam, i.e., the loading determined based on the UKL Model is not equivalent to the loading into Link River in the draft Klamath River TMDL. Further, no explanation was given as to why 0.239 was chosen as the minimum for organic phosphorus calculations.

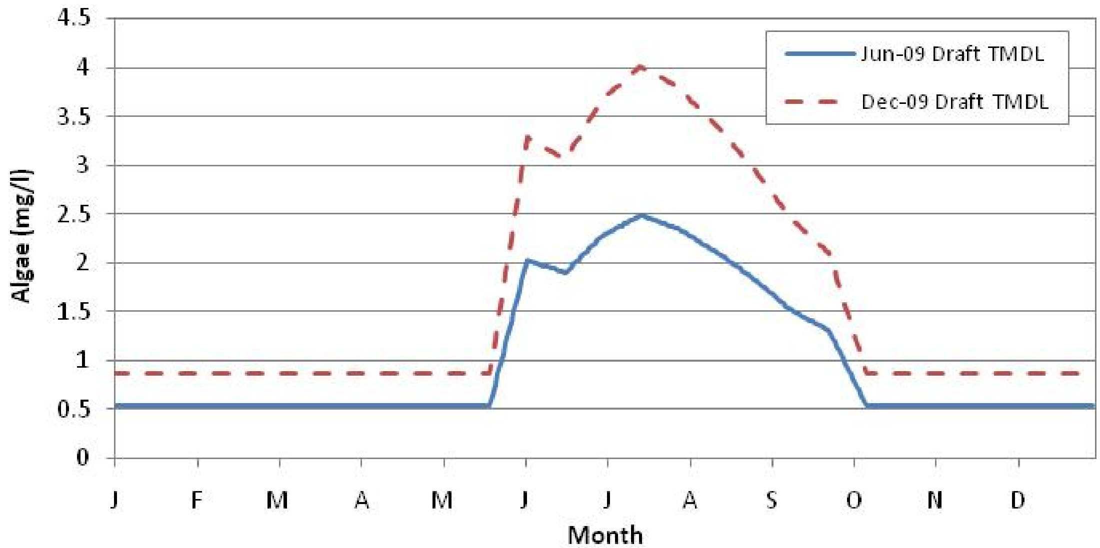

Figure C4. The difference in algae boundary conditions at Link River between the original Draft TMDL (June 2009) and the Revised Draft TMDL (December 2009).

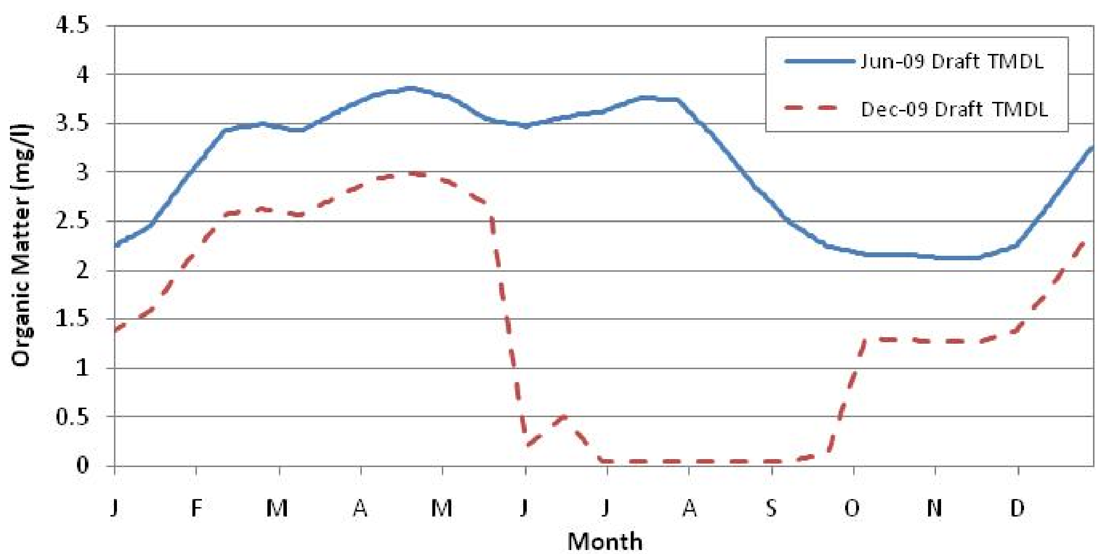

Figure C5. The difference in organic matter boundary conditions at Link River between the original Draft TMDL (June 2009) and the Revised Draft TMDL (December 2009).

In addition, the average ratios developed using historical data were based on impaired conditions at UKL. Hypoxia and sediment nutrient flux loading that occurs under current conditions, coupled with extensive nitrogen-fixing cyanobacteria (Kuwabara, et al, 2009), produce conditions that are inconsistent with a scenario in which UKL TMDL targets are implemented, i.e., low nutrients. Water chemistry that is fully compliant with the UKL TMDL would almost certainly lead to different SRP:TP, NO3:TN and NH4:TN ratios, and also different temporal distribution of such ratios. The attainment of the UKL TMDL also suggests that DO levels will no longer be adverse, i.e., anoxia and associated chemical processes will be absent (ODEQ 2002). Further, without anoxia, the ratio of NH4:NO3 would not be as high as depicted in the Tetra Tech spreadsheet, which is 9.4, because there would be more oxygen for the conversion of ammonia to nitrate – in theory ammonia would largely be absent. As such, the approach of applying these ratios (calculated from samples taken in impaired conditions) on simulated TP values (based on implementation of UKL TMDL) is incorrect and inappropriate.

Further, low nutrient values in the UKL TMDL "natural" conditions baseline seem untenable in the context of current conditions at UKL. UKL is commonly classified as hypereutrophic because of its high primary production rates and impaired water quality conditions. Nevertheless, the SRP values (peak ~ 0.006 mg/l) calculated from the UKL TMDL outflow TP, as well as nitrate and ammonia and associated chlorophyll *a* values, presented in Tetra Tech's "natural" boundary conditions spreadsheet suggest that UKL would be classified as mesotrophic to oligotrophic (SFPUC, 2002 and Wetzel, 2002). In fact the orthophosphate and nitrate boundary conditions used for the Link River model input are below reporting limits for production laboratories. That is, current available methods cannot reproducibly measure values this low. Finally, shifting Upper Klamath Lake from the current hypereutrophic state to mesotrophic would not only be a monumental challenge, but would also shift the lake to a lower trophic status than what existed naturally (Eilers et al, 2004).

Implications of Altering Link Dam Boundary Conditions to Keno Reservoir Water Quality

To assess the implications of altering "natural" boundary conditions at Link Dam and changing conditions in Keno Reservoir, conditions under the "natural" baseline were examined at Keno. Examining conditions at Keno provides an opportunity to look at what water quality conditions would be at the head of the riverine sections of the Klamath River. This approach also lends insight into the critical role that Keno Reservoir plays in downstream water quality. This approach further illustrates that the Keno Reservoir model is one of the most sensitive elements in the entire Klamath River modeling framework, wherein modest modification of boundary conditions and model parameters can have profound impacts on simulated downstream water quality.

<u>Conditions at Keno Dam – "Natural" Conditions</u>: After considering the low loading conditions at the Link Dam boundary conditions, the 10 percent/90 percent partitioning (see comments on Appendix 6) of particulate/dissolved labile organic matter under the "natural" baseline scenario, and the potential implications of increased settling rates in the Keno Reservoir reach, an examination of the TMDL model output at Keno Dam for "natural" baseline was completed using models provided by the Regional Board. Results from the original Draft TMDL and the Revised Draft TMDL were compared to determine the implications of the aforementioned modifications in model boundary conditions and specifications between the two draft documents. The findings illustrated the following:

- The re-partitioning of labile organic matter, coupled with increased settling, and reduction of total organic matter at Link Dam, reduced labile particulate matter at Keno Dam compared to the original Draft TMDL. LPOM is reduced in the range of 70 to 90 percent, as shown in Figure C6 below.

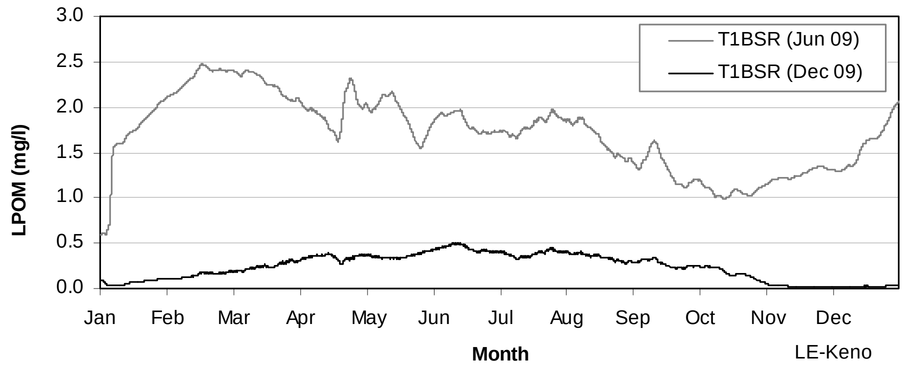

Figure C6. Labile particulate organic matter (LPOM) at Keno Dam (2000) for "natural" conditions model simulations in the original Draft TMDL (June 2009) and the Revised Draft TMDL (December 2009).

- The modified boundary condition at Link Dam employs very low seasonal organic matter (with annual lows in the late spring and summer), which results in very low labile dissolved organic matter in the summer compared to the original Draft TMDL. Typically, seasonal maxima occur during summer months; however under the current TMDL assumptions, seasonal minima occur in the summer months with values well under 0.5 mg/l, as shown in Figure C7 below.

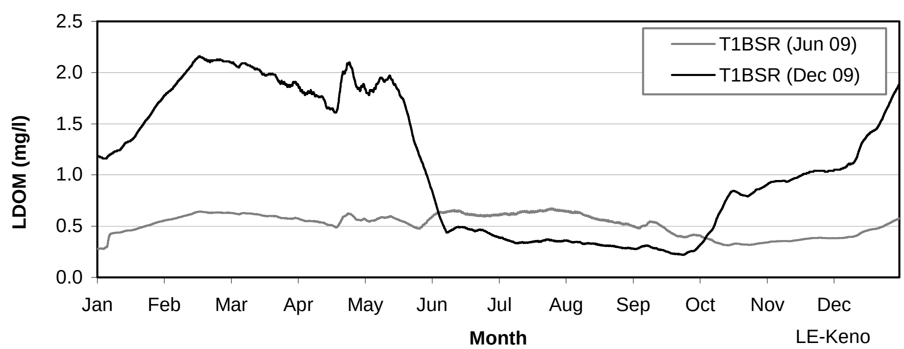

Figure C7. Labile dissolved organic matter (LDOM) at Keno Dam (2000) for "natural" conditions model simulations in the original Draft TMDL (June 2009) and the Revised Draft TMDL (December 2009).

- Phytoplankton at Keno Dam are also considerably lower in the Revised Draft TMDL than in the original Draft TMDL. Due to the changes in boundary OM concentrations and partitioning, an unusual algae dynamic in the Lake Ewauna-Keno reach is developed, as shown in Figure C8 below. Instead of a summer bloom period, there is a spring bloom and the algal standing crop actually diminishes through the late spring and summer period, suggesting nutrient limitation.

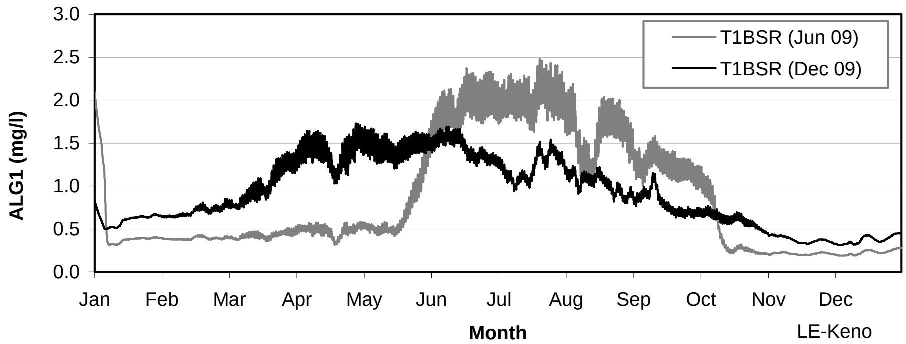

Figure C8. Phytoplankton (ALG1 – healthy) at Keno Dam (2000) for "natural" conditions model simulations in the original Draft TMDL (June 2009) and the Revised Draft TMDL (December 2009).

- Examining inorganic nitrogen and phosphorus indicates that the Revised Draft TMDL modeling assumptions produce extreme nutrient limitation by mid-June. Total inorganic P and N values, depicted in Figure C9 and Figure C10 below are on the order of 0.001 mg/l continuously for 4 months from late spring to early fall. This is an extremely low level of inorganic nutrients for an extended period of time in the typical growth season of algae (long days, warm temperatures), but algal standing crop is not high. This further illustrates the usefulness of examining both total and inorganic forms in regulatory assessments.
- PacifiCorp's previous comments on the original Draft TMDL noted low nutrient values, and the Revised Draft TMDL values are even lower, remarkably lower for all summer months and a good portion of the fall. The total organic (particulate and dissolved) load at Keno Dam is less than 1 mg/l for much of the same period, as is algae concentration.
- Why such changes were made between the original Draft TMDL and Revised Draft TMDL is not documented. Regardless, this level of reduction in everything (nutrients, algae, organic matter) is infeasible given local geology and natural eutrophic conditions at UKL. The water quality results at Keno Dam under the Revised Draft TMDL "natural" conditions simulation are unrealistic, suggesting that the model assumptions for "natural" conditions and possibly existing conditions are unrealistic. Given these extraordinarily low concentrations at Keno Dam, the implications downstream are clear: the current "natural" conditions model removes almost all nutrients and sources of nutrients by the time waters reach Keno Dam. As a result, the principal nutrient source downstream is the springs below J.C. Boyle Dam.

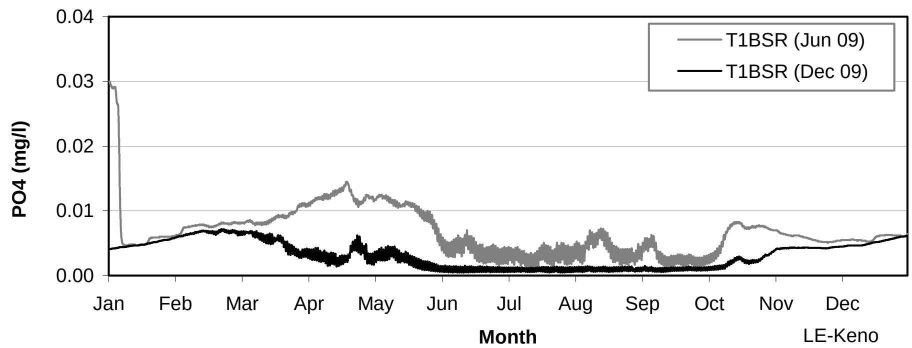

Figure C9. Orthophosphate (PO4), or total inorganic phosphorus, at Keno Dam (2000) for "natural" conditions model simulations in the original Draft TMDL (June 2009) and the Revised Draft TMDL (December 2009).

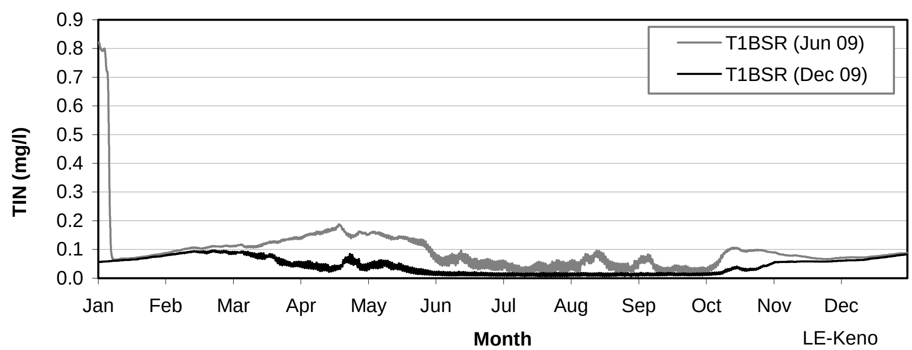

Figure C10. Total inorganic nitrogen (TIN) at Keno Dam (2000) for "natural" conditions model simulations in the original Draft TMDL (June 2009) and the Revised Draft TMDL (December 2009).

Downstream Effects of Realistic Boundary Conditions at Link Dam

The preceding discussions have shown how conditions assumed to represent the "natural" state of the river are unrealistically optimistic, and they are based on assumptions of water quality in Upper Klamath Lake that are unachievable. These assumptions affect all aspects of TMDL target assignments and load allocations. Perhaps most importantly, the TMDL does not address Klamath River water quality if dams are removed but water quality targets have not been achieved for the UKL TMDL or the Klamath River TMDL. Until UKL TMDL compliance is met, the quality of water from Upper Klamath Lake will be poor and contain high concentrations of nutrients and organic matter. Without dams, this condition will translate directly downstream and could potentially have significant impacts on dissolved oxygen concentrations and fisheries health throughout the river and into the estuary. This requires careful consideration as potential dam removal is considered.

"Natural" Conditions in the Klamath River TMDL: The Revised Draft TMDL emphasizes the dominating influence of UKL water quality on the entire river down to the estuary. However, this influence is never fully explored in the draft document. The TMDL does not consider effects of UKL water quality on its "natural" baseline scenario. Instead, under the TMDL "natural" condition (with dams removed), a single set of boundary conditions is applied to Link River based on the UKL TMDL (ODEQ 2002) with the assumption that compliance with the UKL TMDL will occur before dams are removed. The TMDL does not consider the possibility of a "natural" river system with non-compliant water quality in Upper Klamath Lake or in Oregon at Stateline. Given the magnitude of the difference between existing conditions and UKL TMDL-compliant conditions, a logical assessment would include, at a minimum, a transitional reduction in loading conditions at Link Dam to assess intermediate conditions en route to compliance. No such analyses were presented in the draft TMDL. Further, although the Revised Draft TMDL states in Response T13 (page 25-26, Appendix 8) that "based on TMDL modeling analysis, the TMDL allocations and targets would be achieved should the dams be decommissioned," such an analysis was not presented in the draft TMDL (and under such a massive modification to the river, the TMDL would likely need revisiting).

The Revised Draft TMDL assumes that Upper Klamath Lake will be compliant with the UKL TMDL by the time dams are removed. The magnitude of this assumption is illustrated in the difference between Revised Draft TMDL's assumed "natural" water quality (i.e. UKL TMDL-compliant) and existing water quality at Link River, the headwaters of the Klamath River. This difference is shown for total nitrogen (TN) and total phosphorus (TP) in Figure C11 and Figure C12, respectively (below). These figures are derived from data that comes directly from Klamath River TMDL "natural" baseline and "existing conditions" simulations.

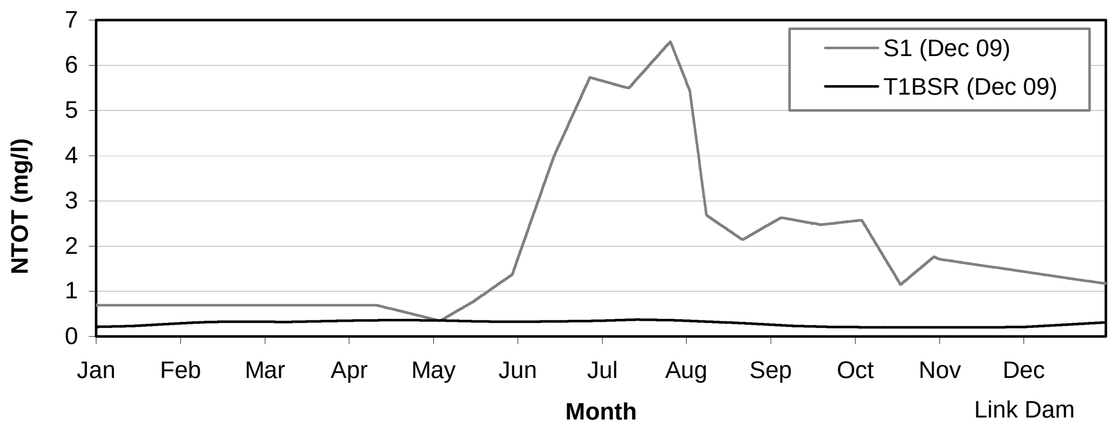

Figure C11: Total nitrogen at Link River under Revised Draft TMDL existing conditions (S1) and TMDL "natural" baseline scenario (T1BSR)

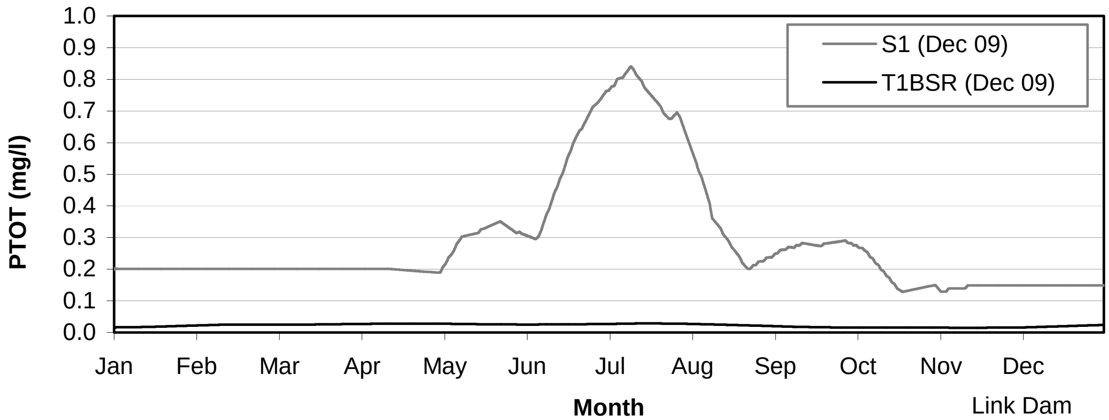

Figure C12: Total phosphorus at Link River under Revised Draft TMDL existing conditions (S1) and TMDL "natural" baseline scenario (T1BSR)

As described in the Revised Draft TMDL, and shown in the figures for TP and TN, assumed "natural" conditions (simulation T1BSR) are dramatic improvements over existing water quality conditions at Link River (simulation S1). Assumed "natural" total nitrogen (TN) concentrations can be more than 18 times less than existing concentrations, and "natural" total phosphorus (TP) concentrations can be more than 25 times less than existing conditions at Link River. Significantly, the difference is most extreme during months of summer water quality impairment, a "critical" time in the TMDL, when nutrient concentrations typically reach their annual peak. This natural and historic summer peak, reflected in monitoring data, is not reflected in the T1BSR simulation. The figures illustrate the large effort that will be required to achieve water quality compliance at Upper Klamath Lake. Because Upper Klamath Lake is a naturally eutrophic system, water quality compliance in the lake will not be achieved quickly, and likely not at all.

Modified "Natural" Conditions: If Upper Klamath Lake or conditions at Stateline are not in compliance when dams are removed, water quality in the Klamath River will be notably different than that described in the Revised Draft TMDL. A modified "natural" baseline scenario, with dams out, is needed to evaluate these conditions. The dams-out scenario presented here represents a TMDL "natural" simulation modified by likely interim boundary conditions at Link River and is therefore referred to as C-T1BSR. Results of this simulation demonstrate the importance of using realistic boundary conditions in TMDL development. They also illustrate the likely water quality of the Klamath River after dams are removed – as early as 2020 – and that Revised Draft TMDL allocations and targets will *not* be achieved should the dams be decommissioned prior to compliance in Oregon.

This modified "natural" simulation uses the Revised Draft TMDL model configured in all respects as it was for the original Draft TMDL except that, instead of UKL TMDL-compliant water quality at the headwaters, the Revised Draft TMDL's "existing conditions" (S1) water quality at UKL is applied at the headwaters. The simulation represents "natural" conditions with the added assumption that UKL TMDL compliance will not be achieved by the time dams are removed, i.e., water quality from UKL will be essentially unchanged from existing conditions.

Key components of the modified "natural" conditions baseline scenario (C-T1BSR) are:

- Klamath River and tributaries configured as in the TMDL "natural" baseline conditions including,
  - representation of the river with no dams, except Link Dam
  - absence of all point sources
  - Lost River Diversion Canal (LRDC) and Klamath Straights Drain (KSD) represented using existing conditions flow, but water quality set equal to UKL conditions
- Upper Klamath Lake (UKL) and all tributary boundary conditions based on TMDL *existing conditions*

Comparing results from RWQCB's assumed "natural" conditions (T1BSR) and C-T1BSR, it is clear that poor water quality in Upper Klamath Lake is directly translated downstream under any "natural" conditions configuration. If Upper Klamath Lake is not in compliance when dams are removed, water quality will be markedly worse than portrayed in the Revised Draft TMDL under full compliance conditions. Total nitrogen concentrations (NTOT) at three locations along the Klamath River from both the T1BSR and C- T1BSR simulations are shown in Figure C13 through Figure C15. Locations include the Link dam boundary, below Keno dam, and below Iron Gate dam (node 757 on the Keno-IG reach). Total phosphorus concentrations (PTOT) at these three locations from both the T1BSR and C- T1BSR simulations are shown in Figure C16 through Figure C18. The "natural" simulation with modified boundary conditions (C-T1BSR) shows significantly more total nitrogen and total phosphorus at all locations than the Revised Draft TMDL simulation (T1BSR).

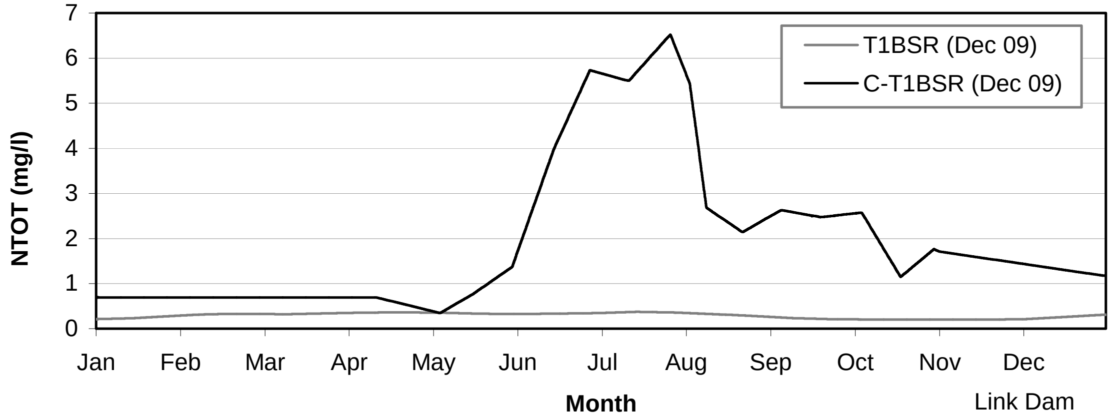

Figure C13: Total nitrogen below Link dam under Revised Draft TMDL "natural" baseline scenario (T1BSR) and under the modified "natural" baseline scenario (C-T1BSR)

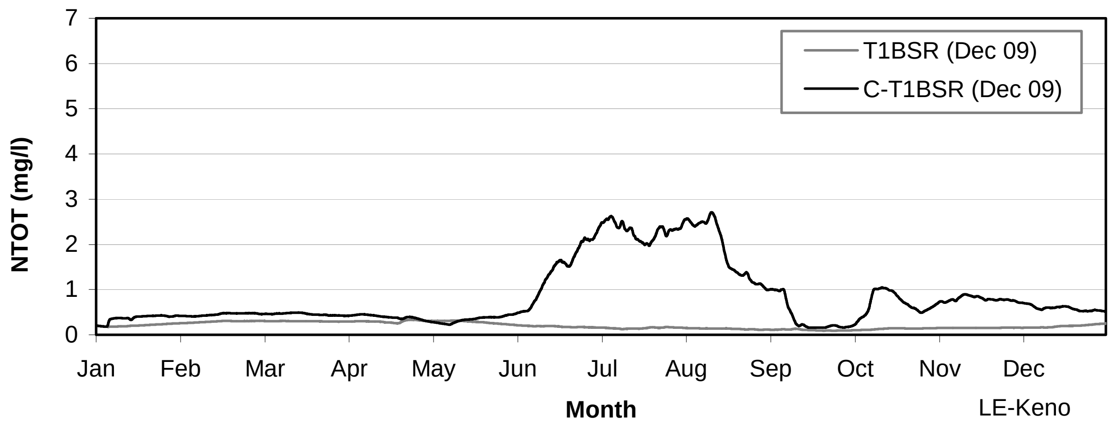

Figure C14: Total nitrogen below Keno dam under Revised Draft TMDL "natural" baseline scenario (T1BSR) and under the modified "natural" baseline scenario (C-T1BSR)

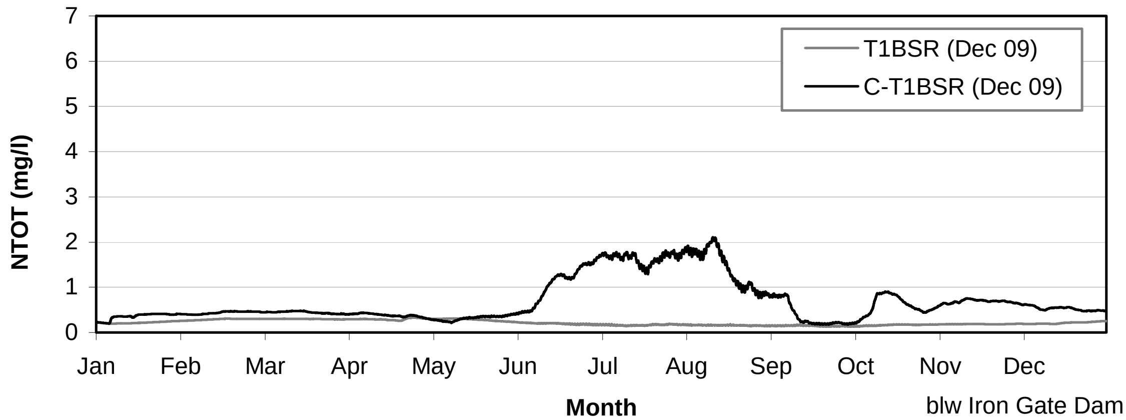

Figure C15: Total nitrogen below Iron Gate dam under Revised Draft TMDL "natural" baseline scenario (T1BSR) and under the modified "natural" baseline scenario (C-T1BSR)

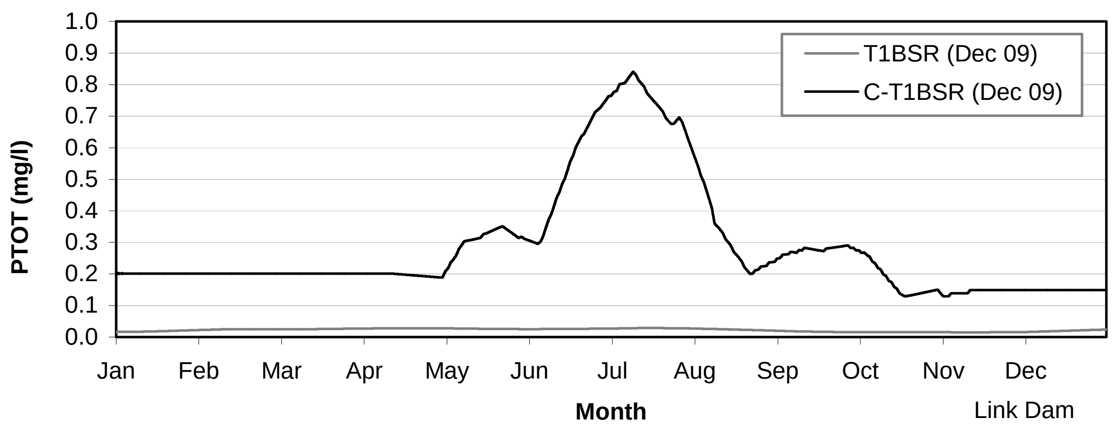

Figure C16: Total phosphorus below Link dam under Revised Draft TMDL "natural" baseline scenario (T1BSR) and under the modified "natural" baseline scenario (C-T1BSR)

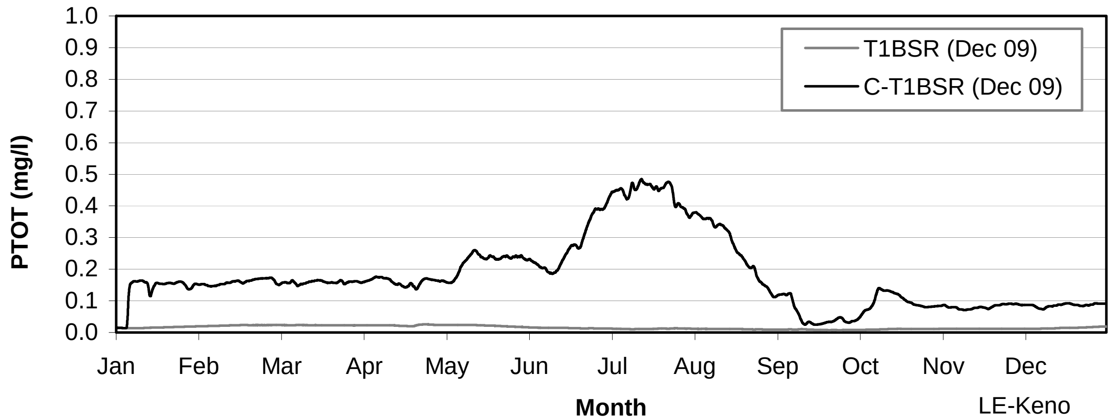

Figure C17: Total phosphorus below Keno dam under Revised Draft TMDL "natural" baseline scenario (T1BSR) and under the modified "natural" baseline scenario (C-T1BSR)

Figure C18: Total phosphorus below Iron Gate dam under Revised Draft TMDL "natural" baseline scenario (T1BSR) and under the modified "natural" baseline scenario (C-T1BSR)

The Revised Draft TMDL's "natural" baseline simulation (T1BSR) was the basis for setting targets and allocations. This simple comparison suggests that the Klamath River will be far from compliance if dams are removed before Oregon is in complete compliance. Clearly, reasonable assumptions about upstream boundary conditions can significantly change "natural" baseline water quality all along the river and thereby require alterations to water quality target and load allocations prior to full compliance in Oregon.

<u>Conclusion</u>: As demonstrated by the Revised Draft TMDL models, dams along the Klamath River can significantly influence water quality. With the quality of water from Upper Klamath Lake as it is now, and as long as water quality from UKL is poor, existing dams can have clear beneficial effects on the Klamath River by reducing nutrients and organic matter. Given the significant influence that Upper Klamath Lake has on water quality downstream, even reasonable progress towards TMDL compliance in Upper Klamath Lake – progress that likely will require several decades – will not be sufficient to meet water quality objectives in the

Klamath River downstream when dams are potentially removed and Oregon is not in water quality compliance. This condition is likely to exist at least for decades.

2. Specific Comment: Revised Draft TMDL Allocations above Copco Reservoir for California Compliance

Allocations of loads to Copco Reservoir are based upon simulations of California compliant conditions using the Klamath River Model. But, in allocating these loads, there appears to be confusion between TMDL modelers and regulators setting the allocations. There is a significant inconsistency between the negative load allocations assigned by regulators, technical documents supporting those allocations and the simulations as provided for public review. It appears that model results have been disregarded in setting negative load allocations upstream of Copco reservoir. In addition, the process for establishing negative loads above Copco reservoir is flawed in that it does not take into account studies describing the system as nitrogen limited. Modelers appear to lack familiarity with the Klamath River system and studies describing it.

Determining Negative Load Allocations Above Copco Reservoir

The process for determining negative load allocations above Copco reservoir is described in technical documentation appearing in Appendix 7, "Modeling Scenarios," of the Revised Draft TMDL. Modelers describe establishing a model simulating "California compliant" conditions with dams in place (T4BSRN). The conditions for this simulation assume compliance with Oregon TMDLs upstream of Stateline. In establishing allowable water quality below Stateline and just above Copco, modelers modified the simulated California compliant inflow conditions to Copco reservoir in an attempt to achieve a target summertime mean concentration for chlorophyll *a* of 10 µg/L within the reservoir. As described in the technical documentation, they set incoming algae concentrations to the equivalent of this target, a constant 0.67 mg/L all year around. They then ran the simulation over and over again, iteratively reducing PO4 and non-algae organic matter (OM) until conditions in Copco met the chlorophyll *a* target. These are the conditions found in the California compliant TMDL simulation, CT4BSRN, and the basis for negative load allocations above Copco. The process is described in the TMDL as follows:

> "The chlorophyll-a concentration coming into Copco Reservoir was set at the target concentration of 10 µg/L, and the PO4 and OM were iteratively reduced until the summer mean chlorophyll-a concentration at the surface (1 m depth) in both Copco and Iron Gate Reservoirs at the location immediately upstream of the dams was equal to or below 10 µg/L. The scenario arrived at summer mean surface (1 m depth) chlorophyll-a concentrations of 9.8 µg/L for Copco and 6.7 µg/L for Iron Gate. The resulting PO4 and OM loads upstream of Copco Reservoir are 30 percent lower than those under the initially simulated T4BSRN condition." (Appendix 7, Page 21, Bullet Point 7)

In other words, the modelers disregarded simulated values of algae concentrations and, in establishing boundary conditions used to calculate load allocations, they simply set algae concentrations to 0.67 mg/l, the equivalent of chlorophyll *a* concentrations of 10 µg/L. This change has large consequences on simulated algae concentrations in Copco reservoir. The difference between initial T4BSRN simulated algae concentrations and concentrations used as inflow to the final allocation simulation, CT4BSRN, are shown in Figure C19.

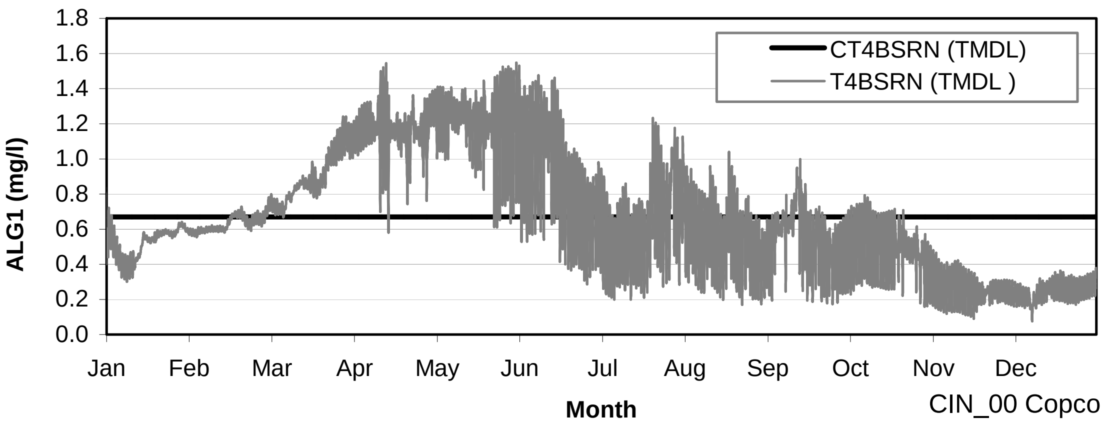

Figure C19. Chlorophyll a concentrations in Copco reservoir under California-compliant TMDL conditions. Values are taken from Revised Draft TMDL simulation CT4BSRN.

In the following sections, we describe several concerns with this approach including:

- TMDL technical documentation inconsistent with TMDL target
- Implicit condition of constant algae concentrations
- Non-representative conceptual model
- Unattainable targets
- Alternative approaches in setting allocations

TMDL target inconsistent with simulations

Upon review of the files associated with the California compliant TMDL simulation (CT4BSRN), we find a significant inconsistency between negative load allocations, technical documents supporting those allocations and the simulations as provided for public review. As presented in simulation files for the CT4BSRN scenario, results of this process do not actually result in compliance in Copco reservoir. It is not clear from TMDL documentation how "summer" is defined, so in checking values we used the common definition of "summer" as June 21-Sept 21. The CT4BSRN files, developed from the process described in technical documentation (see above), show a summer (June 21-Sept 21) mean chlor-a concentration of 10.3 µg/L. An alternate definition of "summer" as June 1-Sept 1 produced a summer mean of 10.6 µg/L. Neither of these summer means match the 9.8 µg/L referred to in TMDL technical documentation. Both are over the Revised Draft TMDL target value and, therefore, the Revised Draft TMDL would seem to result in non-compliance according to its own model results. Results from the CT4BSRN are illustrated in Figure C20.

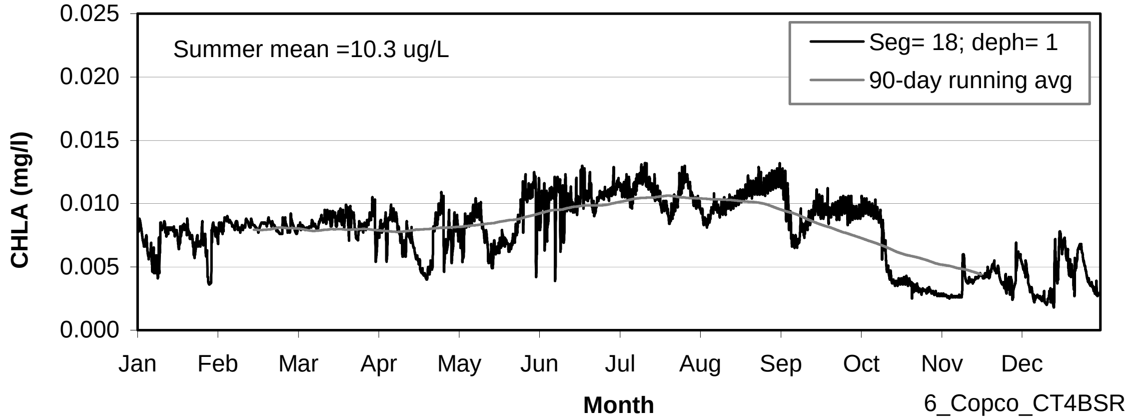

Figure C20. Chlorophyll a concentrations in Copco reservoir under California-compliant TMDL conditions. Values are taken from TMDL simulation CT4BSRN.

Upon further review, we find a different scenario referred to in the metadata associated with CT4BSRN simulation files (i.e., in the model files and not what is documented in the Revised Draft TMDL). This scenario calls for a 30 percent reduction in total phosphorus and would require that PO4, OM, and algae all be reduced by 30 percent. When this simulation is run exactly as the CT4BSRN simulation, the summer mean chlorophyll *a* concentration is 9.8 µg/L (June 21-Sept21), exactly as described in Revised Draft TMDL technical documents referenced above. Seemingly, the negative load allocation was actually based on this simulation, and not what was documented in the Revised Draft TMDL. Results for chlorophyll *a* concentrations from this simulation, called Scenario 3, are presented in Figure C21.

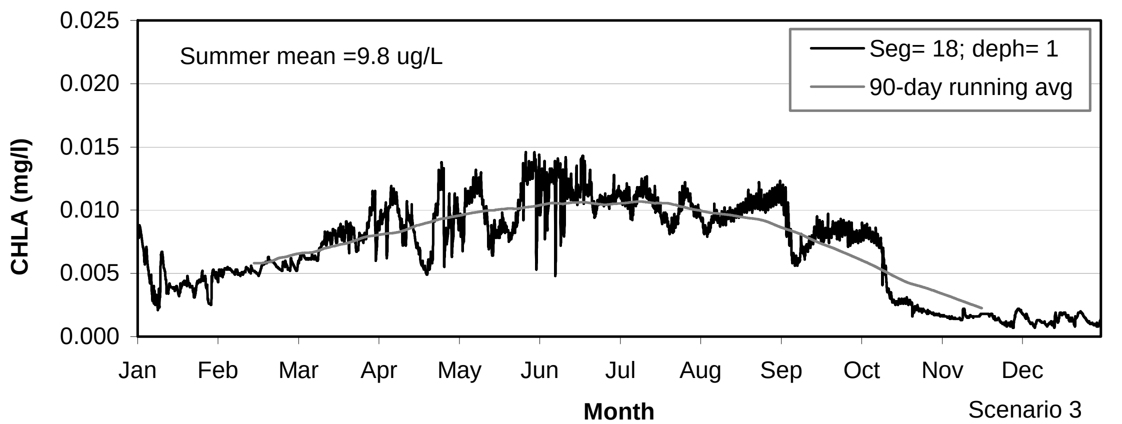

Figure C21. Chlorophyll a concentrations in Copco reservoir under California-compliant TMDL conditions modified to use a 30 percent reduction in simulated inflow algae concentration.

Finally, the Revised Draft TMDL has established a target for chlorophyll *a* somewhat arbitrarily and yet sticks to this specific number rigorously, and without exploring uncertainty around this value. A small change in this target has large implications on the negative load allocation above Copco. When the California compliance scenario (T4BSRN) is run without reducing nutrients, OM or algae (e.g., by 30 percent as noted above) into Copco, the summer (June 21-Sept 21) mean chlorophyll *a* concentration in Copco is 11.4 µg/L. Therefore, a small change in the target of little more than 1 µg/L, or even a change in the definition of "summer" to include May or September, could result in no negative load allocation above Copco. Chlorophyll *a* concentrations in Copco under this scenario, Scenario 1, corresponding to no negative load allocations above Copco, are presented in Figure C22.

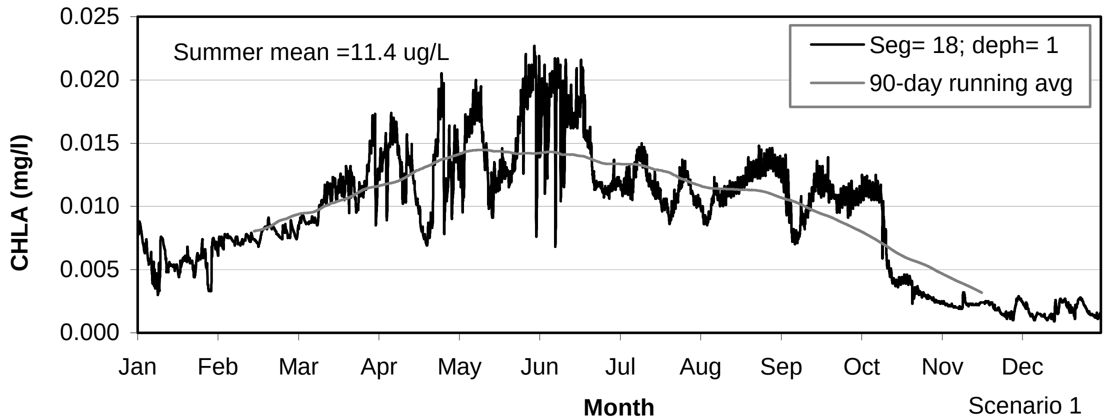

Figure C22. Chlorophyll a concentrations in Copco reservoir under California-compliant TMDL conditions with no negative load allocation above Copco.

Implicit condition of constant algae concentrations

While it seems sensible to establish allocations by iteratively reducing nutrients in simulations of Copco and Iron Gate reservoirs, it does not make sense to change simulated algae concentrations to a constant value. Concentrations of algae in the river have a predictable annual cycle that is reflected in both field studies and in model simulations. This annual cycle is an important part of reservoir algae dynamics. But in these simulations, modelers have ignored the variability in algae concentration – a variability that is carefully preserved from the Upper Klamath Lake boundary to Stateline. Instead, algae concentrations in the inflow to Copco reservoir are set to a constant value throughout the year. This condition, an implicit requirement of the Revised Draft TMDL in the California compliance scenario, has no basis in the realities of natural systems and can never be met in the field. Because simulation results have been discarded, this seems to be more like "gaming" than "simulating" water quality for decision support, and is not appropriate for setting regulatory criteria.

Unrepresentative conceptual model

The approach used in the Revised Draft TMDL to establish nutrient targets above Copco reservoir is inconsistent with the nature of algae dynamics in the Klamath River system. In the Revised Draft TMDL, negative nutrient allocations above Copco reservoir are set by controlling phosphorus, under the assumption that the system is phosphorus limited. In fact, studies have shown that the system is not phosphorus limited, but nitrogen limited. Further, looking at Revised Draft TMDL model output between Stateline and Iron Gate Dam indicates that even under the extreme low nutrient conditions presented, nitrogen concentrations decrease in the downstream direction in summer months, while phosphorus remains relatively constant.

If the river system is nitrogen limited, a more efficient and direct way to control algae (and chlorophyll *a*) concentrations would be to reduce total nitrogen or both nutrients, not solely total phosphorus, into Copco reservoir.

Unattainable targets

The Revised Draft TMDL explicitly calls for a 30 percent reduction in PO4 and non-algal OM, along with an implicit condition that algae concentrations entering Copco reservoir must remain constant at 0.67 mg/L throughout the year. First, this implicit condition on algae needs to be clearly stated in the Revised Draft TMDL, and it should be recognized as unattainable. Furthermore, removal of 30 percent of PO4 and organic matter, when influent concentrations are already so low in the compliance scenario, is unachievable. Even if an assumption of a 30 percent reduction of PO4, organic matter, and algae is made, such a condition could not be realized. The constituents in question are certainly inter-related, but are not necessarily so in a linear fashion. (Further, the influent concentration of simulated algae from upstream, even under a 30 percent reduction in the signal, exceeds 10ug/l criteria for considerable periods of the year.)

Alternative approaches in setting allocations

Instead of promulgating unattainable conditions, the Revised Draft TMDL should explore alternative approaches to meeting targets. One approach may be to simply re-evaluate the target, as in the case of chlorophyll *a*, mentioned above. Another approach is to consider the dynamics of algae growth. The approach used in the Revised Draft TMDL fails to recognize that algae problems are generally associated with the spring and summer months. Alternative scenarios could be evaluated in which nutrients are reduced only when needed (e.g., only in spring or summer months) to suppress nuisance algae growth. A third alternative to the approach used in the Revised Draft TMDL would include a sensitivity analysis on settling rates in Copco. Field studies suggest a range of values not represented in the Revised Draft TMDL that would effectively lower simulated chlorophyll *a* concentrations. A fourth alternative would be to model multiple algae groups in reservoirs. Currently, all inflowing algae is assumed to contribute to harmful BGA. However, the Revised Draft TMDL identifies that little harmful BGA is found in the inflowing waters to Copco. All algae is assumed to be toxin producing, when under low nutrient concentrations, other species may make up a considerable fraction. These alternatives would likely result in more reasonable load allocations above Copco reservoir.

Summary

The Revised Draft TMDL's negative load allocations above Copco reservoir are ill-conceived and poorly developed. Revised Draft TMDL targets, technical documentation and simulation results provided for public review are in disagreement. We note that a small change in the target summer mean chlorophyll *a* concentration could have significant effects on load allocations. Increasing the target by a little more than 1 µg/L may result in no negative load allocation above Copco. In setting algae concentrations constant, the modelers for the Revised Draft TMDL are ignoring standard modeling practice and establishing a condition that is unrealistic and impossible to attain. Without explicitly saying so, they have turned a simulation based on a peer-reviewed model into a "gaming" exercise. Also, because the system is likely nitrogen-limited, controlling phosphorus as is done in the Revised Draft TMDL is an inefficient approach to controlling algae in Copco reservoir. Finally, as discussed above, the Revised Draft TMDL's negative load allocation is unattainable.

3. Other Comments

Page 1, last paragraph. The 1995 median condition does not represent the median conditions from the TMDL, as noted above. Also, there is no discussion about the variability around this median – which is critical to meeting water quality targets. For all years where conditions exceed the median conditions (50 percent by definition), there is a chance for non-compliance. The frequency of acceptable non-compliance is not defined or explored.

Page 2, 2nd major bullet point, lines 2-3. "All the point sources and derived accretion/depletion flows for flow balance in the existing model were removed. Over the course of the year, the accretion/depletion flows average to near zero, so they likely do not represent an ungaged groundwater input. On shorter time scales, the accretion flows can be significant enough to alter the instream concentrations depending on assumptions about their concentrations. Out of concern that the accretion flows might influence allocations to point and discrete nonpoint sources, they were removed in the scenarios."

By removing the A/D terms, the flow balance is no longer closed over short (e.g., daily) time periods.

Page 9 and onward. For a quantitative model to support a rigorous TMDL regulatory process, there is a lot of qualitative discussion regarding results. The Revised Draft TMDL could easily be written to describe how much less, or how significant, or the level something is diminished, etc. This language is qualitative, varies in definition for each reader (and author) and ill-defined for a technical TMDL: What is slightly higher? Higher than what? What is "smooth?" This language pervades the TMDL. While the general interpretation is appreciated, there is little quantitative basis for this discussion – information that could readily be pulled from the model results to indicate levels of concentration, magnitude of differences between the scenarios, and temporal changes at each location.

Page 9, bullet points. Throughout these descriptions there are indications of violations:

- "The 30-day minimum mean DO criterion of 6.5 mg/L is slightly violated at downstream locations…"
- "the Oregon 30-day DO criterion of 8.0 mg/L is violated at all locations…"
- "As for the 7-day DO criterion of 6.5 mg/L, it is only slightly violated at the upstream locations."
- "The simulated pH generally meets the Oregon criterion…"
- "The simulated pH, however, violates the California criterion of 8.5 consistently from upstream to downstream."
- "The chlorophyll *a* criterion of 15.0µg/L is violated at all locations upstream of the station D/S of Scott River due to the high concentration in the UKL boundary condition."

What are acceptable frequencies or percentages of exceedance? Does time of year matter? Is location important? Does the magnitude of deviation above or below a standard make a difference? For example on page 17 the Revised Draft TMDL states: "The predicted violations were deemed acceptable by RWQCB staff in the context of overall uncertainty." Uncertainty is not defined herein – data uncertainty, model formulation uncertainty, model calibration uncertainty, model boundary conditions uncertainty, uncertainty in setting/defining the criteria? This approach seems ambiguous at best and indefensible at worst. Specific criteria should be developed for violations definition.

Page 9, 4th bullet point. The Revised Draft TMDL states, "The chlorophyll *a* criterion of 15.0 μg/L is violated at all locations upstream…". Is this the same chlorophyll *a* criterion that is applied to Copco and Iron Gate Reservoirs? On page 20, the target for the Reservoirs is 10.0 μg/L.

Page 13, 1st bullet point. "The most sensitive location point source loading for pH compliance was just downstream of South Suburban WWTP. The most sensitive location for DO compliance was just downstream of Klamath Falls WWTP. It is suspected that the bathymetry of historic Lake Ewauna creates this sensitive location for DO because of deep, slow moving water."

Some kind of sensitivity analysis would have to be done in order to conclude that certain locations are more sensitive than others, but no details of sensitivity analyses were given anywhere in the Revised Draft TMDL. Further, this language suggests that the WWTPs had a role in local water quality. They may or they may not. River miles should be used to denote sensitivity in relation to constituents, unless specific actions (e.g., point discharges) are identified as playing a direct role. Throughout this page (the only page in the entire document where "sensitivity" is mentioned) it is confusing what is meant by "sensitive." Does it mean "variability?" What defines "sensitive" and "insensitive"?

Page 13, 2nd bullet point. "The most sensitive time period for point source loading was mid-September when flows from Link River were greatly reduced (170 cfs as opposed to a median 736 cfs). However, this flow is still greater than the 7Q10 of 94 cfs. This is also the period in which there was earlier than usual flow into the Klamath River from Lost River Diversion Channel."

The way sensitivity is apparently being used herein suggests that sensitivity would vary from year to year. Since the Revised Draft TMDL is based solely on one model year, i.e., 2000, there could potentially be other years where the sensitivity would deviate from 2000, in which case applicability of the Revised Draft TMDL would be questionable in other years.

Page 13, 3rd bullet point, line 1. "Once point source allocations were determined, the discrete nonpoint sources (KSD and LRDC) were analyzed…"

It is unclear why the point source and nonpoint source allocations were looked at in sequence. Would changes in one affect the other? Please provide discussion.

Page 21, 1st bullet point. Several points:

- "outlet draws water from both the surface and the bottom" – the outlet draws from the full depth, not just the bottom and top.

- "This might be caused by the longer retention time in J.C. Boyle Reservoir that causes a loss of PO4 and NO3 from algal uptake while the benthic source is insufficient to compensate for this loss." – Longer retention time than what? The Revised Draft TMDL identifies retention as of minor importance in Copco and Iron Gate Reservoir but suggests that it is an important mechanism in J.C. Boyle Reservoir.
- "NH4, however, appears to be slightly higher during the summer when J.C. Boyle Dam is present. This might be due to the benthic source." – J.C. Boyle does not experience persistent anoxia, so benthic sources of NH4 should be modest. Could this be coming from upstream?

Page 21, 2nd bullet point, lines 8-9. "The springs' concentrations are not significantly different from the upstream incoming concentration." This is incorrect according to the Revised Draft TMDL model files that indicated that the springs' concentration for PO4 is 0.066 mg/L throughout the year, whereas the PO4 coming out of J.C. Boyle dam has an average of 0.004 mg/L, and a peak of 0.009 mg/L (see Figure C23 below).

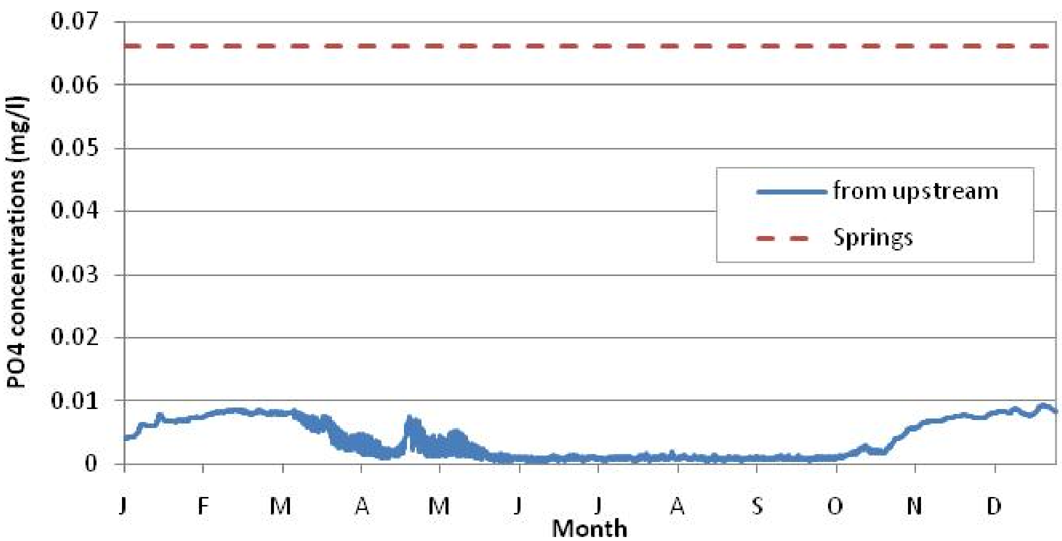

Figure C23. PO4 concentration of the flow coming out of J.C. Boyle Dam (upstream of springs) and the springs.

Appendix 8: Response to Peer Review Comments on Draft Klamath River TMDLs – December 23, 2009

Page 2, Response M1, Paragraph 1, Line 3-4. The response correctly identifies that the system is "naturally eutrophic." Further, under existing conditions the margin for error may in fact be modest. However, application of these models in the natural baseline and compliance scenarios where background concentrations are reduced to extremely low levels, margin for error increases dramatically.

Page 3, Comment M2, End of Paragraph 1. Is this 'lens' stable and dependable? This question is really not answered in the Regional Board staff response.

Page 3, Response M2, Paragraph 1. With regards to the thickness of the compliance lens, setting this thickness to "depth of the river under pre-disturbance regime" seems rather arbitrary; it seems to "feel good, natural, etc" but has no real basis in science or management. The minimum thickness should be whatever is required to maintain and assure stability.

Page 6, Comment C1, Paragraph 1. Dr. Characklis expresses concerns over the model's ability to predict values well. He recommends explicit treatment and discussion of uncertainty as part of the TMDL process. The response states that uncertainty was minimized in other ways, but there is no real presentation of information that provides confidence to the reader that uncertainty was effectively incorporated into the modeling and load allocations.

Page 6, Comment C1, Paragraph 1, Lines 12-15. "…reliance on deterministic modeling results without giving due attention to the levels of uncertainty attendant with these estimates can provide an incomplete picture to those seeking to interpret these analyses for decision making purposes." This seems to be what is happening with the natural conditions model. The model was set up with boundary conditions that are highly improbable, and this was confidently assumed without appropriate consideration.

Page 7, Comment C1, Paragraph 4. Dr. Characklis expresses concern about the limited data set used in these important simulations. His statement that "predictions based on water quality models, even the most advanced models parameterized with extensive data sets, are often highly divergent from observations…" is true and his concern about basing decisions on this model, calibrated with a limited data set and hardly validated at all, is valid. His other point is that relatively small deviations between current and natural scenario results are an inappropriate basis for load allocation and regulation. These small deviations, as noted elsewhere in our comments, are well within any inherent uncertainty and error in this model. We add our concern that, for this TMDL, the full model has only been applied to 1 year of observed conditions, and the model has basically been customized to fit that one year of data. Four years of models were available (2001-2004) to test this model over a considerably wider range of conditions.

Page 7, Comment C1, Paragraph 5. We agree that confidence intervals could have, and should have, been evaluated for this TMDL model. For instance, many years of climate data exist for the Klamath basin. Using a variety of existing historical climate conditions would yield a range of temperature responses for the river and provide a much better basis for decision making.

Page 7, Comment C1, Paragraph 6. We are agree with Dr. Characklis' suggestion of considering a joint modeling and monitoring approach. This implies working together with all entities in the basin, and their contractors, sharing data/files, models, and approaches and being transparent.

Page 8, Response C1, Paragraph 2-3. The Regional Board staff response here seems to dismiss Dr. Characklis' concerns about uncertainty and responds that uncertainty, even a good description of uncertainty, would take too much time and cost too much. We disagree with the Regional Board staff's response. Evaluation of uncertainty is necessary for a model to be useful, especially a complex model such as this one. In view of the time spent on "key best practices," and the importance of this TMDL, a description and good analysis of uncertainty should not be too much to expect and should not require significantly greater effort.

Page 8, Response C1, Paragraph 3, Line 6. Adjusting boundary conditions is not typically a part of normal calibration and doing so (i.e. calibrating by changing boundary conditions that are based on field observation) is questionable practice.

Page 9, Response C1, End of Paragraph 3. If the focus was on "acquiring and incorporating the most accurate and comprehensive data," why stop at one year (2000)? More years of data should have been incorporated into this model.

Page 9, Response C1, Paragraph 5. In making its case for not incorporating uncertainty analyses, the Regional Board staff exaggerates the difficulty of uncertainty analysis. "Interval number, fuzzy parameter, Monte Carlo, and Bayesian analyses" are not required. Further, "4 days of continuous simulation" are not required to run the Klamath models, at least not in an efficient manner. Sensitivity can be done in a systematic and limited manner, particularly with guidance from an experienced modeler who has performed calibration on the system. A straightforward and functional sensitivity analysis could be completed in a variety of ways, including:

- Identifying a subset of modeling parameters and boundary conditions to be tested (i.e., do not perform sensitivity on every single parameter),
- dividing the domain into sub-reaches for certain tests,
- running the model for shorter periods of time during critical periods of the year

Hundreds of scenarios are not required. At the very least a modest set of runs quantifying and bounding the uncertainty should be performed.

Page 10, Response C1, Paragraph 7. The Regional Water Board staff state their belief that "the TMDL models are performing well and are suitable tools for establishing Klamath River TMDL allocations and targets." In agreement with Dr. Characklis' comments, we do not see the basis for this belief. These models have not been completely documented. Nor has uncertainty been quantified in any significant way. At present, these models are inadequate to describe the Klamath River system in the detail required for this TMDL.

Page 10, Comment C2, Paragraph 1. We agree that the algae models, as applied in this TMDL, do not represent algal (chlorophyll *a*) response to nutrients well enough to form the basis for specific nutrient targets.

Page 11, Response C2, Paragraph 1. What is "modern" water quality modeling technology as opposed to "dated" water quality modeling technology? More importantly the statement that "algal biomass in riverine reaches is not related to nutrient concentrations" is misleading. For benthic algal growth this is very important. Further, these nutrients are of paramount importance for the lower river and, in particular, the estuary.

Page 11, Response C2, Paragraph 3. Calibration results are not predictions. Further, the response clearly states that Copco and Iron Gate reservoirs were not validated (or "corroborated" in Klamath River TMDL language). More importantly a simple graphic showing unquantified "increases" during summer and fall provide no quantitative or technical basis for load allocations, i.e., having "more" at one period than another hardly makes the model a useful tool for load allocations. A quantitative sensitivity and uncertainty analysis is required, with corresponding model performance metrics so decision makers have a clear grasp of the model and data capabilities.

Page 12, Response C3, Lines 4-8. How significant is this "release of dissolved inorganic nutrients into the water column"? What percentage of the total dissolved inorganic nutrients already in the water column is it? Also, there is no mention of settling that occurs in these reservoirs that would, in fact, trap some of these nutrients already in the water column and potentially reduce the downstream river from these nutrients. With free-flowing conditions, all the existing nutrients will simply be transported downstream, thus causing potential impairment in the lower river.

Page 13, Response C4. The response to comment C4 ignores that question completely. Dr. Characklis specifically voiced his concerns on how the temperature reductions in Copco and Iron Gate would be achieved. The response to the comment vaguely states the objective of getting the temperature of current condition water to natural conditions. For example, the Regional Board staff appears to ignore the practicality in the comment that temperature changes of 0.1 and 0.3 degrees C across Copco and Iron Gate reservoirs, respectively, are unachievable (let alone measurable). Instead, staff seems to assume that dams will have to be removed. These temperature targets are derived from a "natural conditions" scenario, but they are not necessary to protect beneficial uses.

Page 14, Response C5. Regional Board staff has devised a "compliance lens allocation" to protect fish. The comment is that this solution is conceptually interesting but untested and probably unsound. The Regional Board staff then responds that "how the allocation is met is ultimately the responsibility of PacifiCorp," but the definition of the compliance lens (the full length of the reservoir and the full width of the reservoir) is unattainable under a stratified condition because the thermocline is not coincident with the water surface (which defines the full length and width of the reservoir).

Page 14, Response C6. The response to climate change is inadequate. This is not a complicated analysis and is required for a TMDL with potentially long implementation timelines. The Upper Klamath Lake TMDL will take decades to implement and through this time notable climate changes may occur, increasing temperatures in an already compromised basin. Without a climate change assessment, realistic load allocations cannot be determined. Even a simple assessment can provide considerable insight (See Analysis F: Climate Change)

Page 17, Comment C10. Dr. Characklis states that the TMDL needs more data before it can accurately assess allocations. He states there is insufficient data to make any informed judgments. The response restates the section on climate change, but ignores Dr. Characklis' concerns on insufficient data.

Page 22, Response T6, Paragraph 1. The statement is made that the "temperature calibration…demonstrates the model's ability to represent both observed magnitude and trend." However, due to the undocumented 20 percent reduction in solar radiation to all reaches except the Project reservoirs, the calibration and subsequent application of the models to natural conditions is invalid.

Page 22, Comment T8, Paragraph 1. The peer reviewer makes an excellent point that implementation and the condition of the river in the interim are not considered by the proposed allocations and targets. We agree with the reviewer's concerns about the use of limited data. As stated, "an analysis of model uncertainty is absolutely warranted."

Page 23, Response T12, Paragraph 1, Line 6-7. The model was not calibrated for multiple years for the California portions, and because parameters were changed between the calibration and validation years, the outcome is suspect. Again, the model has simply demonstrated an ability to be somewhat calibrated to one year of observed data. It has not been fully or adequately calibrated for multiple years. We question the statement that "the year 2000 exhibited poor water quality, and thus was deemed a key consideration for TMDL development." Elsewhere, the document states that the year 2000 was chosen because it contained the only available data. How would one know that 2000 was a year of poor water quality without other years of data, and where is that analysis? Would a range of conditions provide a better test for the model than a single year? (As a matter of note, the estuary model was not reviewed due to the limited public comment period.)

Page 26, Response T13, Paragraph 1. Regional Board staff seem to ignore the very important point made in this comment, which is: Regional Board staff should consider how the TMDL targets can be met during the interim period between approval of the targets and decommissioning."

Page 29, Response K4, End of Paragraph 1. Are proposed DO objectives calculated from local air temperature and air pressure? We note that the Regional Board staff states that the "natural conditions baseline modeling scenario" didn't meet life-cycle and DO objectives.

Page 34, Response K13, Paragraph 1. Regional Board staff state that "excess accumulation of periphyton…appear to play an important role in high levels of parasite infection." Is this a hypothesis or does it derive from research? There is not citation associated with this statement.

Page 34, Comment and Response K14. The comment is correct – that tributary contributions play a dominant role in thermal refugia form and function, with different effects in the upper reaches than in the lower reaches. Different tributary contributing watershed areas for flow and mainstem stage and flow play vital roles. Review of the draft TMDL did not reflect the basic processes at work in refugial areas near creek-mainstem confluences. There is extensive exploration of these processes in Klamath River refugia completed by USBR that were ignored in the draft TMDL.

Page 35, Comment K18, Paragraph 1. Again, uncertainty should be included when presenting model results. Again, model was not validated in California reaches.

Page 35, Response K19. Two citations were added to the document. Over half a dozen references on extensive thermal refugia work in the Klamath Basin were included with Chapter 4 comments. This seminal work – completed by Reclamation in cooperation with the Yurok and Karuk Tribes – was submitted to the Regional Board staff in response to a request for thermal refugia information. This information was apparently not considered.

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