Oregon
Theodore R. Kulongoski, Governor

Department of Fish and Wildlife
High Desert Region
Prineville Office
2042 SE Paulina Hwy
Prineville, OR 97754
(541) 447-5111
FAX (541) 447-806
Internet WWW:http://prihydro@crestviewcable.com/

March 15, 2006

Honorable Magalie Roman Salas
Secretary
Federal Energy Regulatory Commission (FERC)
888 First Street, NE
Washington, DC 20426

Subject: KLAMATH HYDROELECTRIC PROJECT, FERC No. 2082
COMMENTS AND RECOMMENDED 10(j) TERMS AND CONDITIONS FOR PACIFICORP

Dear Ms. Salas,

Pursuant to Section 10(j) of the Federal Power Act and in response to the Federal Energy Regulatory Commission (FERC) Notice of Application Ready for Environmental Analysis (REA) dated December 28, 2005, the Oregon Department of Fish and Wildlife (ODFW) submits the attached Comments and Preliminary Recommended Terms and Conditions (Attachment A).

The hydroelectric license issued by the FERC for the Klamath Hydroelectric Project (Project), No. 2082, located on the Klamath River, expired March 1, 2006. PacifiCorp (Licensee) applied for a new license to operate the project. ODFW staff consulted extensively with the Licensee during the course of the pre-licensing consultation phases, and provided the Licensee with comments and recommendations on the First Stage Consultation Document, Draft License Application (DLA) and Final License Application (FLA). ODFW also attended the scoping meetings and reviewed and commented on the scoping documents issued by FERC for the relicensing of the Klamath Project.

ODFW regards this relicensing effort to be of critical importance to fish and wildlife resource protection and restoration in the Klamath River Basin. A number of fish and wildlife species listed under the state and federal Endangered Species Acts are present in the Project area. The three downstream-most dams of the Project were constructed without fish passage, and Iron Gate Dam at River Mile 190 now forms the upstream extent for anadromous fish populations in the mainstem Klamath River. In addition, the Project causes impacts to remaining habitats upstream, in the Project area, and downstream. Because of these and other important natural resource issues, ODFW has participated fully in this relicensing effort since the Licensee officially initiated relicensing in 2000. We have participated in resource work groups, Plenary Work Group meetings, site visits, and consultations associated with relicensing the Project. ODFW has provided data, information and expertise on various aspects of fish and wildlife species distribution and abundance, and habitat quality and utilization, and has actively contributed to issue scoping and study planning.

Attachment A to this letter provides ODFW's preliminary 10(j) recommended terms and conditions for the new license. These are a reflection of the complex nature of the Project. ODFW staff believes that implementation of the operating proposal provided by the Licensee and the minimal measures proposed in the FLA will not adequately protect fish and wildlife resources and water quality in the Project area. FERC staff should adopt ODFW's section 10(j) recommended terms and conditions in their entirety in the preferred alternative for the Draft Environmental Impact Statement (DEIS) to ensure adequate mitigation and protection for fish, wildlife and habitat resources of the Klamath River basin during the next license period.

Summary

ODFW appreciates the amount of work the Licensee has expended in completing studies and preparing the FLA and responses to the Additional Information Requests (AIRs). However, ODFW is concerned that the FLA and the responses to AIRs fail to disclose significant impacts to fish and wildlife and their habitats caused by Project facilities and operations. There are still substantial areas of disagreement between the Licensee, ODFW, and the many stakeholders regarding Project impacts to fish and wildlife resources. ODFW is supportive of continued discussions with the Licensee that may lead to the filing of a comprehensive settlement for the relicensing of the Klamath Project. ODFW may modify these recommendations pursuant to the Commission's regulations which allow filing modified section 10(j) recommendations during the comment period on the DEIS as specified in 18 C.F.R. § 4.34(b)(4), or in the event that settlement negotiations lead to filing of a settlement agreement, then ODFW reserves the authority to add to, delete from, or modify the 10(j) recommendations, terms and conditions in order to provide final terms that are consistent with the terms of any agreement.

Sincerely,

/s/ ***Amy M. Stuart***
Amy M. Stuart, Hydropower Program Biologist
High Desert Region

Attachment
C: Klamath HART (Brown, Grainey, Belsky, Houck, McNamee, Stewart-Smith, Burkholder)
Klamath Service List
Klamath Relicensing stakeholders

ATTACHMENT A

PRELIMINARY

COMMENTS and 10(J) RECOMMENDED TERMS AND CONDITIONS

for

PACIFICORP's KLAMATH HYDROELECTRIC PROJECT

FERC #2082

By the

OREGON DEPARTMENT OF FISH AND WILDLIFE
March 15, 2006

Prineville, Oregon

OVERVIEW

This document provides the Oregon Department of Fish and Wildlife's (ODFW) Section 10(j) Recommended Terms, and Conditions for relicensing of PacifiCorp's relicensing of the Klamath Hydroelectric Project (Project) Federal Energy Regulatory Commission (FERC) Project No. 2082. Our comments are organized first with a section describing the authorities that guide ODFW's participation in this relicensing process, followed by comments and recommended terms and conditions for the new license for operation of the Project. These terms and conditions may be modified as needed with the issuance of the FERC Draft Environmental Impact Statement, and as new information and additional study reports from the Licensee, federal, state and tribal entities are made available during the remainder of the relicensing process.

ODFW's Statutes, Management Policies, and Rules for Fish and Wildlife Resources

ODFW has authority pursuant to Section 10(j) of the Federal Power Act (FPA) and the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) to provide recommended terms and conditions to the FERC regarding protection, mitigation of damages to, and enhancement of fish and wildlife and their habitat affected by operation and management of the Klamath Project.

Oregon Revised Statutes (ORS) Chapter 496 requires ODFW to manage fish and wildlife resources of the state to maintain and enhance the natural resources of the state and to protect the natural resources of the state from adverse impacts caused by the continued existence of a project. Where impacts cannot be avoided, those impacts shall be mitigated for and can include compensation for lost fish and wildlife habitat, including loss of individuals.

ODFW's goals and objectives for the fish and wildlife populations in the Klamath Basin are found in the following statutes (ORS) and Oregon Administrative Rules (OARs):

Wildlife Policy (ORS 496.012)

Establishes wildlife management policy to prevent serious depletion of any indigenous species and maintain all species of fish and wildlife at optimum levels.

Oregon Plan for Salmon and Watersheds (ORS 541.405)

Plan to restore native fish populations, and the aquatic systems to support them, to productive and sustainable levels that will provide environmental, cultural, and economic benefits.

Policy to Restore Native Stocks (ORS 496.435)

Establishes goal of the State of Oregon to restore native stocks of salmon and trout to their historic levels of abundance.

ODFW's Fish Passage Law (ORS 509.580 - 509.645)

Establishes as state policy that upstream and downstream passage is required at all artificial obstructions in those Oregon waters in which migratory native fish are currently or have historically been present. For existing hydroelectric Projects, relicensing by the FERC is the "trigger" that initiates consideration of fish passage.

Native Fish Conservation Policy (OAR 635-007-0502-0509)

Establishes policy to (1)prevent the serious depletion of any native fish species by protecting natural ecological communities, conserving genetic resources, managing consumptive and non-consumptive fisheries, (2) maintain and restore naturally produced native fish species, taking full advantage of the productive capacity of natural habitats, and (3) foster and sustain opportunities for sport, commercial, and tribal fishers.

Fish Passage (OAR 635-412-0005-0040)

Establishes policy that (1) requires the owner of an artificial obstruction to implement a fish passage plan to provide fish passage for all native migratory fish and life history stages for fish species currently or historically present at the site which requires fish passage and (2) includes fish passage criteria.

Trout Management (OAR 635-500-0100-0120)

Requires maintenance of the genetic diversity and integrity of wild trout stocks and the protection, restoration, and enhancement of trout habitat.

Fish and Wildlife Habitat Mitigation Policy (OAR 635-415-0000-0025)

Requires mitigation for losses of fish and wildlife habitat.

Klamath Basin Fish Management Plan (OARs 635-500-3600 thru -3860)

Plan to protect and promote natural production of indigenous species and protect and restore their habitats through coordination and cooperation with other agencies, entities and landowners.

Together, these statutes, rules and plans set forth the State of Oregon's comprehensive plan and standards that ODFW has used to develop its 10(j) recommendations. The fundamental principle behind these recommendations is to uphold Oregon's standards by ensuring that Oregon fish and wildlife resources are holistically managed to maintain or enhance the natural resources of the state, and to protect those resources from adverse impacts caused by the continued existence of a project.

These statutes, rules, and plans are provided to FERC to assist with its development of protection, mitigation and enhancement measures for the new Project license. In addition to FERC's duties under Section 10(j), Section 10(a) of the Federal Power Act requires FERC to consider "the extent to which a project is consistent with a comprehensive plan for improving, developing or conserving a waterway affected by the project." ODFW respectfully requests that FERC consider these standards and plans in preparation of the Environmental Impact Statement (EIS) for a new hydroelectric license.

INTRODUCTION

General

Construction of the Klamath hydroelectric project and ongoing operation and maintenance activities has adversely affected fish and wildlife and their habitat. The Final License Application (FLA) submitted by the Licensee on February 28, 2004 to FERC contains minimal provisions to protect, conserve, or enhance fish and wildlife resources. Since ODFW is charged with implementation of the fish and wildlife policies of the State of Oregon, ODFW is recommending measures to protect, conserve, and improve fish and wildlife resources for the Project relicensing.

Project Description

The Project is located on the upper Klamath River in Klamath County of south-central Oregon, and in Siskyou County of north-central California. The Project has six mainstem hydroelectric developments between river mile (RM) 190 and RM 254, a re-regulation dam with no generation facilities and one tributary hydroelectric development on Fall Creek.

The Licensee holds water rights and/or claims in the adjudication process to divert water from Link River, the Klamath River and Fall Creek. The East Side development at the Link River Dam (RM 254) is authorized at this time for 1,150 cfs (150 cfs under Claim number 167 and 1,000 cfs under water right certificate 24508), although the Licensee documents 1,200 cfs is used. The West Side development at the Link River Dam is under Claim number 168 for 205 cfs, although the Licensee documents use of 250 cfs. The JC Boyle diversion is authorized for 2,500 cfs under HE 180, which has an expiration date of December 31, 2006. Information in the FLA indicates a maximum capacity of 3,000 cfs at the Boyle powerhouse. Claim number 218 is for 16.5 cfs from Spring Creek, a tributary of Jenny Creek which is diverted to the Fall Creek powerhouse in California.

The Oregon impoundments created by Project dams are Keno Reservoir, made by Keno Dam (RM 233), with 2,475 surface acres and Topsy Reservoir, the impoundment made by JC Boyle Dam (RM225) with 420 surface acres. The California Project impoundments are Copco 1, Copco 2 and Iron Gate Reservoir at 1,000, 40, and 944 surface acres respectively.

Downstream reaches below each of the dams are affected by low flows in dewatered reaches and in some cases, peaking or re-regulated flows with a cumulative length of 45 miles of affected reaches on the Klamath River, 1.2 miles of Fall Creek, 0.5 miles of Spring Creek (which in turn affects 5.5 miles of Jenny Creek). The Link River dewatered reach is approximately 1.5 mile long from the dam to the confluence of the tailraces of the Eastside and Westside diversions. Minimum flow in the Link River Dewatered reach is 90 cfs from the dam (as per agreement with ODFW) with 250 cfs during the summer when water quality is adverse as per the US Fish and Wildlife Service (USFWS) 1996 Biological Opinion (USDI FWS 1996).

The Keno Reach is approximately 5 miles long from Keno Dam to Topsy Reservoir. Although water is not diverted, it is highly regulated as a “re-regulation” reach and therefore flows are impacted by hydroelectric operations. It has a minimum flow of 200 cfs, per an agreement with ODFW since the drought years of the early 1990’s.

The JC Boyle dewatered reach is approximately 5 miles long and has a minimum flow of 100 cfs below JC Boyle Dam. Approximately half way through the dewatered reach, additional spring flow of 220 cfs augments flows to approximately 320 cfs. The reach below the JC Boyle powerhouse is 22 miles long from the JC Boyle Powerhouse to Copco 1 Reservoir. It is affected by large daily flow fluctuations. Daily flows range from a minimum of the 320 cfs from the dewatered reach (100 cfs minimum plus 220 cfs spring flow) up to 3,200 cfs at turbine capacity, a 10 fold daily flow change.

The Copco 2 dewatered reach is approximately 1.5 miles long and has a minimum flow of 10 cfs. Below Iron Gate dam, the FERC minimum release flows are 1,300 cfs from September to April, 1,000 cfs in May and August, and 710 cfs in June and July. However, since 1997, the US Bureau of Reclamation’s (USBR’s) annual project operations plans for the irrigation project in the upper basin have prescribed instream flow releases below Iron Gate Dam. These flows are set by the estimated amount of storage and upper-basin stream flow based on water year type. These instream flows are as low as 500-600 cfs in June, July and August, depending on the water year type.

The Spring Creek diversion removes flow from about 0.5 miles of Spring Creek and about 5.5 miles of Jenny Creek. The Fall Creek dewatered reach is approximately 1.2 miles long with a 0.5-cfs minimum flow.

Ramp rates for the affected reaches range from no restrictions in the Copco 2 and Fall Creek dewatered reaches to a FERC-licensed restriction of 9 inches per hour in the reach below JC Boyle powerhouse. In the reach below Link River dam, PacifiCorp has a written/verbal agreement with ODFW that limits ramp rates to 20 cfs/5 minutes for 0-300 cfs, 50 cfs/30 minutes for 300-500 cfs, and 100 cfs/30minutes for 500-1500 cfs with fish salvages required per the 1996 USFWS Biological Opinion below 300 cfs (USDI FWS 1996).

Indigenous Fish Populations

Summer steelhead *Oncorhynchus mykiss*, spring and fall Chinook *Oncorhynchus tshawtscha*, coho *Onchorhynchus kitsutch*, and Pacific lamprey *Lampetra tridentata* were extirpated from their historical range in the upper Klamath River basin and its associated tributaries (Fishpro 2000) when Copco 1 and 2 dams were constructed in

1917 without fish ladders. Later, Iron Gate Dam was constructed downstream from Copco 1, and was also constructed without fish ladders. The Klamath Hydroelectric Project blocks passage of native anadromous fish to 65% of the Klamath basin. A review of historic distribution indicates that anadromous fish once occupied over 300 miles of habitat that is now blocked by the Project. The Klamath River historically had the third largest salmon runs on the Pacific Coast of North America, after the Columbia and Sacramento rivers. ODFW's goal for Klamath River fish populations is to restore native, indigenous species to the fullest extent possible.

Native potamodromous fish in the vicinity of the Project include redband trout, and two species listed by the federal Endangered Species Act (ESA) as Threatened, the shortnose sucker *Chasmistes brevirostris*, and Lost River sucker *Deltistes luxatus*.

Native Trout Management Program

Native migratory redband (rainbow) trout *Oncorhynchus mykiss* evolved in the warm, nutrient rich waters of the upper Klamath basin and compared to other rainbow trout stocks are more tolerant of high temperature and turbid conditions. However, artificial manmade barriers of the Klamath Hydroelectric Project have fragmented the native stocks of the upper Klamath basin. As a result, redband trout in the Klamath River are managed conservatively.

ODFW manages these streams using Option A of the Trout Plan and applying the following guidelines:

- No hatchery fish will be stocked.
- Habitat protection, rehabilitation, and enhancement are the primary management activities.
- Harvest and angling effort will be regulated in accordance with the management alternative selected.

Because the native migratory trout populations affected by the Project are unique, extra consideration must be given to their protection. ODFW actively pursues and promotes habitat protection and enhancement to maximize the productivity of the stock, conserve stock fitness and life history characteristics, and to maintain healthy trout populations with multiple age classes. ODFW has implemented very conservative angling regulations in the Keno Reach and below JC Boyle Dam as a consequence of fish passage problems at Project facilities and impacts to the native redband trout populations.

Relicensing Summary

The Project is owned and operated by PacifiCorp under a single FERC license (No. 2082), issued in1956. The existing license expired March 1, 2006. PacifiCorp initiated formal FERC relicensing in December 2000 when it filed a Notice of Intent and First Stage Consultation Document (FSCD) to relicense the project. The Licensee followed

FERC’s Traditional Relicensing Approach and initiated a “Plus” process of consultation with state, federal, and tribal agencies and other stakeholders. ODFW provided comments on the FSCD in March 2001 and subsequent study proposals in later letters and emails. The Licensee conducted studies and filed its DLA with the State of Oregon, and other stakeholders on June 24, 2003.

The State of Oregon provided comments on the DLA to PacifiCorp on September 17, 2003. In its review of the DLA, ODFW found that the Licensee failed to provide requested information. In some cases field studies and data analysis were not completed. In other cases, the Licensee either chose not to conduct certain studies recommended by ODFW, or chose not to use standard study methodologies recommended by ODFW. The Licensee also did not propose protection, mitigation and enhancement measures (PMEs) to mitigate for project impacts in the new license period as required by 18 CFR 16.8 Identification of Protection, Mitigation and Enhancement measures. ODFW concluded that the DLA was incomplete (State of Oregon 2003).

The FLA, submitted to FERC in February 2004, was required to address study deficiencies, determine appropriate PME types and scale, and present conclusions of comprehensive studies that were requested by ODFW and other participants, including description of the scope, methods, results, and analysis of such studies. Similar to the DLA, the FLA was incomplete and lacked completed studies and descriptions of current conditions, Project impacts and PM&E’s. ODFW filed comments on the FLA and requested Additional Study Requests in our letter to FERC dated April 23, 2004.

FERC issued a series of Additional Information Requests (AIRs) on February 17, 2005 to PacifiCorp, requiring complete information from fish passage, water quality and instream flow studies.

The Final License Application

As described by FERC regulations (18 CFR 4.51), the purpose of the FLA is to fully disclose effects of the Project on the environment, provide sufficient information for FERC to meet its obligations under the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA), and tribal trust responsibilities, and propose protection, mitigation and enhancement measures (PMEs) that will mitigate for the impacts of the Project. The FLA is required to completely describe current conditions and Project impacts, address study deficiencies, determine appropriate PME types and scale, and present conclusions of comprehensive studies that have been requested by ODFW and other participants, including description of the scope, methods, results, and analysis of such studies.

During relicensing consultation, the Licensee modified the formal traditional process by adding an informal collaborative process with ODFW and other stakeholders including tribal, state and federal agencies and non-governmental organizations (NGO's). The informal collaborative process, called the Klamath Collaborative, was to develop, conduct, and evaluate studies in order to establish a complete technical and scientific record necessary for analyzing impacts and developing license terms and conditions, PMEs, and agency recommendations. ODFW fully participated in this informal collaborative process and met numerous times with the Licensee and other stakeholders to resolve disagreement, develop study plans, and gather important information for the relicensing.

ODFW supported the Klamath Collaborative process. However, of the many aquatic and fish passage study plans developed by PacifiCorp, only three were approved by the Aquatics and Fish Passage Work Groups because major disagreements prevented stakeholders from approving study plans (FLA Exhibit E 4-139). In response, the Licensee split studies into smaller proposals. For example, documenting impacts of peaking below the JC Boyle powerhouse became a mix of three approved study plans, three unapproved study plans and others as incomplete concepts.

The Licensee supplied thousands of pages in its FLA and its subsequent response to FERC's AIRs. However, the FLA and AIR responses fail to fully describe and quantify Project impacts. Since the Licensee minimized the scope of important studies or simply declined to do several studies, other parties (e.g. the Environmental Protection Agency, the North Coast Regional Water Quality Control Board, the Oregon Department of Environmental Quality and the Klamath Tribes) have funded additional data collection and analyses. As a consequence, development of a comprehensive administrative record describing Project impacts to aquatic and riparian resources is still pending.

ODFW disagreed with the conclusions the Licensee drew from specific studies. As an example, the Licensee drew conclusions from a radio-telemetry study that one fish out of 42 fish ascending the ladder as evidence that the "ladder is functioning properly, and that few of the downstream fish are inclined to migrate upstream toward the dam" (FLA Exhibit E 4-142). In fact, ODFW research has led to the opposite conclusion that lack of an effective ladder has caused a 98% decline in migration of redband trout when compared to one year after the ladder was constructed in 1961 and a substantial decrease in size of redband trout using the ladder in the intervening years (Buchanan et al. 1990, 1991, ODFW 2006).

Many of the study plans are simple compilations of background information from other projects or a literature review that would normally be included in a first stage consultation document. While stakeholders agreed on the need for baseline information, a literature review does not translate into site-specific impacts of a project on fish and wildlife resources or significant progress in understanding project impacts and developing PMEs.

We appreciate the AIRs that FERC requested of PacifiCorp on February 17, 2005 since a complete technical and scientific record was not assembled in the FLA. However, while results have been submitted in the past several months from the fish passage, water quality and instream flow studies, and despite these studies' results, there is a lack of significant PMEs to address Project impacts. Discrepancies of fact have not been resolved, differences in interpretation of study results remain, and results and conclusions based on independent analysis contradict the Licensee's study conclusions. Because of these discrepancies of facts, conclusions and independent analysis, ODFW submits to FERC 10j recommendations to avoid and minimize the risks of Project impacts to fish and wildlife populations to the greatest extent possible and to ensure resource goals and objectives and state statutory requirements are met.

Status of Keno Dam and Riverine Reach in the FERC Project Boundary

The Licensee has proposed to remove Keno Dam from the FERC project boundary in the FLA. This is reflected in the Notice of Request for Environmental Assessment (NREA) which only includes the Project proposal submitted by PacifiCorp to FERC. ODFW contends that Keno Dam and the river reach below should remain in the FERC boundary since it is owned and managed by the Licensee for reregulating flows to maximize peaking and power generation at downstream facilities. ODFW also recognizes that Keno Dam facilitates management of water for the US Bureau of Reclamation (USBR) irrigation project.

An analysis of input and output flows at Keno Dam along with Link River, Lost River and irrigation project net diversions was conducted to compare Link River and Keno reach flows. When spill is not occurring the analysis documents that the Licensee's fluctuation in Keno releases are primarily a result of refill needs at the JC Boyle reservoir to maximize peaking at JC Boyle powerhouse. The analysis indicates that there appears to be little relationship between Keno flows and the daily change in irrigation operations, and, on some days they even move in the opposite direction in relation to how irrigation operations should affect Keno releases.

The Licensee originally included Keno Dam and the river reach within the project boundary in its DLA. The purpose of Keno Dam in the DLA included flow regulation for hydroelectric power (see ODFW comments on DLA, page 40, State of Oregon 2003). The Licensee now proposes to eliminate Keno Dam from the Project boundary in the FLA, to avoid responsibility for mitigating its substantial impacts to fish and wildlife resources, which would prevent FERC, ODFW and other agencies from recommending or requiring mitigation measures for the substantial impacts to fish and wildlife resources such as lack of effective upstream and downstream fish passage at this Project facility (see ODFW Comments to DLA pages 14 and 21, State of Oregon 2003).

Keno Dam also causes major water quality problems to the Klamath River (Deas 2003, 2004). Water quality modeling and data indicates that Keno Dam negatively affects water quality parameters by storing water, increasing retention time and solar exposure, thereby contributing to water quality problems related to temperature, dissolved oxygen, pH, un-ionized ammonia, and nutrient dynamics. Water quality is particularly impacted at Keno Dam, which impounds a large shallow reservoir with a long retention time (19 days or more) and high solar exposure, leading to lethal conditions for fish during summer periods and violations of water quality standards. Deas (2003) documented that Keno Reservoir has very poor water quality conditions, dominated by a large standing crop of phytoplankton. The reservoir experiences extreme persistent anoxia, elevated nutrient conditions, high sediment oxygen demand and heavy thermal loading during spring and summer. Given that Keno facilities and operations are key for flow regulation for hydropower generation, result in significant degradation of water quality within Keno Reservoir, and this impact can be measured over 200 miles downstream, and adversely affects upstream and downstream fish passage, ODFW opposes the Licensee's proposal to remove Keno Dam and its river reach from the Project boundary.

The Licensee's proposal to "delete" Keno Dam from the Project boundary, but still own and operate it, allows the Licensee to avoid the legal obligations imposed by relicensing through both the Federal Power Act and potentially through the Section 401 Clean Water Act requirements. ODFW strongly recommends to FERC that Keno Dam and the river reach be retained in the Project boundary. ODFW would consider concurring with removal of Keno from the FERC boundary only after all of the Keno development impacts on fish and wildlife resources and water quality have been eliminated or adequately mitigated. The 10(j) recommendations below include conditions for the Keno portion of the Project.

Resource Concerns for the Relicensing of the Klamath Hydroelectric Project

ODFW's priority concern is to ensure that adequate mitigation is provided for ongoing and unavoidable losses of habitat and riparian areas caused by the Project.

The Project has many impacts to fish and wildlife resources and their habitats within the Project area and downstream along the Klamath River. These impacts are briefly summarized and include but are not limited to the following.

1) Fish Passage: The Project impacts upstream passage at Keno and JC Boyle dams because current fish ladders are not constructed or operated to meet current state and federal criteria. There is no upstream fish passage at Project facilities located in California.

Downstream fish passage is impacted by entrainment in power canals because there are no screens at Eastside and Westside diversions at Link River Dam, or at Copco 1, Copco 2, Iron Gate diversion and Fall Creek intakes. JC Boyle intake is screened, but not to current state and federal design standards. ODFW has documented injury and mortality of redband trout and federally listed suckers at the JC Boyle screens. Currently, the majority of downstream migrating fish are diverted through unscreened or poorly screened diversions and into powerhouse turbines. Repeated fish salvages over the past several years in the power canal have documented large numbers of trout and suckers entrained, despite salvaging only a tiny fraction of the water that passes through the power canal. In addition, the JC Boyle Dam has had screen failures from debris loading as recent as February 7, 2006. Multiple screen failures have occurred in the past, documenting that the Project has been out of compliance with License Article 32 and continuing to operate, despite lack of screens in place.

More than 300 miles of migration, spawning, and rearing habitat are no longer accessible for salmon, steelhead, and Pacific lamprey due to the construction and operation of the California dams of the Klamath Project. Lack of fish passage facilities at Copco 1, Copco 2, and Iron Gate Dam has blocked passage to the upper basin, which encompasses 65% of the total Klamath River Basin area. All species of anadromous fish in the Klamath Basin have been on a general decline for much of the past century. The decline of the anadromous fish in the Klamath Basin coincides with the construction and operation of the Project.

2) Fish Resources: Existing operating conditions and facilities cause impacts to fish populations by reducing stream flow, which limits spawning and rearing habitat; by fluctuating stream flows, which causes mortality of fish by stranding; by entraining fish into power diversions; and by adversely affecting water quality. PacifiCorp is proposing to adjust the Project boundary to exclude the Keno Dam, which will limit the scope of analyzing project effects on fish populations.

ODFW has drawn conclusions from studies conducted by ODFW Research (1988-91), the Salt Caves License Documents (City of Klamath Falls 1986), and recent work conducted by ODFW management and research personnel (ODFW 2003, ODFW 2006, Tinniswood memorandum to Smith, April 8, 2004).

Based on ODFW Research staff and other sources, the Project's impacts to fish resources include but are not limited to:

- Reduced trout spawning and rearing habitat in the Copco and JC Boyle dewatered reaches and the reach below JC Boyle powerhouse.
- Continued loss of spawning habitat inundated by JC Boyle, Copco, and Iron Gate reservoirs.
- Delayed upstream migration of trout past the JC Boyle facilities.
- Depleted prey and macroinvertebrate sources.
- Stranding and mortality of juvenile and fry salmonids below the JC Boyle powerhouse.
- Loss or alteration of spawning and rearing habitat as a consequence of peaking operations.
- Impacts of altered thermal regimes on fisheries.
- Impediments to upstream migration that result in increased susceptibility to disease, reduced metabolic efficiency, and reduced reproductive potential.
- Barriers to upstream migration and downstream recruitment of trout
- Enhanced habitat for non-native fish that compete with native species for forage and habitat in Project reservoirs.
- Reduced habitat and degraded water quality for native, migratory trout as a function of low minimum flows downstream of JC Boyle Dam.
- Habitat loss and degradation as a result of diversions and lack of fish ladders and screens on Spring Creek.

- Massive fish die-offs from Keno Reservoir downstream to Topsy Reservoir due to poor water quality in Keno Reservoir.
- Decreased fish health and size in the JC Boyle peaking and dewatered reaches.
- Lack of habitat for redband trout fry and native minnow species in the JC Boyle peaking reach.

3) Flow Fluctuations and Minimum Flows: Under the existing FERC license, no peaking or ramping restrictions apply to Project operations, except below the JC Boyle Powerhouse, where ramp restrictions are liberal and not adequate to protect aquatic or riparian resources. Impacts caused by flow fluctuations vary with timing (seasonal, night, and day), magnitude, duration, and frequency. The fluctuations reduce aquatic habitat, strand fish on shorelines, reduce spawning success, reduce important stream edge habitat, and reduce production capacity for aquatic species. Peaking also causes bank erosion and has affected the extent and character of riparian vegetation.

The Project impacts flows in approximately 45 miles of Klamath River within Oregon, and many more miles within California. Low flows and high ramping rates affect both dewatered reaches and peaking reaches below dams where flow is regulated. There are no FERC mandated minimum streamflow requirements in Project impacted reaches except in the JC Boyle dewatered reach for 100 cubic feet per second (cfs), and the Copco 2 dewatered reach for 10 cfs. Low stream flows reduce available fish habitat and exacerbate water quality problems. During most of the year, from JC Boyle powerhouse to Iron Gate Dam, river flows are diverted through powerhouse turbines. In the case of JC Boyle and Copco 2 facilities, these flow diversions result in largely dewatered segments of the river between the dam and the powerhouse, with the majority of water diverted to penstock intakes and turbines. Flows below JC Boyle Dam are 80-100 cfs, largely from the screen bypass and the fish ladder. Fish that enter the JC Boyle and Copco 2 dewatered reaches below the JC Boyle and Copco 2 dams face substantially altered river characteristics.

In addition, flow diversion and peaking operations have altered hydrologic conditions in the Klamath River, affecting the hydrology between JC Boyle and Iron Gate Dams and portions of Fall Creek, Spring Creek, and Jenny Creek. The proposed boundary adjustment by the Licensee would eliminate analysis of Project-affected reaches from Link River Dam to the JC Boyle Powerhouse. The following bullets summarize impacts in dewatered and peaking reaches:

- Diversion of flows from the JC Boyle dewatered reach (100 to 2,850 cfs) reduces flows in the upstream portion of the dewatered reach by 75% to 97% and with addition of natural springs of approximately 220 cfs, reduces flows in the downstream portion of the dewatered reach by 48% to 90%.
- The magnitude, frequency, and duration of peak flows (seasonal high flows) in the JC Boyle dewatered reach are reduced as a result of Project operations.
- The seasonal and annual variability of flow in the JC Boyle dewatered reach is reduced as a result of Project operations.

- Project operations reduce summer daily minimum flows (40 to 60%) in the JC Boyle peaking reach, during off-peak hours, exceeding impacts described in the FLA.
- Project operations increase summer daily maximum flows in the JC Boyle peaking reach during on-peak hours.
- Project operations divert 98 to 99.5% of flow from the Copco 2 dewatered reach except during peak flows in excess of 3,200 cfs.
- The Spring Creek diversion reduces flows in Spring and Jenny creeks.
- Fall Creek flows are reduced by 99% by the Fall Creek diversion.

In the absence of meaningful PMEs, these Project impacts will continue to degrade aquatic and riparian habitat and water quality and prevent ODFW management objectives for restoration of riverine and riparian habitat for fish and wildlife species.

<u>4) Water Quality</u>: The Klamath River suffers from very poor water quality in part attributable to the Project. From its headwaters at Upper Klamath Lake to its mouth at the Pacific Ocean, the Klamath River is identified by the States of Oregon and California as water quality limited under Section 303(d) of the federal Clean Water Act. Warm water temperatures and enriched nutrient conditions, particularly during the summer months, plague the river system and affect fish, aquatic organisms, and other state-designated beneficial uses of the waters.

Data and modeling results from the water quality relicensing studies indicate that Project dams including Keno, JC Boyle, Copco 1, and Iron Gate, negatively affect water quality by storing water and increasing retention time and solar exposure, thereby contributing to water quality problems related to temperature, dissolved oxygen, and nutrient dynamics. Reduced flows in the JC Boyle dewatered reach cause seasonally increased warming and rates of warming upstream of the springs and colder stream temperatures downstream of the springs to the powerhouse.

The FLA does not include an adequate and comprehensive discussion of Project impacts on water quality and beneficial uses. Since FERC requested completion of the water quality studies in an AIR request, some information has become available. The complete set of water quality modeling results and hydrologic data has been difficult to assess with the set of CDs released by the Licensee; therefore it is impossible to fully validate the Licensee's conclusions regarding the impact of Project operations on water quality. Despite the lack of a completely transparent data gathering, reporting, and analysis process, the current data appear to indicate that Project operations alter water quality for temperature, dissolved oxygen (DO) and nutrient cycling within and downstream of Project reservoirs and in river reaches subject to diversion and peaking operations, as well as in Spring, Fall and Jenny creeks.

<u>5) Sediment and Geomorphology:</u> The Project has impacted sediment and channel geomorphology. Project dams have trapped sediment, blocking movement of bedload materials such as gravels. Daily large flow fluctuations below the JC Boyle powerhouse

have coarsened the bedload and much of what was once the riparian zone along the mainstem has become a varial zone of alternately wetted and dried riverbed with little remaining riparian function. Project dams have changed channel morphology and fluvial processes, such as coarsening of bed material and reducing the extent of active alluvial features, resulting in deleterious effects on stream and riparian habitats, including channel incision and/or widening or narrowing, increased bank erosion, and reduced channel migration. In addition, the overflow spillway in the JC Boyle dewatered Reach has caused impacts to water quality, floodplains, riparian, and aquatic habitat by eroding a significant portion of the hillside causing releases of dirt, fines, sands, coarse cobble, large rocks and pumice into the Klamath River.

The geomorphology discussion in the FLA describes continuing impacts of the Project on sediment supply and fish spawning but does not consider indirect impacts to other resources, such as riparian habitat. Project impacts on elements of the sediment budget have not been fully validated. Key issues associated with the analysis relate to the sediment transport study and verification of data used to quantify stored sediment.

The FLA describes a difficulty in determining “project effects on fluvial geomorphology and sediment transport” because of synergies between natural and anthropogenic impacts. However, the technical analysis clearly illustrates impacts as a result of Project operation.

For example, in early December 2005, a slope and canal failure in the JC Boyle dewatered reach upstream of the emergency spillway introduced thousands of yards of mixed boulder, cobble, gravel and fines in the river channel and active flood plain and potentially impacted an important nearby redband trout spawning area. In the week following the canal failure, the Licensee completed repairs to the canal section and hillslope below the canal. Numerous conversations between ODFW, BLM and resource agency staff occurred with the Licensee and FERC compliance staff. Until FERC compliance staff were brought into the discussion, PacifiCorp staff did not consider any environmental damages, particularly to aquatic resources, as part of their legal obligations. An estimated 700-1000 cubic yards of colluvial material remained in the active channel (below normal high water elevation) after the mechanical removal of a small amount of the debris in the fan. Due to high flows experienced during the first week of January 2006, much of the fine sediment posing risk to aquatic habitats in downstream areas was mobilized and transported downstream. If this flow had not been provided by USBR flood control releases or if an accident of this nature occurs in the future, resource agencies including ODFW will request that the Licensee provide sustained flows of 5000 cfs to the dewatered reach for a minimum of 24 hours before February 1 or until the impingement is removed, and prior to onset of redband trout spawning.

<u>6) Wildlife Species and Habitat Impacts</u>: The Project intercepts intermittent and perennial streams and creeks, blocks animal movement across reservoirs. Project canals restrict wildlife movement resulting in habitat fragmentation. Project roads and

property also impair terrestrial habitats. Project roads and facilities cause direct mortality to wildlife (including sensitive species) and create barriers to wildlife movement and habitat continuity. Project roads and operations spread non-native noxious weeds, affecting terrestrial habitat and ecosystem functions. These noxious weeds in the Project area are abundant and widespread and Project operations have the potential to facilitate spread of these species across the broader landscape. Project impacts on hydrologic regimes, Project-related road access, and right-of-way disturbances are the primary vectors for dispersal of invasive species. Project transmission lines cause direct bird and bat (including sensitive species) mortality/injury from collision and/or electrocution. Large daily flow fluctuations limit accessibility and create unsuitable habitat for native amphibians. Flow fluctuations cause continued degradation and instability of western pond turtle *Clemmys marmorata* basking sites and nesting/over-wintering habitat adjacent to the river. Pond turtle foraging habitat is lost during peak flows. Riparian habitat has been altered by large flow fluctuations and altered hydrologic and geomorphic processes that limit establishment of riparian habitat and impact overall habitat suitability.

<u>7) Riparian and Wetland Habitat:</u> The Project has caused a 90% reduction in potential future riparian vegetation inundated by Project reservoirs and an associated landscape-scale shift in distribution of palustrine and riparian vegetation. Altered geomorphic, hydrologic, and ecologic processes have impacted 170 acres of riparian and wetland habitat. The Project has reduced habitat potential for colonization of native riparian species due to highly altered flows, reduced sediment supply and reduced seasonal and

annual variation of flows in the JC Boyle dewatered reach. The Project has caused a reduction of 27 acres of riparian habitat within the varial zone below the JC Boyle powerhouse. Daily flow fluctuations in the peaking reach have enhanced conditions for establishment of invasive reed canary grass *Phalaris arundinacea* monocultures and reduced the potential for establishment of native riparian species (e.g., willow *Salix* species).

<u>8) Recreation Resources</u>: Flow manipulation in the JC Boyle peaking and dewatered reaches creates and detracts from a variety of recreation opportunities, primary among these whitewater boating and fishing. Peaking operations diminish the value of the reach for recreational fishers by impacting fish resources through lost productivity and habitat and also impacts angling catch rates. While the Project does support whitewater boating, it does so to the detriment of fisheries and angling opportunities.

<u>9) Cumulative Impacts</u>: The incremental impact of the Project and other land and water use practices, such as alteration of the natural hydrology, on the environment was not analyzed in the FLA. Cumulative effects can result from individually minor, but collectively significant impacts occurring over the lifetime of the Project. While there are many different land and water management activities that have contributed to the decline of the Klamath River fishery and habitat, construction of the Licensee's hydroelectric Project stands out as the most direct and detrimental of all the activities. The combination of daily large flow fluctuations, lack of fish passage, loss of contact of

the river with a native, riparian zone, lack of sediment recruitment, and degraded water quality has led to the steady decline of native fish and wildlife populations.

10) Restoration: The Licensee has not proposed PMEs to address near-term habitat restoration. Failure to provide for mitigation for these types of impacts causes the continued disruption of natural ecological relationships, resulting in habitat loss, habitat fragmentation, and biological resources loss, as well as causing an overall drop in fish and wildlife production. FERC has authority to require mitigation measures that will restore fish and wildlife resources and to reduce negative impacts attributable to a project since its construction, as confirmed in American Rivers et al. v. FERC, 187 F.3d 1007 (9th Cir. 1999). Species that show a declining trend in populations include wild spring chinook, wild steelhead, wild fall chinook, and Pacific lamprey. Coho in the Lower Klamath River are listed as a federally threatened species.

ODFW believes the Licensee should provide additional mitigation in the form of specific habitat mitigation projects or, in the alternative, establish a fund that will be used to develop additional habitat mitigation. The scope of the Licensee's commitment should include acquisition of instream water rights or flows, critical riparian/riverine reserves and refugia, and passage and screening at non-project facilities. Continued inundation of key historic spawning habitats and lost production capacity cannot be replaced by passage facilities. Passage facilities, even if reasonably effective, will cause continued mortality to fish several factors including reservoir predation, capturing and handling, and delayed migration. Continued operation of the Project will limit anadromous fish production unless the new license includes a combination of fish passage and habitat restoration.

ODFW believes the Licensee needs to provide additional mitigation for stream and riparian habitat, consistent with ODFW's Fish and Wildlife Habitat Mitigation rules. This habitat should be in-kind and on-site. Since stream, riparian and wetland habitat often derives its high value from local relationships of water, soils, terrain and plant life, ODFW recognizes this habitat may not be possible to replace onsite without major disruption to the Project. In the alternative, mitigation for lost riparian and riverine habitat is often accomplished through restoration or enhancement of nearby existing riparian and riverine habitat.

It should be noted that a license term greater than 30 years might reduce financial risk for the operators, but increases the risk that mitigation measures will not be sufficient to deal with project impacts over the next license period. Public values will change during the next 30-to-50 years. As an example, the last 50 years included major federal legislation such as the Clean Water Act and Endangered Species Act, which reflected a shift in recognition of public resource values. In addition, unidentified and unforeseen impacts will occur, such as future listing of additional species. For these reasons, it is of particular importance that the Licensee provides sufficient mitigation for the Project.

10(j) RECOMMENDED TERMS AND CONDITIONS

ODFW provides the following terms and conditions, pursuant to the Fish and Wildlife Coordination Act, 16 USC 661et seq., and Federal Power Act, 16 USC 803(j). ODFW will submit revised 10j recommendations, that may reflect updated information, following 45 days of the issuance of the DEIS.

Development of these terms and conditions has been coordinated with the Oregon state agencies of Department of Environmental Quality (ODEQ), Water Resources Department (OWRD), Parks and Recreation Department (OPRD), Department of Energy (DOE), State Marine Board (OSMB), the Public Utility Commission (OPUC), and the Governor's Natural Resources Office as part of the State of Oregon Hydroelectric Application Review Team (HART) process. These recommended terms and conditions have been coordinated with other state and federal agency stakeholders including the California Department of Fish and Game (CDFG), California State Water Resources Control Board (CSWRCB), US Fish and Wildlife Service (USFWS), US National Marine Fisheries Service (NMFS), US Bureau of Land Management (BLM), US Forest Service (USFS), US Department of Interior (DOI), US Bureau of Reclamation (USBR), US Bureau of Indian Affairs (BIA), and US National Park Service (NPS). These recommended terms and conditions have also been shared with entities including representatives of the Klamath, Yurok, Karuk and Hoopa Tribes and other interested stakeholders including Non-governmental Organization (NGO) representatives such as American Rivers, Oregon Trout, California Trout, and Trout Unlimited.

Recommended license terms and conditions are set forth below in italics, followed by a discussion of the issue and rationale for each recommendation.

1. Resource Management Plans, Annual Reports, and Monitoring And Compliance Reports

1A. *Resource Management Plans.* *Within one year of license issuance, the Licensee shall develop and submit to FERC for approval Resource Management Plans for 1) Project Operations, 2) Water Quality, 3) Fish Passage, 4) Sediment and Gravel, 5) Aquatics Monitoring, 6) Wildlife Mitigation, 7) Fish and Wildlife Habitat Restoration, and 8) Vegetation and Noxious Weed Management to direct and guide implementation of these license conditions over the term of the license. These Resource Management Plans shall be proposed as a part of the first Annual Report submitted within one year of license issuance. The Licensee shall consult in the formulation of the resource plans with resource staff from ODFW and other state, federal and tribal resource agencies and the Resource Management Plans shall be reviewed and approved by ODFW and other state, federal, and tribal stakeholders. The Resource Management Plans shall be updated every five years with consultation and approval from ODFW and other resource agencies to reflect new information, new management needs, and updated implementation strategies.*

1B. *Annual Reports*. *For the term of the license and any subsequent annual licenses, the Licensee shall annually submit to the FERC, ODFW and other state, federal and tribal agencies an Annual Report to ensure resource management consistent with these license conditions. The Annual Report shall consist of an the Annual Work Plan for the upcoming year, and a narrative summary and associated tables and graph where appropriate, of completed implementation for the previous year of resource plans for Project Operations, Water Quality, Fish Passage, Fish and Wildlife Habitat Restoration, Sediment and Gravel, Aquatics Monitoring, Wildlife Mitigation, Vegetation and Noxious Weed, and Monitoring and Compliance Reports. Each of these sections of the Annual Report shall be developed according to procedures and specific requirements set out in these license conditions.*

1C.Consultation on Resource Plans*. The Licensee shall prepare each Resource Plan after consultation with ODFW. The Licensee shall allow a minimum of 60 days for ODFW to comment and make recommendations prior to filing the plan with the Commission. The Licensee shall include with the plan documentation of consultation and copies of comments and recommendations on the completed plan after it has been prepared and provide to ODFW, and specific descriptions of how ODFW's comments are accommodated by the plan. The Licensee shall implement the approved Resource Plans.*

1D. *Monitoring and Compliance Reports.* *As a part of the Annual Reports, the Licensee shall submit Monitoring and Compliance Reports for each of the eight* *resource plans. Monitoring and Compliance Reports shall provide specific information regarding compliance with these license conditions, and short and long term monitoring of activities conducted pursuant to these license conditions. Monitoring and Compliance Reports are required for each resource plan:*

1. <u>Annual Project Operations Report.</u> A report with narrative and graphs summarizing an annual compilation of the monthly information. (See Condition 10).

- *Daily Project inflow;*
- *Graphical plots of hourly flow data below the Link River, Keno and JC Boyle dams and JC Boyle powerhouse;*
- *A graphical plot of hourly ramping rates; and*
- *An annual summary of Non-Compliance Reports.*

2. <u>Annual Water Quality Report.</u> A report with narrative and graphs summarizing data demonstrating compliance with water quality requirements and standards for Project reservoirs and reaches, and an annual summary of Non-Compliance Reports. (See Condition 8).

- *Water temperature;*
- *Dissolved oxygen (DO);*
- *Total Dissolved Gas (TDG);*
- *pH;*
- *Chlorophyll a;*
- *Nutrients including nitrogen, phosphorus;*

- *Toxic Algae; and*
- *An annual summary of Non-Compliance Reports.*

3. <u>Annual Fish Passage Report.</u> A report with narrative and graphs summarizing an annual compilation and summary of the activities associated with implementation and monitoring of fish passage: Items shall include evaluation of passage options and improvements, monitoring of biological, water quality and hydraulic criteria for upstream and downstream passage facilities, and a report of upgrades and improvements where performance measures met and are not met. (See Conditions 3 and 4).

4. <u>Annual Sediment and Gravel Report</u>. A report with narrative and graphs summarizing an annual compilation of activities associated with mitigation and restoration measures and associated monitoring that shall be implemented to mitigate for the lack of sediment transport through Project reaches to riverine habitat. (See Condition 9).

5. <u>Tri-Annual Aquatic Monitoring Report.</u> A triennial report with narrative and graphs summarizing monitoring activities associated with restoring aquatic and fish population productivity including fish health and condition ,fish habitat condition, reach productivity (bioenergetics), population structure (age distribution, sex ratios, species assemblages), spawning populations, and fish migration and movement. Monitor native fish populations for effects of flow. (See Condition 11).

6. Annual Wildlife Mitigation Report. A report with narrative and graphs summarizing an annual compilation of information and data for wildlife mitigation measures including a) Raptor Protection for monitoring raptor injury and mortality at power poles and implementation of protection devices, and b) Wildlife Entrapment and Mortality to monitor and implement wildlife protection at power canals and other project features. (See Condition 12).

7). Annual Fish and Wildlife Habitat Enhancement Report. A report with narrative and compilation of information summarizing progress toward restoring fish and wildlife habitat within the Project area, below, within and above the Project area. (See Condition 13).

8). Annual Vegetation and Noxious Weed Management Report. A report with narrative and compilation of information, data and graphs summarizing progress toward implementation of strategies for managing native vegetation to optimize habitat for wildlife species and control invasive weed species. (See Condition 13).

Issue and Rationale

Resource management plans are needed to provide a framework and guidance to bring the Project up to current environmental standards and to provide an opportunity for the Licensee to consult with FERC, and ODFW and the other state, federal and tribal agencies on development and implementation of resource plans. Under the existing license, there is little to no tracking of impacts of Project facilities and operations to natural resources. With the onset of the relicensing process, there was very little historical data that had been compiled by the Licensee to assess Project effects. The relicensing process has strongly illuminated the need to build a series of implementation plans to guide Project implementation of PMEs along with an interactive and functional process of coordination and communication between the Licensee and resource agencies.

Annual monitoring and reporting is needed to organize Project implementation activities, resource management information, promote resource goals, and ensure compliance with ODFW's section 10(j) recommendations for license conditions and other resource agency conditions adopted into the new license. The annual reporting and planning process provides ODFW and other regulatory agencies a means of overseeing and tracking the Licensee's compliance with the agency conditions and provides a process to implement adaptive management during the term of the license where needed. This condition also structures management and reporting requirements for the convenience of the Licensee.

The Klamath Hydroelectric Project has had issues of non compliance with respect to some resources such as upstream and downstream fish passage at JC Boyle Dam (i.e. ODFW Memorandum Engineering Review – JC Boyle Fishway Operations and Site visit 9/17 – 9/18, dated October 7, 2003) and ramp rates (Huntington 2004) in the JC Boyle peaking reach. Development and implementation of resource plans and annual monitoring and compliance reporting will provide a means for resource agencies to bring information forward to the Licensee and FERC when concerns for impacts to resources arise in the new license.

2. Consultation Requirement

2A. Consultation Requirement*. The Licensee shall provide a minimum of a 60 day notice, and opportunity for ODFW and other state, federal and tribal stakeholders to provide review and comment on all plans and actions required by these license conditions. Consultation shall be documented in each plan or report submitted to the Commission.*

Issue and Rationale

Fish and wildlife resources under the jurisdiction of ODFW are impacted, both directly and indirectly, by the operation of the Project. The Project impoundments are located upon private and federal lands and directly impact riparian and wetland resources, shorelines, water quality, native fish and wildlife populations, and their habitats. ODFW has developed recommended license conditions and prescriptions, which it has concluded, are necessary to address these impacts and provide for the protection and utilization of these resources for the public of the State of Oregon. To assist the Licensee in developing plans and reports that appropriately address the Project's impacts to these natural resources it is necessary for the Licensee to engage ODFW and other state, federal and tribal stakeholders in consultation regarding the fulfillment of these section 10(j) license conditions, and other license prescriptions proposed by other agencies.

3. Upstream Fish Passage Facilities

3A. *Upstream Passage at Keno and JC Boyle dams.* *The Licensee shall provide for the safe, timely, and effective upstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout and federally listed suckers. The Licensee shall, construct, operate, maintain, and evaluate volitional fishways at JC Boyle and Keno dams. The ladders shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control. The ladders shall have a minimum of two entrances and associated entrance pools. The auxiliary water system (AWS) shall be designed to augment ladder flow from the forebay. The ladder entrances shall be located downstream of the fish screen bypass outfall (JC Boyle) and any existing velocity barriers below the existing ladder entrances. The AWS shall be screened in accordance with NMFS juvenile fish screen criteria or such alternative criteria as may be determined acceptable by ODFW, NOAA, USFWS and CDFG (Fish Agencies). The AWS shall be designed to provide the correct water temperature and water quality as to attract fish. The fish ladders and AWS together must supply at least 5-10 percent of high fish passage design flow for adequate* *attraction to the ladder. The maximum slope of the fish ladders shall not exceed 10 percent at JC Boyle Dam and 4 percent at Keno Dam. The fishways shall be constructed and operational within three years for Keno Dam and four years for JC Boyle Dam after issuance of the new license.*

Biological evaluations shall be accomplished with either visual monitoring equipment or installation of a fish trap and counting system. The Licensee shall purchase, and replace when needed, the necessary equipment to monitor fish passage. The Licensee shall promptly provide fish passage records to ODFW upon request.

The Licensee shall, within two years of license issuance and in consultation with the ODFW, develop detailed design and construction plans of the ladders for review and approval by the ODFW, NMFS and USFWS prior to construction. The design shall include features to hold and sort fish by age and species. The Licensee shall provide designs, and upon Fish Agencies' agency approval, construct volitional upstream fish passage (ladders) at Keno and JC Boyle dams. The ladders must meet performance standards and criteria set forth in Oregon Administrative Rules (OAR) 536-412-0010 through 0040 for juvenile and adult rainbow trout and also meet criteria for anadromous fish including Chinook salmon, Coho salmon, steelhead, and Pacific lamprey and federally listed species of the shortnose and Lost River suckers. Alternatively, the Licensee shall design fish passage facilities that are required to meet criteria under Table 1 in Section 3D below. The Licensee shall provide a minimum of 60 days for ODFW and other Fish Agencies to review and comment on the fishway design and *construction plans. The Licensee shall implement any design modifications necessary for the upstream movement of fish as required by ODFW. The ODFW-approved designs shall be filed with FERC.*

The ladder design must meet the criteria set forth in OAR 635-412-0035 and for fishway components which are not addressed in OAR 635-412-0035, be designed in accordance with current NMFS or USFWS fish passage criteria and guidelines. In addition, the ladder design must include adequate facilities for evaluating ladder performance (e.g. fish trapping capability).

Construction of fish passage facilities at the Keno and JC Boyle dams must be completed within three and four years, respectively, following issuance of the new FERC license. The Licensee shall, prior to the completion of construction of the new fishways, in consultation with ODFW and other Fish Agencies develop a post-construction monitoring and evaluation plan to assess the effectiveness of the fishway. The plan shall include hydraulic, water quality, and biological evaluations to assess the performance of the fishway, including measures for follow-up evaluations of fishway effectiveness. Specific biological performance parameters shall include the number of fish, by species, size, and age class observed at each facility. The Licensee shall keep a record of the daily observations by a qualified fisheries biologist on the physical condition of the fish using the fishways. Water quality parameters shall include a continuous record of DO and water temperature at locations in the fishway as directed by ODEQ, ODFW and other Fish Agencies and in front of and adjacent to the *entrance(s) and exit(s) of the fishways. The evaluation plan and the results of effectiveness monitoring shall be provided to ODFW, ODEQ, and other Fish Agencies for review and comment, with a minimum of a 60-day review period. The Licensee shall implement any plan, operational or physical modifications necessary for the safe, effective, and timely passage of fish as may be required by ODFW and affected agencies. Hydraulic evaluation of each facility shall be initiated within one month following construction completion. Biological evaluation shall be initiated within a timeframe established through consultation with ODFW and other Fish Agencies considering the timing and magnitude of potential fish migration.*

3B. *Upstream Passage at Copco 1, Copco 2, Iron Gate Dam, and Spring and Fall Creek diversions.*

The Licensee shall provide designs, and upon ODFW approval, construct volitional upstream fish passage at Copco 1, Copco 2 and Iron Gate dams, and at Spring and Fall Creek diversions. The ladders must meet performance standards and criteria stated in Table 1 of Section 3D or established by the Fish Agencies for juvenile and adult rainbow trout, and also meet applicable criteria for anadromous fish including Chinook and Coho salmon, steelhead, and Pacific lamprey for Copco 1 and 2 dams and Iron Gate Dam, and juvenile and adult rainbow trout at Spring and Fall Creek diversions.

Construction of fish passage facilities must be completed within six years for Copco 1 and 2 dams and five years for Iron Gate Dam following license issuance. Fish passage facilities for Spring and Fall Creek diversions must be completed within three *years following license issuance. The Licensee shall, prior to the completion of construction of the new fishways, in consultation with the Fish Agencies develop a post-construction monitoring and evaluation plan to assess the effectiveness of the fishway. The plan shall include hydraulic, water quality, and biological evaluations to assess the performance of the fishway, including measures for follow-up evaluations of fishway effectiveness. Biological evaluations shall be accomplished with either visual monitoring equipment or installation of a fish trap and counting system. The Licensee shall purchase, and replace when needed, the necessary equipment to monitor fish passage. The Licensee shall promptly provide fish passage records to the Fish Agencies upon request. Specific biological performance parameters shall include the number of fish (by species, size, and age class) observed at each facility. The Licensees shall keep a record of the daily observations by a qualified fisheries biologist on the physical condition of the fish using the fishways. Water quality parameters shall include a continuous record of DO and water temperature at locations in the fishway as determined by the Fish Agencies, and in front of and adjacent to the entrance(s) and exit(s) of the fishways. The evaluation plan and the results of effectiveness monitoring shall be provided to the Fish Agencies for review and comment, with a minimum of a 60-day review period. The Licensee shall implement any plan, operational or physical modifications necessary for the safe, effective, and timely passage of fish as may be required by the Fish Agencies. Hydraulic evaluation of each facility shall be initiated within one month following construction completion. Biological evaluation shall be initiated within a timeframe established through consultation with the Fish Agencies, considering the timing and magnitude of potential fish migration.*

3C. ***Submittal of Draft Designs*.** *The Licensee shall submit draft design plans to ODFW and other Fish Agencies within one year for Spring and Fall Creek fish passage facilities and within two years for Copco 1 and 2 and Iron Gate fish passage facilities following license issuance for Fish Agency approval of design specifications for upstream fish passage facilities. The Licensee, after consultation with ODFW and other Fish Agencies and within six months from the start of construction, shall file for Commission approval functional design drawings of the upstream fish passage facilities.*

***3D*. Performance Standards.** *In the event that the Licensee proposes upstream facilities that do not meet Oregon fish passage criteria for volitional fish passage facilities set forth in OAR 635-412-0010 to 0040, the Licensee shall design, construct, test, operate, and maintain upstream fish passage that meets the performance standards set forth in the following table.*

Table 1. Performance Standards for Klamath Hydroelectric Project Fish Ladders

Passage Component	Measures of Success
Upstream Passage Survival at each Klamath Hydroelectric Project facility/reservoir	> 95 % adult survival during first 5 years of operations. > 98 % adult survival after 5 years.

The criteria contained in Table 1 will be applied as follows:
1. *Design and build the facility to achieve the adult survival rate.*
2. *Test the facility hydraulically and biologically to optimize performance for five years after construction.*
3. *If, after five years, test results indicate that adult survival rates associated with the ladder fall within the range of values contained in the table above, no additional modifications are required.*
4. *If test results indicate that injury and mortality rates fall below the range of values contained in the table above, the Licensee will undertake minor additional*

modifications to reduce injury and mortality rates. If after two years of additional testing, minor additional modifications achieve the adult survival rates identified above, and adult survival rates fall within the range of values above, no major modifications are required.

5. If test results indicate that adult survival rates associated with the facility fall below those in the table, the Licensee shall undertake major operational or structural modifications to reduce injury and mortality.

6. If test results after major operational or structural modifications to reduce injury and mortality cannot meet performance objectives 10 years after license issuance, the Licensee shall construct new volitional passage facilities as prescribed in OAR 635-412-0010 through 0040.

3E. *Post Construction Evaluation and Improvements.* *In the event that performance standards set forth in Section 3A and in Table 1 are not met during the post construction evaluation period, the Licensee shall implement changes to Project operations or facilities at any facility not meeting the performance standards within a time frame developed through consultation with the Fish Agencies. Measures to bring the fish passage facilities into compliance with performance standards at each facility may include, but are not limited to, the following: (1) improved hydraulic balancing of ladder cells or structural modifications, (2) construction of additional upstream fish passage facilities, (3) seasonal changes in operations to facilitate upstream fish passage, and (4) reductions in flow diversions.*

3G. Tailrace Barriers. *All Project powerhouse outlet facilities shall be equipped with a tailrace barrier designed in consultation with and approved by the Fish Agencies according to current criteria. Prior to construction of a tailrace barrier, the Licensee shall, in consultation with and approved by the Fish Agencies, prepare a post-construction evaluation plan, including hydraulic and biological performance evaluation. All tailrace barriers shall be completed within eight years of issuance of the new license.*

3H. *Written Operation and Maintenance Procedures.* *The Licensee shall develop written standard operation and maintenance procedures (including operator training and supervision) to ensure that the upstream fish passage facilities operate effectively during the life of the project. The operation and maintenance plan shall include procedures for prior notification and coordination with ODFW and other Fish Agencies on maintenance scheduling or emergencies that may affect functioning of the facilities*. *The operation and maintenance plan shall include measures for daily inspections for staff gage readings and obstructions during the peak seasonal migration of major species including redband trout, suckers and anadromous fish, and weekly inspections during non-peak migrations.*

3I. *Post Construction Monitoring Plan.* *Prior to completion of the upstream fish facilities, the Licensee, in consultation with ODFW and other Fish Agencies, shall prepare a written post-construction monitoring plan and implementation schedule to evaluate the efficiency and biological effectiveness of the facilities. The plan shall incorporate recommendations by ODFW and other Fish Agencies before implementation. The plan must include hydraulic and biological evaluation to ensure proper performance of the facilities in accordance with applicable criteria. The written plan shall evaluate and monitor fish movement by species and life stage immediately following construction to evaluate the fish passage facilities. The plan shall determine whether fish death, injury, or delay is occurring; and whether fish have difficulty in locating the ladder entrances, moving through the ladders, or falling back over the* *spillway on the dam. The results of the monitoring shall be submitted to the Fish Agencies according to the approved schedule. If after two years of monitoring and evaluation, the results of the monitoring show that modifications to the facilities are necessary to eliminate or minimize adverse impacts to the fish resources, the Licensee shall file with the Commission recommendations for modifying the facilities and a schedule for implementing the measures that shall incorporating Fish Agency recommendations developed through consultation. Measures to bring the ladders into compliance with the standards may include, but are not limited to, improved hydraulic balancing of ladder cells or structural modifications, seasonal Project shutdown, or reduction in flow diversion. These changes may be required for the remaining term of the license or may be required temporarily until alternative measures are implemented to achieve the standards*

3J. *Operations and Maintenance.* *The Licensee shall maintain all upstream fish passage facilities by keeping them in good repair, operating them within federal and state criteria, and open and free from obstructions at all times, consistent with state and federal law.*

3K*. Maintenance Shutdowns and Fish Salvages.* *The Licensee shall notify ODFW and other Fish Agencies at least two weeks in advance of any contemplated maintenance shutdowns that may result in dewatering the waterways or reduced flow conditions that may result in stress or mortality to fish. The Licensee shall salvage live* *fish from the waterways during such maintenance shutdowns and consult with ODFW and the Fish Agencies to determine where the salvaged fish will be relocated.*

3L. *Decommissioning.* *To the extent that agency consultations determine that it is infeasible to provide safe, timely and effective upstream fish passage at any Project facility, the Licensee shall prepare a decommissioning proposal for the subject facility in consultation with state, federal and tribal stakeholders.*

Issue and Rationale

Compliance with Oregon State Law: The Klamath Hydroelectric Project is not operated in compliance with ODFW's statutes, rules, and fish management plans. The Project fishway facilities located in Oregon are ineffective and do not meet federal or state passage criteria for trout, anadromous salmonids, or native suckers and lamprey, while the California dams do not have upstream (or downstream) fish passage facilities.

Oregon's fish passage law (ORS 509.580 - 509.645) establishes a state policy that upstream and downstream passage is required at all artificial obstructions in those Oregon waters in which migratory native fish are currently or have historically been present. At existing hydroelectric projects, relicensing by FERC and reauthorization of a hydroelectric license or water right by Water Resources Department are the "triggers" that initiate consideration of fish passage. Licensees are required to request approval from the Oregon Fish and Wildlife Commission for a fish passage proposal or a waiver or exemption of fish passage. As part of a waiver proposal, a licensee must submit an alternative mitigation package that provides a net benefit to fish than is greater than the benefit of providing passage.

The Licensee has not proposed modifications of existing facilities or new facilities that address anadromous fish passage, nor proposed a consistent, comprehensive strategy for native, migratory fish passage through Project facilities. Needed upgrades at JC Boyle and Keno Dam are not proposed, and no passage facilities are proposed for Iron Gate, Copco 1, or Copco 2 dams, where native, migratory species are isolated by lack of passage. Thus, passage needs of potamodromous fish, including listed suckers, have not been adequately addressed. The Licensee does not comply with Oregon's fish passage statutes because the Licensee has not prepared a fish passage plan or a passage waiver with an alternative mitigation plan with net benefits to fish, for approval from the Oregon Fish and Wildlife Commission.

Fish passage is recommended at Project facilities in California to support restoration of anadromous fish to historic habitats in Oregon, since State of Oregon interests are affected by Project facilities and operations at the California Klamath Project dams. Oregon and California coastal fishers have shared a mixed stock fishery of anadromous fish originating rivers from the northern California and southern Oregon coasts for over a century. The Klamath stocks have had a very low abundance and as a weak stock, have restricted ocean fisheries for Chinook south of the Columbia River. The health of Klamath stocks affects allocation of fish resources for Oregon, Washington, California and Alaska users, as well as numerous tribes with fishing treaties with the United States government. The Klamath populations also factor into harvest allocation agreements between the United States and Canada, regulated by the Pacific Salmon Treaty.

Existing Upstream Fish Passage Project Facilities: Currently, there are no upstream fish passage facilities at the Project diversions and dams in California. There is an ineffective ladder at the JC Boyle facility. Link River Dam is owned by USBR and therefore provides upstream fish passage for native fish species including redband trout and ESA-listed suckers.

Upstream Passage problems at JC Boyle Dam:

Existing Design Problems:

The design parameters used for the construction of the existing upstream adult fish ladder is outdated and there is no practical or cost-effective means to reconstruct the facilities to meet current standards to allow for more efficient fish passage. Improving upstream fish passage is an identified objective of the ODFW's Klamath River Subbasin Fish Management Plan (ODFW 1997) and is a goal of other agencies involved in the FERC relicensing.

The JC Boyle dam has a pool and weir fish ladder with submerged orifices built during the 1957-1958 dam construction. The ladder is 569 feet long and the change in elevation between pool 1 and pool 57 is approximately 67 feet. Criteria at the time included 12-inch drops between pools and a vertical to horizontal slope of 1:8.5.

Contemporary criteria for resident trout fishways are 6 to 9 inch drops between pools and minimum of 1:10 slope.

Physical Problems:

- Attraction flow is limited to about 2% of the 10% annual exceedance flow, whereas 5 to 10% is preferred for modern fishway design. The 10% annual exceedance flow for the flow duration curve is approximately 3,400 cfs.
- Flow in the ladder was estimated in September 2001 at 0.6 cfs through the 4 inch orifices and 20 cfs over the 6 foot wide weirs (CH2MHill 2003).
- The slope of the ladder is 1V:8.5H, which is steeper than both the current criteria for trout (1V:10H) and current criteria for suckers (1V:22H).
- With an approximate flow volume of 21 cfs, the turbulence factor for the typical pool is estimated at 6.8 ft-lb/s/ft^3, which is 1.7 times the modern recommended value of less than 4.0 ft-lbs/s/ft^3.
- Existing pool volume is generally too small for proper energy distribution. In general, pools are 6 feet wide by 8 feet long by 6 feet deep. Typical pool volumes for modern well-designed ladders are 8 foot wide by 10 foot long by 6 feet deep, allowing for fish to rest and stage for the next jump in the ladder.
- An automated gate with an auxiliary water supply system provides a total of about 80 cfs for attraction flow at the entrance, which is a discrepancy from the 2003 Ch2MHill report. It is uncertain, at the time of this review where the auxiliary water comes in – at the forebay or down the ladder. However, during observations by

visiting biologists from ODFW and USFWS, and during the 1988-91 ODFW study, ladder flows have ranged from nonexistent to raging whitewater.

- The existing entrance location to the fishway is difficult for fish to find during spill events and may be obscured by hydraulic problems and water quality differentials. The location of the entrance could be improved by performing hydraulic study and/or site observations and basing the new entrance on the results of the study.
- There are also problems associated with different temperature and water quality between water from the bypass and ladder and water in the diversion reach. Flow issues need to reconcile releasing more water down the dewatered reach to avoid water temperature and scent confusion to facilitate passage of adults in finding the entrance to the ladder.
- Design and construction of a new facility should include maximum flexibility to respond to future management decisions (e.g. anadromous fish reintroduction). This should include trapping and sorting facilities, adjustments to spillway and downstream facilities.

Biological Studies and Results:

- Trapping in the fish ladder done in 1959 documented and estimated upstream passage of 5,529 redband trout (Hanel and Gerlach 1964). Internal correspondence by Hanel (1959) reported that 83% of the total catch of rainbow trout migrating over JC Boyle occurred in the fall of the year. Within 3 years, the estimated number of migrating fish declined almost 60% (N=2,295). The extent of this decline may be underestimated because a significant portion of the run may have been missed in

1959 (ODFW 2006). Trapping in 1959 began on 10 May and 82% of all fish handled in 1961 and 1962 were caught in March and April (Gerlach and Hanel 1964). Estimates in 1960 and 1961 were 3,882 and 2,295 fish, respectively.

- Between 1960 and 1963, 866 redband trout were tagged and 12% (N=105) were recaptured by anglers fishing the Klamath River from the Peaking Reach near the Frain Ranch (RM 215) to Keno Dam (RM 231.5). Most of the angler recoveries (84%) were caught in the dewatered reach (Gerlach and Hanel 1964). These results suggest that at least some of the fish migrating above JC Boyle Dam returned to reaches downstream of the dam after spawning, and were strongly associated with the dewatered reach. However the location of tags recovered by angler harvest was likely influenced by access of fishing sites and therefore may not accurately reflect distribution of post spawning fish.
- Trapping efforts by Beak consultants in 1981 showed a small run of trout in the spring and the 1984 study showed a very small spring migration and a larger one in the fall. The fyke trap was operated 5 days per week in the spring (April to June) and fall (late August to October, City of Klamath Falls 1990). Only eight trout were captured in the spring period and 130 in the fall period.
- Beak consultants tagged 453 redband trout over 200 mm in the fall of 1988 downstream of the powerhouse (City of Klamath Falls 1989). By 1988, the contribution of adult fish from the Peaking Reach to the spawning population above JC Boyle Dam appeared to have disappeared (ODFW 2006). In the fall of 1988, 453 redband trout (>200 mm fork length) were floy-tagged in the Peaking Reach (City of

Klamath Falls 1989). None of these fish was recaptured moving upstream in the JC. Boyle fish ladder trap operated by the ODFW from March 1988 through 1991

- ODFW monitored fish passage at the ladder in late 1988 through 1991. None of the tagged fish were observed in the fish ladder, and of those sampled in the ladder, 64% were less than 200 mm long. The average length of redband trout captured from the ladder during March through May decreased from 30 cm in 1961 to 18 cm in 1990.
- Movement of redband trout upstream past JC Boyle Dam was monitored using a fyke trap in the fish ladder from February 1988 through December 1991 (Hemmingsen et al. 1988, 1992; Buchanan et al. 1989, 1990, 1991, ODFW 2006). These totals were expanded to account for trap effort and showed low numbers relative to those in 1959. Between 1988 and 1990, the estimated total of fish passing over the dam averaged 502 trout (range, 412 to 588), which was less than 10% of the estimated total in 1959. An estimated total of 70 redband trout passed over dam in 1991, which was less than 2% of the estimate in 1959. Numbers of fish were 507, 588, 412, and 70 in 1988, 1989, 1990, and 1991, respectively.
- A radio telemetry study consisting of 3 groups of 14 trout in each group were tagged and released at locations below JC Boyle dam. Of the 42 fish, only 1 passed successfully over JC Boyle Dam (PacifiCorp 2004, Fish Resources FTR). That same fish, a radio-tagged adult redband trout, 287 mm fork length, was entrained in the power canal, diverted past the dewatered reach, and ended up residing in the peaking reach (PacifiCorp 2004).

- Fluctuating flows through the fish ladder were frequently reported in the monthly ODFW research reports. Since ladders are usually designed for an optimum hydraulic range for depth and velocity for migrating fish, passage is compromised by constantly changing flows in the ladder. The September 1989 flow fluctuation washed the trap out twice. The June 1989 ODFW research monthly report documented wild flow fluctuations ranging from an extreme high flow to zero cfs on one day.
- ODFW research staff also noted numbers of fish captured in the JC Boyle Ladder trap increased sharply in days following periods of spill from the dam.
- There may be problems with diffusion pool of attractive water. The April 1988 monthly report noted that electroshocking samples regularly caught trout from 220-316 mm.

Existing upstream fish passage facilities at JC Boyle Dam pass some redband/rainbow trout and other fish (PacifiCorp 1997) but they are ineffective and do not meet current passage criteria for potamodromous and anadromous fish. Passage problems may be related in part to channel degradation near the entrance of the fish ladder which occurred after dam construction (USDI 2004, USDI Fish and Wildlife Service 2004b). The gradient that existed as part of the original fishway has not been maintained over the term of the license. Steep gradient, low attraction flow, hydraulic barriers, and problems with entrances limit the passage effectiveness of JC Boyle dam fishway (USDI 2004).

ODFW research studies documented that redband trout generally passed over JC Boyle Dam from February through November each year (Buchanan et al. 1989, 1990, 1991, Hemmingsen et. al. 1992, ODFW 2006). There were two peaks in annual abundance of migratory fish, one occurring in April and one in either September or October. From 1988 to 1991, 765 redband trout captured in the trap at JC Boyle Dam were floy-tagged and only 4% (N=29) were recaptured. Among the recaptures, three movement patterns were observed. First, mature redband trout migrated past JC Boyle Dam in March-May (spring) and were recaptured in the Spencer Creek trap 1 to 12 days later. The second movement pattern was immature redband trout passing JC Boyle Dam in the spring were recaptured in the Spencer Creek trap during the spawning period the following year, apparently spending summer and winter in Topsy Reservoir or in the Keno Reach of the Klamath River. Finally, two recaptured fish that migrated past JC Boyle Dam in September-October (fall) entered Spencer Creek the following spring, presumably after overwintering in Topsy Reservoir or the Keno Reach.

Recent radio telemetry studies of adult redband trout in the dewatered reach and peaking reach of the Klamath River add further evidence that adult life history connectivity above and below JC Boyle Dam has been reduced. The Licensee's telemetry study documented that only one out of 14 radio-tagged redband trout from the dewatered reach moved above the dam in 2002 and none of the 28 tagged fish from the peaking reach moved above JC Boyle Dam (PacifiCorp 2004, Fish Resources FTR). For the one tagged-fish that did migrate above the dam, the data indicate a delay of 5 days (USDI 2004). One fish was tracked to within 200 m of the JC Boyle fish ladder and was subsequently observed below a known heron nesting site alongside JC Boyle Reservoir. Another tagged redband trout moved 15 miles upstream and stopped just downstream of the JC Boyle powerhouse tailrace. The remaining fish that were tagged in the peaking reach were tracked into or near known spawning areas near Shovel Creek or in the JC Boyle dewatered reach.

In a separate study, in 2003 and 2004, ODFW captured and radio-tagged 51 adult redband in the Klamath River below JC Boyle Dam (ODFW 2006). In the dewatered reach, only 2 fish were tracked through the spawning period or to known spawning areas. Both fish moved downstream about 1.5 miles to known spawning areas in the lower dewatered reach. Two radio-tagged trout from the upper dewatered reach (RM 221.5) showed upstream movement in fall; both fish were recorded at a fixed telemetry station 150 m below the JC Boyle fish ladder (RM 223) in early October and both fish appeared to be preyed upon before climbing the JC Boyle fish ladder.

ODFW Research staff concludes that there are many factors caused by the hydroelectric facility that contribute to the decline in abundance and size of adult redband trout migrating upstream over JC Boyle Dam (ODFW 2006). The dam is managed solely for hydroelectric power production and, during base flow conditions at least 80% of the Klamath River discharge is stored in the reservoir and then diverted through the powerhouse diversion canal. Therefore, for the bulk of the year, the dewatered reach has less than 20% of the natural flow regime, which reduces habitat volume and carrying capacity in this reach. The short and infrequent periods of spill at

JC Boyle Dam or entrainment and mortality in the power canal and turbines have reduced recruitment of juvenile migrants from Spencer Creek to the dewatered, substantially diminishing an important life history component of native, migratory trout that reside in the Klamath basin. Also, the construction of the dam and fish ladder has substantially narrowed passage opportunity for fish migrating upstream. Although the fish ladder is passable for some redband trout, it has excluded other species and created a passage bottle-neck that may increase predation mortality on redband trout attempting to enter ladder. ODFW concludes that the above information and results of the site-specific studies provide the evidence that fish passage has been highly impacted and is causing significant adverse affects on resident fish populations in the Klamath basin.

Upstream Passage Problems at Keno Dam:

Keno Dam has a fishway that generally conforms to salmonid-based criteria but does not meet slope guidelines for sucker passage (Gatton 2003, USFWS 2005). Although it conforms to slope and energy dissipation criteria for salmonids, the Keno Dam fishway and auxiliary water supply system have attraction hydraulics and flow regulation problems.

Automated weirs 25 through 28 lack adequate orifice passage and fish using the ladder have to jump over these last four weirs to pass into the reservoir. While trapping studies indicated that trout use the ladder, the existing structure does not meet ODFW criteria for passage of trout. Additional hydraulic and biological evaluation is needed to address effectiveness of the ladder for all species including native trout, suckers, lamprey and anadromous fish.

ODFW Research staff documented that migration timing and the recapture of fish marked at the fish ladder trap at Keno Dam from 1988 to 1991 showed that a substantial number of fish appear to overwinter between Keno Dam and Link River Dam and return to Spencer Creek to spawn in the spring. At Keno Dam, the estimated number of redband trout ascending the fish ladder alternated from about 200 fish in 1988 and 1990 to 60 fish in 1989 and 1991. Over all years of trap operation, approximately 12% of the estimated number of fish that migrated over Keno Dam were captured in March and April while 77% were captured in October and November.

Anecdotal information suggests that redband trout once migrated freely upstream and downstream throughout Project reaches and to tributaries above Upper Klamath Lake. However, by the early 1990's, ODFW research staff reported that from results of fish tagged at the Link River Dam (owned by USBR), connectivity between redband trout populations in the Link River Reach of the Upper Klamath River and tributaries of Upper Klamath Lake was sporadic and represented only a small fraction of the adults produced downstream of Upper Klamath Lake (Buchanan et. al. 1990, 1991, ODFW 2006). Of the fish floy-tagged at Link River Dam, four were caught by anglers in Upper Klamath Lake; one was recaptured in December 1990 near spawning areas at Kirk Springs on the Williamson River, a tributary at the north end of Upper Klamath Lake; and another was recaptured in April 1991 in the upstream migrant weir trap of Spencer

Creek. These results support the anecdotal information and demonstrate that fish historically migrated freely throughout the Project reaches and into tributaries above Upper Klamath Lake until Project dams were constructed.

Although a small percentage of fish (12%) caught in the Keno Dam trap showed movement timing that suggested spawning may be occurring above Keno Dam, Keno Reservoir has inundated any potential spawning habitat and redband trout spawning has never been observed in Link River (ODFW 2006). The 1966 ODFW Klamath Annual Report reported that:

> "Salvage Operations were conducted on the Klamath River above the construction site of Pacific Power and Light Company's Keno Dam. Sections of the river were drained so that the channel could be deepened. Eight hundred and seventy five rainbow trout from 6-25 inches were salvaged. Mortalities occurred because deep pools, turbid water and enormous amounts of aquatic vegetation made it difficult to reach some of the stranded fish on time. Table 13 lists the results of salvage operations. A total of 325 rainbow trout mortalities were documented."

Table 13 from the 1966 ODFW Monthly Report:

Table 13

Numbers of rainbow trout salvaged from Klamath River during channel changes at Keno Dam construction and the numbers of mortalities that occurred

Date	Length of channel, miles	Size range, inches	Number salvaged	Number mortalities
4/5-6	0.50	6-25	275	125
6/10	0.25	15-25½	250	50
7/20	0.75	8-20	200	50
9/30	0.10	8-15	150	100
Total			875	325

The information indicates that habitat inundated by Keno Dam was important spawning and potentially provided some rearing habitat as well. While fish habitat under Keno Reservoir will continue to be inundated in the new license, it is essential to improve ladder passage for redband trout, ESA-listed suckers and other native fish species to maintain connectivity and migratory life histories of native fish populations.

Upstream Passage Problems at Copco 1, Copco 2 and Iron Gate dams:

The remaining project dams and diversions including Copco 1, Copco 2, and Iron Gate dams and the Spring and Fall Creek diversions do not have upstream fish passage facilities. The Licensee has not proposed any upstream fish passage facilities at Copco 1, Copco 2, and Iron Gate dams but has proposed fish ladders for the Spring and Fall Creek diversions.

Upstream Passage Problems at Spring and Fall Creek diversions:

The Spring and Fall Creek diversions do not have upstream fish passage facilities. The proposed ladders at the Spring and Fall Creek diversions will have pool and weir type ladders with a 0.5 foot vertical jump. However, these facilities will need to meet all fish passage criteria described in OAR 635-412-0010 through 0040.

Reintroduction of Anadromous Fish: Pacific lamprey, spring and fall Chinook salmon, coho salmon, and steelhead trout were present historically above the Project. Adequate passage conditions will ensure that the project does not impair future restoration of fish populations in the upper Klamath system.

Fish passage through the Project for a suite of species is essential to reconnecting the system ecologically. The Klamath River once supported the third largest salmon and steelhead runs on the Pacific coast. Runs of spring and fall chinook salmon and were present in upper basin tributaries to the Upper Klamath Lake. Steelhead were in the Mainstem River up to Link River Falls and possibly in the Upper Klamath Basin (Buchanan et. al. 1994), and coho were documented in the Klamath River above Iron Gate and Copco dams. Pacific lamprey distribution is thought to have coincided with anadromous fish distribution.

The Project effectively blocks access and upstream movement of salmon adults into the historic spawning areas above RM 190 and many important tributary habitats. The dams further constrain the ability of smolts and juvenile fish to migrate downstream. The present day distribution of anadromous fish in the Klamath River is restricted to below Iron Gate Dam. Coho have been listed as threatened under the Endangered Species Act. This listing along with declines in salmon and steelhead runs emphasize the need to provide mitigation that will increase or restore self-sustaining populations in historic ranges to ensure conservation of species. Fish passage is essential mitigation that will address the loss of natural fish production capability from historic habitat in and above the Project and loss of fish harvest opportunity from Project operations.

The Klamath River was once one of the largest salmon-producing watersheds on the west coast, supporting large anadromous fish runs that included spring and fall-run

Chinook salmon, coho salmon, steelhead, green sturgeon *Acipenser medirostris*, and anadromous Pacific lamprey. These runs supported significant commercial, recreational, subsistence, and tribal harvests. Upper Basin Tribes also relied on extensive harvests of suckers, lamprey, and potamodromous trout.

Spring and fall runs of Chinook salmon occurred in the Sprague, Williamson, and Wood Rivers in the Upper Klamath Basin, now all rendered inaccessible to anadromous fish by the construction of Copco Dam in 1918. These rivers were important salmon spawning streams (Fortune et al. 1966; Lane and Lane Associates 1981; Hamilton et al. 2005). Steelhead trout also migrated through the Project area to upper basin tributaries. Coho salmon and Pacific lamprey historically accessed habitat above Iron Gate Dam.

Salmon passage was considered before the 1918 completion of Copco I Dam blocked upstream fish passage in the Klamath River. During construction of the dam, the Klamath Tribes noted that salmon runs were affected, and the Vice President of the California-Oregon Power Company stated the company's intention to provide a fish ladder at Copco I Dam. Provision of a ladder at Copco I was also consistent with the wishes of the BIA. Subsequently, however, the power company decided to build a hatchery at Fall Creek, and not to construct a fish ladder at Copco I (USDI 2004).

<u>Habitat Production Potential</u>: Huntington (2004) conservatively estimated over 110,000 returning adult spring and fall chinook (Table 2) as a lower end of potential productivity

and more than 6,500 returning adult steelhead if passage is provided through and above the Project (Huntington 2004, 2006). Huntington also estimated potential productivity from existing suitable habitat based on multiple, simple expansions from other data, an analysis that suggested 18,700 Chinook salmon and about 8,000 steelhead trout could result from providing passage at this time. Huntington's estimates of potential production are based entirely on habitat potential and do not account for mortality caused by fish passage facilities at existing hydropower dams, effects of flows, poor water quality (especially temperature), and harvest. Huntington's estimates also do not account for additional fish produced as "half pounders", a life history of pre-cocial steelhead produced in many southern Oregon and northern California rivers. The river above Iron Gate Dam would likely produce half pounders due to the fact that Bogus Creek steelhead have almost an 100% half pounder life history and provide a very popular fishery from Seiad Valley to the mouth of the Klamath River.

Huntington (2006) also estimated that over 50 miles of habitat was immediately available for use by anadromous salmon and steelhead within Project reaches (Tier 1). The author estimated an additional 300 miles of immediately usable historic habitat and 60 mile of recoverable habitat is available in the upper Klamath basin above Link River Dam when passage is provided at Project facilities (Tier 2).

Table 2. Adult Chinook Estimates (number of returning spawners) of historic production, present production below Iron Gate Dam, and production in reaches above and below Upper Klamath Lake. Data from Huntington 2004.

Reach	**Before Dams**	**Present**	**Full Volitional Passage**
Mouth to Iron Gate Dam	101,000	Average 46,000	46,000

Iron Gate Dam to Upper Klamath Lake	27,800	0	3,200
Above Upper Klamath Lake	111,200	0	17,800
Total	**240,000**	**46,000**	**67,000**

In the Pacific Northwest, reintroduction and/or restoration via dam removal or passage improvement efforts at FERC hydroelectric projects is underway on the Elwha, Deschutes, Lewis, Cowlitz, Skagit, Umpqua, Hood, White Salmon, Sandy, Clackamas, Willamette, and Upper Columbia rivers. There are numerous examples of successful introductions of anadromous salmonids to new habitats from Alaska (Blackett 1981; Wright et al. 1997; Bryant et al. 1999) as well as New Zealand, Chile, and the Great Lakes (Healy 1991 in (Groot and Margolis 1991).

Native, Potamodromous Fish: Improved passage at the Oregon and California Project dams provides benefits to the restoration of native migratory redband trout including restoration of historical seasonal migration patterns for immature fish, restoration of population connectivity and genetic diversity. The development of detailed design and construction plans in consultation with ODFW and affected agencies is critical to ensure that effective passage measures are incorporated into the design. The construction timelines are necessary to meet resource goals and objectives as quickly as possible.

Habitat fragmentation and degradation have been identified as the most likely limiting factors for native migratory redband trout and ESA-listed suckers in the Klamath River. With the exception of JC Boyle and Keno that have passage facilities with limited effectiveness, the five mainstem dams of the Project lack passage and have isolated potamodromous fish populations. Native fish abundance is reduced within some segments, and disrupted potamodromous fish movement is disrupted between river segments.

The JC Boyle and Keno dams have ladders with a pool and weir design, however, ODFW considers the ladders an obstacle to fish passage due to inadequate design. Historically, migrations of redband trout were documented throughout the Klamath River basin. Redband trout in the JC Boyle and Keno areas of the river exhibit a spring time migration from the Frain Ranch area at river mile (RM) 217 to Klamath Lake at RM 251, with a smaller migration during the fall (Fortune et. al. 1966). The evidentiary record prepared by ODFW regarding redband trout passage at JC Boyle Dam indicates that 95-98% of adult fish passage has been lost (ODFW Response to DLA 2003 (State of Oregon 2003), Buchanan et. al. 1991, Hemmingsen et. al. 1992, Hemmingsen 1997). Contemporary passage continues to be less than 5-10% of that reported 1 year after project construction of JC Boyle Dam. In addition, the size of redband trout passing over the ladder showed a significant decline in length in the intervening 30 years (Buchanan et. al. 1991). Buchanan et. al. (1994) reported that the close similarity of redband trout from Spring Creek and Trout Creek (which are above Upper Klamath Lake) to Spencer Creek and the Klamath River (which are below Upper Klamath Lake) and to steelhead from Bogus Creek in California suggests that some of these lake populations were once associated with runs of anadromous rainbow trout. The ladder at JC Boyle is steeper than current ODFW criteria for trout. Its entrance location, flow and water quality relative to the river may provide poor attraction for upstream migrating fish.

Similarly, the Keno Dam ladder has a much steeper slope than the criteria for passage of suckers. Sucker passage is important at this ladder to reconnect endangered suckers in the Keno Reach and Topsy Reservoir to sucker habitat upstream of Keno Dam, including Upper Klamath Lake. Most of the automated weirs lack adequate orifice passage. Fish using the ladder have to jump over the last four weirs to pass into the reservoir. Trapping studies indicated that while some trout use the ladder, the Keno fish ladder does not meet ODFW criteria for passage of trout.

Locations of the entrance, weir design, flow velocity, hydraulic gradients and water quality at the JC Boyle and Keno ladders have not been evaluated by the Licensee during the relicensing process to ascertain rainbow trout, lamprey and sucker population passage needs and potential reintroduction of anadromous fish. The JC Boyle ladder is contained in License article 32 of the existing FERC license. Future facilities will require hydraulic evaluation to determine facility effectiveness. Future facilities will also require biological evaluations to assess passage effectiveness, potential migration delays, fallback or injury, fishway entrances, ladder configurations, and velocity gradients or barriers. The Licensee will also need to further modify newly constructed facilities based on biological and hydraulic evaluation study results and agency approval, to ensure proper performance.

4. Downstream Fish Passage Facilities

4A. *Downstream Passage at JC Boyle Dam.* *The Licensee shall provide designs and upon ODFW approval, construct volitional downstream fish passage at JC Boyle Dam. The Licensee shall, to provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout, as well as protection of federally listed suckers, construct, operate, maintain, and evaluate a fish screen at JC Boyle Dam. The screens shall be operated year-round and shall be designed in accordance with OAR 635-424-0100 through 0040 or alternative criteria as determined by ODFW and other Fish Agencies. The screens shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project maintains operational control.*

Passage facilities shall be designed to include a trap for evaluating screen performance and to accommodate long-term monitoring of the downstream migrant population. The screens shall divert all fish to a sorting facility, where federally listed suckers are segregated from downstream migrating fish and suckers are returned to upper JC Boyle reservoir on a daily basis. Downstream migrating fish shall be delayed no longer than eight hours, with the exception that fish captured at night shall be released at night, while fish captured during the daylight shall be released during daylight.

Construction of downstream fish passage facilities at JC Boyle Dam must be completed within four years of license issuance. Hydraulic evaluation of each facility shall be initiated within one month following construction completion. Biological evaluation shall be initiated within a timeframe established through consultation with ODFW and other Fish Agencies, considering the timing and magnitude of potential fish migration.

The screen and bypass design shall meet the criteria set forth in OAR 635-412-0035 and, for fishway components which are not addressed in OAR 635-412-0035, be designed in accordance with current NMFS or USFWS fish passage criteria and guidelines for juvenile and adult redband trout, ESA-listed sucker species and Chinook salmon, Coho salmon, steelhead, and Pacific lamprey. Performance standards for fish passage of juvenile fish are stated in Table 2 of Section 4F. In addition, the screen and bypass design must include adequate facilities for evaluating screen and bypass facility performance (e.g. fish trapping capability). The screen facility, where appropriate, shall include criteria recently adopted by interagency agreement of ODFW, USFWS, and CDFG in July 2005 for interim criteria for the upper Klamath basin (not set forth in OARs). These include NMFS juvenile salmonid criteria, except in slack water where a bypass is not practical, an approach velocity of 0.2 ft/sec, or a special site agreement with the three fish agencies.

4B*. Downstream Fish Passage at Keno Dam.* *Within one year of license issuance, the Licensee shall prepare a biological evaluation plan after consultation with ODFW and other Fish Agencies to determine safe, effective downstream fish passage at Keno*

Dam. The Licensee shall allow a minimum of 60 days for ODFW and other Fish Agencies to comment and make recommendations prior to filing the plan with the Commission. The Licensee shall include with the plan documentation of consultation and copies of comments and recommendations on the completed plan after it has been prepared, and provide to ODFW and other Fish Agencies, and specific descriptions of how ODFW and other Fish Agencies' comments are accommodated by the plan.

Within two years of license issuance, the Licensee shall implement the approved biological evaluation plan to determine whether passing through the small gate openings of the spill gates, auxiliary water supply, or sluice conduit is harmful to potamodromous and anadromous fish. The Licensee shall use the results of the evaluation, in consultation with ODFW and other Fish Agencies to determine whether spillway modification is necessary, and implement any necessary changes. The evaluation may be conducted by radio tagging groups of fish released upstream of the dam, setting up receiver antennas in the spill gate openings, and monitoring passage. Continued tracking shall assess mortality. The Licensee shall trap a sample of fish as they exit through the spill gates to examine fish for physical injury.

Within four years of license issuance, the Licensee shall implement modifications to downstream passage facilities for downstream migrating juvenile fish.

4C. *Downstream Passage at Copco 1, Copco 2 and Iron Gate Dams and Spring and Fall Creek diversions.*

The Licensee shall design, and upon ODFW and other Fish Agencies' approval, construct new screen and bypass facilities at the Klamath Project California mainstem hydroelectric facilities to provide volitional fish passage at Copco 1, Copco 2 and Iron Gate dams, and at Spring and Fall Creek diversions for native potamodromous and anadromous fish species. The downstream fish passage facilities must meet performance standards and criteria established by the Fish Agencies for juvenile and adult rainbow trout at the Spring and Fall Creek diversions, and meet applicable criteria for anadromous fish including chinook and coho salmon, steelhead, and Pacific lamprey at Copco 1, Copco 2 and Iron Gate dams.

The Licensee shall provide designs, and upon Fish Agencies approval, construct volitional downstream fish passage at Copco 1, Copco 2 and Iron Gate dams and at the Spring and Fall Creek diversions. The Licensee shall provide for the safe, timely, and effective downstream passage of Chinook and coho salmon, steelhead trout, Pacific lamprey, and redband trout, as well as protection of federally listed suckers. The Licensee shall construct, operate, maintain, and evaluate fish screens at Copco 1, Copco 2 and Iron Gate dams and at the Spring and Fall Creek diversions. The screens shall be operated year-round and shall be designed in accordance with applicable criteria. The screens shall provide for the uninterrupted passage of fish over the full range of river flows for which the Project diversions maintain operational control.

Construction of the downstream fish passage facilities must be completed within six of license issuance for Copco 1 and 2 fish passage facilities and at for Iron Gate Dam *within five years of license issuance. Construction of downstream fish passage facilities at the Spring and Fall Creek diversions must be completed within three years following license issuance. Hydraulic evaluation of each facility shall be initiated within one month following construction completion.*

Passage facilities shall be designed to include a trap for evaluating screen performance and to accommodate long-term monitoring of the downstream migrant population. Downstream migrating fish shall be delayed no longer than eight hours, with the exception that fish captured at night shall be released at night, while fish captured during the daylight shall be released during daylight. Biological evaluation shall be initiated within a timeframe established through consultation with the Fish Agencies, considering the timing and magnitude of potential fish migration by all native species.

4D. Downstream Passage at Eastside and Westside Diversions. *The Licensee shall, after consultation with ODFW and other Fish Agencies, prepare a Decommissioning Plan for the Eastside and Westside diversions that includes permanent sealing of the intakes and fish-proofing of potential areas of mortality or injury. The Licensee shall allow a minimum of 60 days for ODFW and other Fish Agencies to comment and make recommendations prior to filing the plan with the Commission. The Licensee shall include with the Decommissioning Plan documentation of consultation and copies of comments and recommendations on the completed plan after it has been prepared and provided to ODFW and affected agencies, and specific descriptions of how ODFW and affected agencies' comments are accommodated by the* *plan. Within one year of license issuance, the Licensee shall submit the Decommissioning Plan to the Commission for approval. The Licensee shall implement the Decommissioning Plan within one year of approval by the Commission.*

4E. ***Submittal of Draft Designs.*** *The Licensee shall, within two years of license issuance, develop detailed design and construction plans for review and approval by ODFW and other Fish Agencies prior to construction. The design shall include features to hold and sort fish by age and species for the safe, effective, and timely passage of fish. The Licensee shall provide a minimum of 60 days for ODFW and other Fish Agencies to review and comment on the fish screen design and construction plans. The Licensee shall implement any design modifications necessary for the downstream movement of fish as required by ODFW. The approved designs shall be filed with the Commission. The Licensee, after consultation with ODFW and other Fish Agencies and within six months from the start of construction shall file for Commission approval functional design drawings of the downstream fish passage facilities.*

***4F*. Performance Standards.** *The Licensee shall design, construct, test, operate, and maintain fish screen(s) in accordance with criteria set forth in OAR 635-412-0010 through 0040 and must meet performance standards set forth in Table 3 below. Fishway components which are not addressed in OAR 635-412-0035 must be designed in accordance with current NMFS or USFWS fish passage criteria and guidelines for juvenile and adult redband trout, ESA-listed sucker species and Chinook salmon, Coho salmon, steelhead, and Pacific lamprey.*

Table 3. Performance Standards for Klamath Hydroelectric Project Fish Screens

Smolts > 60 mm in Length		*Fry < 60 mm in Length*	
Mortality	*Injury*	*Mortality*	*Injury*
Design performance objective < 0.5% mortality	*Design performance objective < 2% injury*	*Design performance objective < 2% mortality*	*Design performance objective < 4% injury*
Actual mortality ≥ 0.5% but < 2% would require additional work to lessen mortality	*Actual injuries ≥2% but < 4% would require additional work to lessen injuries*	*Actual mortality ≥ 2% but < 4% would require additional work to lessen mortality*	*Actual injuries ≥4% but < 6% would require additional work to lessen injuries*
Actual mortality ≥ 2% would require major operational or structural changes	*Actual injuries ≥4% would require major operational or structural changes*	*Actual mortality ≥4% would require major operational or structural changes*	*Actual injuries ≥6% would require major operational or structural changes*

The criteria contained in Table 3 will be applied as follows:
1. Design and build the screen to achieve injury and mortality rates contained in the first horizontal row of the table.
2. Test the screen hydraulically and balance the screen to optimize performance.
3. Test the screen biologically. If test results indicate that injury and mortality rates associated with the screen fall within the range of values contained in the first horizontal row of the table, no additional modifications to the screen are required.
4. If test results indicate that injury and mortality rates fall within the range of values contained in the second horizontal row of the table, undertake minor additional modifications to reduce injury and mortality rates. The objective of such modifications is to achieve the injury and mortality rates contained in the first horizontal row of the table. However, if minor additional modifications fail to achieve the injury and mortality rates contained in the first horizontal row of the table, but injury and mortality rates fall within the range of values contained in the second horizontal row of the table, no major modifications are required.
5. If test results indicate that injury and mortality rates associated with the screen fall within the range of values contained in the third horizontal row of the table, the Licensee shall undertake major operational or structural modifications to reduce injury.

4G. *Post Construction Evaluation and Improvements.* *In the event that performance standards in Table 3 are not met during the post construction evaluation period, the*

Licensee shall implement changes to Project operations or facilities at any facility not meeting the performance standards within a time frame established by ODFW and other Fish Agencies and developed through consultation with the Licensee. Measures to bring the screens into compliance with performance standards at each facility may include, but are not limited to, the following: (1) improved hydraulic balancing of screens or structural modifications, (2) construction of additional screening facilities, (3) seasonal shutdowns of turbines, and (4) reductions in flow diversions.

4H. *Written Operation and Maintenance Procedures*. *The Licensee shall develop written standard operation and maintenance procedures (including operator training and supervision) to ensure that the downstream fish passage facilities operate effectively during the life of the Project. The operation and maintenance plan shall include procedures for prior notification and coordination with ODFW and other Fish Agencies on maintenance scheduling or emergencies that may affect functioning of the facilities. The operation and maintenance plan shall include measures for daily inspections of downstream fish passage facilities for staff gage readings and obstructions during the peak seasonal migration of major species including redband trout, suckers and anadromous fish, and include weekly inspections during non-peak migrations.*

4I. *Post Construction Monitoring Plan*. *The Licensee shall, prior to the completion of construction of the new fishways, in consultation with ODFW and other Fish Agencies, develop a post-construction monitoring and evaluation plan to assess the effectiveness of the fishway. The plan shall include hydraulic, water quality, and biological* *evaluations to assess the performance of the fishway, including measures for follow-up evaluations of fishway effectiveness. The plan will guide monitoring activities immediately following construction to evaluate the fish passage facilities. The plan shall determine whether fish death, injury, or delay is occurring, and whether fish have difficulty in locating the screen and bypass facilities. The plan must include the estimation, through statistical sampling, of the number of fish, by species, size, and age class observed at each facility and a record of the daily observations by a qualified fisheries biologist on the physical condition of the fish using the fishways. The plan must also include provisions for documentation of a continuous record of DO and water temperature within the fishways at locations to be determined by ODFW, ODEQ and Fish Agencies, and in front of and adjacent to the entrance(s) and exit(s) of the fishways. The evaluation plan and the results of effectiveness monitoring shall be provided to ODFW, ODEQ, and other Fish Agencies for review and comment. At least 60 days shall be provided for review. The results of the monitoring shall be submitted to the agencies according to the approved schedule. If the results of the monitoring show that modifications to the facilities are necessary to eliminate or minimize adverse impacts to the fish resources, the Licensee shall file with the Commission recommendations for modifying the facilities and a schedule for implementing the measures that shall incorporate agency recommendations developed through consultation. The Licensee shall implement any plan, operational or physical modifications deemed necessary for the safe, effective, and timely passage of fish identified by ODFW and other Fish Agencies. Measures to bring the screens and bypass facilities into compliance with the standards may include, but are not limited to,* *improved hydraulic balancing, structural modifications, seasonal Project shutdown, or reduction in flow diversion. These changes may be required for the remaining term of the license or may be required temporarily until alternative measures are approved and implemented to achieve the standards.*

4J. ***Operations and Maintenance.*** *The Licensee shall maintain all downstream fish passage facilities by keeping them in good repair, and open and free from obstructions at all times, consistent with state and federal law.*

4K. ***Maintenance Shutdowns and Fish Salvages.*** *The Licensee shall notify ODFW and other Fish Agencies at least two weeks in advance of any contemplated maintenance shutdowns that may result in dewatering the fishways or reduced flow conditions that may result in stress or mortality to fish. The Licensee shall salvage live fish from the waterways during such maintenance shutdowns and consult with state and federal agencies to determine where the salvaged fish will be relocated.*

4L. ***Decommissioning.*** *To the extent that agency consultations determine that it is infeasible to provide safe, timely and effective downstream passage at any Project facility, the Licensee shall prepare a decommissioning proposal for the subject facility in consultation with state, federal and tribal stakeholders.*

Issue and Rationale

Compliance with State Law: Much of the same Issue and Rationale discussed in upstream passage recommendations applies to downstream passage as well. The Licensee does not operate the Project in compliance with ODFW's statutes, rules, and fish management plans. The JC Boyle fish screens and bypass facilities are ineffective for native trout and suckers while the Eastside and Westside diversions and California Project diversions have no screen and bypass facilities to prevent entrainment of fish. The Project entrains indigenous trout and suckers into diversion canals, depleting fish populations. Entrainment of fish into the power canals removes them from natural streams, removes them from the spawning population, causes injury and mortality by increased predation and passage through turbines, and reduces recreational opportunities.

ODFW has a responsibility to protect downstream migrating fish under ORS 498.311 and 509.615. These statutes require installation, operation, and maintenance of a fish screen on any diversion of water in Oregon by the project diverter, in this case, the Licensee. ODFW provided screening criteria for hydroelectric projects with specific guidance and criteria on implementing screening facilities that best protect fish species in Oregon in our comments to the FSCD. There are additional criteria to reflect the unique needs for sucker juveniles. New facilities will need to be constructed at all the Licensee diversions for the Klamath Hydroelectric Project to meet the needs of lamprey and suckers in the basin as well as salmonids (OAR 635-412-0010 through 0040).

In the event that the Licensee reconsiders operating the Eastside and Westside diversions, ODFW reserves the right to prescribe 10(j) fish passage recommendations for native redband trout and federally listed Lost River and Shortnose suckers according to standards and criteria set forth in OAR 635-412-0010 through 0040.

Existing Downstream Fish Passage Project Facilities: Currently, there are no downstream fish passage facilities at the Project diversions and dams in California. There is a screen and bypass system at the JC Boyle facility. There are no downstream fish passage facilities at the Link River Eastside and Westside diversions. Turbine entrainment at all Klamath Hydroelectric Project causes significant mortality to downstream migrating fish. For the facilities on the mainstem Klamath River which lack screens and divert flow through Francis turbines, one can assume a 24% average mortality based on the literature (Electric Power Research Institute (EPRI) 1987). Based on the literature and limited site specific sampling, significant numbers of native, potamodromous fish are currently entrained and killed at Project facilities. Dams with a higher degree of head cause far greater mortality due to pressure changes and either immediate mortality or delayed mortality due to disorientation and predator mortality.

Downstream Passage Problems at Link River Eastside and Westside diversions:

Entrainment and turbine mortality harm large numbers of native fish species including ESA-listed shortnose and Lost River suckers and redband trout. Typical diversion flows for the East Side and West Side are 1,200 cfs and 250 cfs respectively (Fishpro 2000). Neither of these diversions is screened to prevent entrainment of fish into the power canals. ODFW believes screens are needed at these locations to protect lamprey, suckers, and resident trout (PacifiCorp 2003, DLA, Table 5.3-20 [information not included in the FLA]).

PacifiCorp and Cell Tech completed an entrainment study at the Eastside and Westside powerhouse canals on the Link River from 1997 to 1999 (Gutermuth et al. 2000). Based on entrainment indices calculated from the number of fish collected, percent of canal flow sampled and sampling efficiency, an estimated 792,000 fish passed through the Eastside powerhouse from July 1997 to October 1999. Similarly, an estimated 528,000 fish passed through the Westside powerhouse. The study concluded that large amounts of fish were diverted, generally proportional to the volume of the flow diverted. The study indicated that large amounts of juvenile and adult suckers were captured moving downstream, through the spring, and especially during late summer and early fall. Overall, Westside catch rates were very high often following re-opening of the canal after a period of closure. Within the late summer period of high sucker entrainment, sucker and all fish entrained increased with canal flows. Overall, Westside catch rates were very high often following re-opening of the canal after a period of closure. Within the late summer period of high sucker entrainment, sucker and all fish entrained increased with canal flows. Some rainbow trout were also entrained during the study although they were a relatively small percentage of the catch.

PacifiCorp conducts fish salvage operations to recover any suckers or trout stranded following certain spill reductions at Link River Dam, Eastside powerhouse, and at project facilities that need to be dewatered for waterway or powerhouse maintenance (Lesko 2003). Salvage procedures allow fish to be relocated while minimizing stress on the fish and possible mortality. The company's fish salvage procedures for specific project facilities are described in PacifiCorp's 1996 Draft Operations and Maintenance Plan. Salvages at the Link River facilities (Eastside and Westside) occur typically in the Eastside canal, the Link River dewatered below the dam, and the reach below the powerhouses. From 1995-2005, a total of 782 suckers and 220 redband trout have been salvaged during maintenance activities. Of the 782 suckers, 228 were federally listed species, of which shortnose and Lost River suckers comprised 24% and 5%, respectively. The remaining suckers were unidentified due to a small size of less than 6 inches that makes species identification impossible.

Downstream Passage Problems at JC Boyle Dam:

Existing Design Problems:

The design parameters used for the construction of the existing downstream juvenile screens and bypass facilities are outdated and there is no practical or cost-effective means to reconstruct the facilities to meet current standards to allow for more efficient fish passage. Improving downstream fish passage with appropriate installation of screening facilities is an identified objective of the ODFW's Klamath River Subbasin Fish Management Plan (ODFW 1997) and is a goal of other agencies involved in the FERC relicensing.

Presently, each of the four entrances at the intake structure is equipped with Rex vertical traveling screens to prevent entrainment of fish into the power canal (CH2MHill 2003). The existing screens are 11’2” wide and 29’6” high at a low forebay of 3,788 ft. This screen height assumes 6 inches at the bottom of the screen is ineffective due to the normal seal arrangement. The gross approach area for each of the four screens is 329.4 square feet for a total gross area of 1,318 square feet. The resulting approach velocity with an intake flow is 2.3 fps, which, is almost six times the modern criteria of 0.4 fps. The existing screen bypass system, although consistent with the design one would normally expect for traveling band screens, does not meet modern design standards. The flow rate for the existing bypass is estimated at 20 cfs.

High pressure spray systems are supposed to keep the screens free of debris buildup. Fish screen housings were modified in 1988 to allow year-round operations, prior to that time; screens were removed during the winter period to avoid ice buildup. Metal screens were replaced in 1992 with 1/8 mesh, but debris occasionally damages the screens requiring time-consuming repair with no backup screens in place during repair. Chronic damage to the screens has reduced the effectiveness of the screens to protect fish from entering the power canal. For example, in the spring of 2000, one of the screens was pulled for a period of several months due to damage from floating debris. The Project continued to generate power and not provide fish protection during the entire time.

There is also no tailrace barrier at the powerhouse.

Biological Studies and Results:

- The Licensee conducted a radio telemetry study of 42 tagged fish to assess upstream passage at JC Boyle dam. Ironically, of the 42 fish, only adult passed successfully over JC Boyle Dam, and that same fish passed downstream through the power canal and turbines.
- Beak consultants placed a fyke net in the fish ladder and fished once a week for a 24-hour period from April to mid-June and August through mid-October 1984 (City of Klamath Falls 1986). They estimated a downstream movement of 128,246 juveniles.
- In 1991, over 25,000 juvenile (age-1+) redband trout were captured in the downstream-migrant weir trap in Spencer and most of them were marked by a caudal clip and released. In order to estimate the magnitude of recruitment of juvenile trout into the Klamath River Dewatered Reach, a rotary screw trap was installed in the dewatered reach approximately 200 m downstream of JC Boyle Dam in April 1991 and operated through May 1992. Over this period, only 54 marked trout from Spencer Creek were recaptured in the screw trap. Although these catches were not intended to estimate abundance, the researchers were surprised by the low numbers of juveniles that passed below the dam (Buchanan et al. 1991; Hemmingsen et al. 1992). These results suggested that the operation of JC Boyle Dam may impede recruitment of juvenile trout from Spencer Creek to downstream portions of the Klamath River. Based on informal assessment of angler catches, the

trout populations appears to be sustaining a limited fishery but with extremely conservative regulations of one trout per day, flies and lures only.

- ODFW Research staff radio-tagged and PIT-tagged outmigrating juvenile trout captured in a weir trap near the mouth of Spencer Creek in 2004 and 2005 (ODFW 2006). Fixed telemetry receiver stations were installed on the JC Boyle Dam and fish ladder; the Klamath River dewatered reach, and the powerhouse diversion canal. In 2005, a receiver was added at the upstream end of Topsy Reservoir to monitor fish movement into the first 500 m of the Keno reach of the Klamath River. In the first year of study, 2004, there was no movement of radio-tagged juvenile trout from Spencer Creek below JC Boyle Dam. By mid July 2004, when all transmitter batteries had expired, 71% of radio-tagged trout remained in lower Spencer Creek and 25% in Topsy Reservoir. In the second year of the study, 2005, more fish moved upstream toward the Keno Reach after exiting Spencer Creek and recruitment downstream of JC Boyle Dam also was observed. By mid July 2005, 34% of radio-tagged trout remained in lower Spencer Creek, 31% (20/65) of the radio-tagged fish moved to upper Topsy Reservoir or the Keno Reach, and 17% (11/65) of radio-tagged trout were observed downstream of the dam. Telemetry receiver stations detected one fish moving downstream via the fish ladder, at least four through the fish bypass facility, two via the power diversion canal, and four may have passed over the dam through the spillway during peak discharge in May. Differences in juvenile dispersal between 2004 and 2005 appeared to be related to the dramatic differences in Klamath River discharge and operation of JC Boyle Dam. Over 70% (8/11) of the downstream passage of juvenile trout over the dam occurred when the dam spillway was open. In 2004, peak discharge on the Klamath River only reached 2,000 cfs and the spillway was not opened during the study period. These results suggest that inter-annual variability in discharge and dam operation affect juvenile fish passage over JC Boyle Dam and recruitment to the dewatered reach of the Klamath River.

- The May 1988 monthly report also reported sampling the attraction flow diffuser chamber at Boyle Dam with a backpack electroshocker, and 7 redband trout were from 142-337 mm.
- ODFW monthly reports documented fish salvages in the JC Boyle power canal of 133, 12 and 68 trout in July 1988, 1990 and 1991, respectively, when the Project was shut down for annual maintenance. Fish ranged in size from 50-300mm. This was reported as “alarming as only a small percentage of the total volume of water in the canal was sampled, and that fish screens had been operating at JC Boyle since the last shutdown. The finding of fish in the canal seems to indicate the effectiveness of the Boyle dam fish screening devices is limited at best”. The July 1989 salvage report was missing.
- The ODFW downstream trap in Spencer Creek captured a total of 37,483 juvenile redband trout from October-November 1990, March through September 1991, October and November 1991 and March through May 1992. These numbers were not adjusted for trapping effort but show patterns of downstream timing and relative abundance. However, the downstream screw trap in the Klamath River immediately below JC Boyle fish screen bypass captured only 152 juveniles from April through December 1991, and late February through May 1992.

- ODFW monthly reports from Klamath District staff began noting annual fish salvages were conducted by the Licensee in the JC Boyle power canal during annual maintenance operations starting in the mid-1980's. For example, the July 1984 monthly report documented:

> "PP&L [the Licensee] made their annual shutdown for maintenance of the Boyle project. We assisted them with salvage of trout from the flume. We salvaged about 200 rainbow trout alive; another 89 died from high water temperatures of 86F. These trout ranged from fish of the year to 13 [inches]. Jack Hanel, PP&L, speculated that the fish entered the flume this spring before they were able to install and maintain the screens which were delayed because of icing conditions. We are working with PP&L to streamline the salvage operation whenever it is necessary."

- The Licensee has documented all suckers and trout salvaged in the power canal during project shutdown and maintenance operations since 1995. The intake for the powerhouse canal is screened to prevent fish entrainment, but the screens do not effectively exclude fish. PacifiCorp crews drain the 2-mile canal for maintenance at least once per year and, using electrofishers to attempt to salvage redband trout and sucker species from the canal. These fish are counted and transferred to the peaking reach of the Klamath River. From 1996 to 2005, over 1,600 trout were salvaged in the power canal. Federally listed and identified suckers are occasionally salvaged as well.

The screens that are currently installed at JC Boyle Dam do not meet current design criteria and are ineffective. There are no practical or cost-effective means to reconstruct the facilities to meet current standards to allow for more efficient fish passage. Fish protection at the Licensee's diversions should provide at least the same level of protection as facilities recently constructed on other diversions within the basin, such as the A-Canal, 1,900 feet upstream from Link River Dam. The approach velocity at all 4 screens at JC Boyle Dam is 2.3 feet per second (fps), which is almost six times the modern criteria of 0.4 fps for redband trout and almost 11.5 times the interim agency criteria of 0.2 fps adopted in the upper Klamath basin for weaker swimming species including listed juvenile suckers. The existing screen bypass system, although consistent with the design one would normally expect for traveling band screens, does not meet modern design standards. The flow rate for the existing screen bypass is estimated at 20 cfs.

High pressure spray systems are supposed to keep the screens free of debris buildup. However, debris chronically builds up which occasionally damages the screens requires time-consuming repair, with no backup screens in place during repair. The last screen failure occurred on February 7, 2006 when two of the four screens collapsed with resulting non compliance with Article 32 of the existing license as the Licensee continued to operate the Project without screens in place. While the Licensee installed the traveling screens from the Powerdale project (FERC #2659) in place of the damaged screens 5 to 6 days later, these screens were documented not protect fish from entrainment in the power canal and to cause direct injury and mortality to several salmonid species during relicensing studies at the Powerdale project (FERC #2659).

Fish salvages in the JC Boyle power canal demonstrate significant impact to the redband trout and sucker populations. This is apparent in the number and size of trout and suckers salvaged during canal maintenance activities (ODFW 2001). Salvaged redband trout range in size from 50 to 300mm. PacifiCorp (1997) also reported tagging a high number of fish as a result of salvage operation in the canal below the dam. Salvage operations in the power canal document that fish of various species avoid the screen and bypass, and are diverted to the power canal and turbines. This information clearly indicates that both small and large fish are passing through or around downstream protection screens at JC Boyle.

Studies from the pilot study for radio-tracking upstream passage documented the migration of a single, large14-inch trout that passed upstream through the JC Boyle ladder and subsequently avoided the existing fish screens and migrated downstream through the power canal and turbines (USDI 2004).

The ODFW researchers documented that discharge, primarily spill, appeared to be correlated with juvenile migration from Spencer Creek to rearing areas below the dam (ODFW 2006). This was similar to the results documented regarding migration rates of steelhead kelts from through eight mainstem hydroelectric projects on the mainstem Columbia River. Fish migration from Lower Granite Dam to 8 km east of Portland on the Columbia River was poorer during low flow non-spill conditions in 2001 (4.1 %) than typical flow conditions in the year 2002. During spill periods on the Columbia River, 90% of steelhead typically passed Snake River and Columbia River dam using non-turbine routes whereas only 47.2% of steelhead kelts were directed out of the turbine intakes by fish screens during non-spill events (Wertheimer and Evans 2005).

Downstream Passage Problems at Keno Dam:

Although Keno Dam is not a hydroelectric dam but a reregulating dam, downstream passage of juvenile fish is still impacted. The sluiceway intake is not screened. All other flows go through undershot radial gates and into shallow areas that may be predator holding locations. Lack of downstream passage facilities at this dam may cause fish injury and mortality at low flow conditions. Keno Dam does not divert water to a power canal and passes stream flow through spill gates or the fish ladder, auxiliary water supply, and sluice conduit. Fish moving downstream must pass through one of these routes. Fish passing under the spill gates during low flow conditions (narrow spill gate opening) are subject to mechanical or hydraulic-caused injury and mortality.

Downstream Passage Problems at Copco 1, Copco 2, and Iron Gate dams:

The remaining project dams and diversions including Eastside and Westside diversions, Copco 1, Copco 2, and Iron Gate dams do not have downstream fish passage facilities. The Licensee has not proposed downstream fish passage facilities at Copco 1, Copco 2, and Iron Gate dams. All fish captured in the power canals are entrained and pass through the turbines. The lack of fish passage facilities has prevented federal and state agencies from meeting fish and habitat management objectives such as restoration of anadromous fish to historic habitat, reconnecting native resident fish populations, and improving production of native fish populations.

Downstream Passage Problems at Spring and Fall creek diversions:

The Spring and Fall Creek diversions do not have downstream fish passage facilities. All fish that are diverted with the flow (99% of the flow is diverted at both facilities) are entrained into the power canal and are highly subject to turbine injury and mortality. The proposed screens at the Spring and Fall Creek diversions will have diagonal-type screens with a maximum approach velocity of 0.4 feet per second (fps) and a sweeping velocity of 2 times the approach velocity. However, these facilities will need to meet all fish passage criteria described in OAR 635-412-0010 through 0040.

Reintroduction of Anadromous Fish: Many of the necessary components of the Klamath River ecosystem, despite degradation of habitats, appear to be present and functional, or are restorable to functional form. Roni et al. (2002) commented that a strategic approach to restoring Pacific Northwest Watersheds is to first focus efforts on reconnecting isolated, high quality fish habitats made inaccessible by artificial obstructions. Construction of effective upstream and downstream fishways on the Klamath River is consistent with this strategy. A run of over 30,000 hatchery and natural spring Chinook salmon still exists in the Trinity River and a remnant run of wild spring-run Chinook persists in the Salmon River. In the area of the Basin upstream from Iron Gate Dam, existing habitat continues to support fluvial and ad-fluvial populations of redband trout. In addition, several sources reported that significant unutilized habitat exists above the Project (Fortune et. al. 1966; Lane and Lane Associates 1981; National Research Council 2003; Chapman 1981; and Huntington 2004a).

An example of performance standards in the Pacific Northwest is contained in the 1995 NMFS Biological Opinion for the Columbia River hydro projects, which had a combined downstream fish passage efficiency criteria of 80% per project and 95% per dam survival, which was adopted by the Northwest Power Planning Council Fish and Wildlife Program in 1994. This fish passage criterion was adopted by fish managers in the 1980s as a way to address delayed mortality and included fish passage through non-turbine routes such as spill, sluiceways and screens. The long term fish passage efficiency standard for the Columbia River tribes is 90% which equates to 98% per dam survival.

These performance standards were updated in the 2000 NMFS Biological Opinion, the fish passage efficiency standard was changed to a direct survival standard, which is 95% per dam and 91% per project (dam and pool). This was an outcome of the survival standards developed by NMFS and the Mid-Columbia public utility districts for the Habitat Conservation Plan. For the Elwha River dams, fishery managers set a 98% passage standard for each dam as necessary to restore 5 stocks of salmon and steelhead. The downstream passage performance standards in this recommended license condition are consistent with those required for Soda Springs Dam by the FERC license for the Licensee's North Umpqua hydroelectric project (FERC #1927).

When anadromous species are restored above Project dams, juvenile out-migrants will be particularly vulnerable to this impact. The progeny of these fish must negotiate not only the reservoir but the dam, powerhouse, and spillway for each Project facility during their outmigration. Volitional fish passage to a bypass around the turbine intakes will ensure that ODFW meet its statutory goals and objectives for resource management. The development of detailed design and construction plans for review and approval by ODFW is essential to ensure that effective passage measures are incorporated into the design.

Native, Potamodromous Fish: Fortune et. al. (1966) reported that Klamath Basin redband trout exhibit a pattern of downstream migration as fry or juveniles and return upstream as adults. Downstream migration of fry and juvenile redband/rainbow trout has been diminished either due to a population decline and/or this life history has been nearly eliminated because the fish screens at JC Boyle are inadequate and Link River, Copco 1, Copco 2, and Iron Gate facilities have no downstream fishways. Project dams have fragmented habitat, which has resulted in significant effects to population abundance, life history diversity, and productivity.

ODFW Research staff monitored downstream movement below JC Boyle Dam to measure possible recruitment from Spencer Creek a major tributary above the Dam that provides the bulk of redband trout recruitment to the Klamath River (Buchanan et. al. 1991, Hemmingsen et. al. 1992, Hemmingsen 1997). The ODFW Research staff concluded that the low numbers of redband trout recruitment in the Klamath River below JC Boyle were not adequate to maintain the population in the river between JC Boyle Dam and the state line (Hemmingsen et al. 1992). While some trout recruitment is from a small spawning area documented in the dewatered reach, research personnel concluded that, based on an informal assessment of angler catches, the trout populations only appears to be sustaining a limited fishery with extremely conservative regulations of one trout per day, flies and lures only.

An examination of the age distribution of fish populations in different segments of the Klamath River fragmented by JC Boyle Dam also indicate the impact of lack of adequate passage and project operations from the hydroelectric power project. Historically, the river was known for its abundant population of large redband trout that migrated throughout the length of the Klamath River drainage. ODFW District staff documented that fish in the peaking reach are smaller in size and have significantly lower relative weights compared to fish in the Keno reach, largely due to peaking impacts which, cause catastrophic losses to shoreline macroinvertebrates (ODFW 2003). Lack of adequate fish passage over JC Boyle Dam inhibits native, migratory redband trout from moving to and foraging in more favorable habitats.

Buchanan et al. (1994) documented a remarkable genetic similarity of rainbow trout from Spring Creek and Trout Creek (tributaries above Upper Klamath Lake) to trout from Spencer Creek and the Klamath River (tributaries below Upper Klamath Lake) and to steelhead from Bogus Creek (below Iron Gate Dam). The study concluded that some of these upper basin populations were likely once associated with runs of anadromous rainbow trout. Fishways would reconnect these now fragmented populations and allow redband/rainbow trout and steelhead to be a source of adaptive variability in Klamath Basin salmonid populations.

Restrictive angling regulations have been implemented in riverine reaches of the Klamath River in recognition of redband populations impacted by Project facilities and operations. Significant recreational fisheries for redband trout remain popular in the Project area, as well as in Upper Klamath Lake, and its tributaries. Adequate upstream and downstream fish passage at JC Boyle Dam will result in restoring the connectivity of migratory redband populations in the mainstem Klamath River with those in Spencer Creek. Spencer Creek provides important habitat including spawning, and temperature related refugia areas for redband trout. Inadequate passage at JC Boyle Dam has impaired connectivity.

The only entrainment study completed for the Klamath Hydroelectric Project was at the Eastside and Westside diversions prior to relicensing from 1997 to 1999 (Gutermuth et al. 2000). Based on entrainment indices calculated from the number of fish collected, percent of canal flow sampled and sampling efficiency, an estimated 792,000 fish passed through the Eastside powerhouse from July 1997 to October 1999. Similarly, an estimated 528,000 fish passed through the Westside powerhouse. The study concluded that large numbers of fish were diverted, generally proportional to the volume of the flow diverted. Large amounts of juvenile and adult suckers were captured moving downstream, through the spring, and especially during late summer and early fall. Overall, Westside catch rates were very high, especially after re-opening of the power canal after a period of closure. Sucker entrainment increased in the late summer, and all fish entrainment increased as flows increased in the power canal. Some redband trout were also entrained during the study although they were a small percentage of the catch.

Entrainment and Turbine Mortality: Entrainment and turbine mortality can have serious consequences for fish populations, especially among anadromous species (Cada 2001). Survival of juvenile salmonids passing dams during their seaward migration is highest through spillways and lowest through turbines (Muir et. al. 2001), turbine mortality being caused by pressure changes, cavitation, shear stress, turbulence, strike, and grinding (Cada 2001). Unless protected by effective screen and bypass systems, fish migrating downstream can suffer injury or death by passing through turbines at hydroelectric plants (Electric Power Research Institute (EPRI) 1987). EPRI (1987) reported that Francis turbines, such as used at JC Boyle have an average mortality to downstream moving fish of about 24 percent. The JC Boyle development, at 440 feet of head, may have even greater mortality. For projects with Francis turbines, the EPRI study found a high correlation (r = 0.77) between head and fish mortality. Four hydroelectric developments with Francis turbines that had greater than 335 feet of head had mortality ranging from 33 to 48 percent (EPRI 1987). This indicates that entrainment mortality at JC Boyle is likely in this range with mortality caused by greater pressure differential.

The Licensee acknowledged, based on its initial review of other studies, that tens of thousands of resident fish are likely entrained annually at each of the unscreened mainstem Klamath River developments and estimated that about 10 to 20 percent of those fish are killed passing through each powerhouse (PacifiCorp 2004, Exhibit E 4-112). The Licensee estimated that approximately 85,848 fish are entrained annually at each mainstem development and that many of these fish are nongame or warmwater fish species.

The Licensee developed its turbine mortality estimates based on species composition of fish in the Project reservoirs and conservative estimates of fish mortality based on size. However, ODFW developed a rough estimate of potential redband trout mortality (excluding nongame and other fish species) based on fish salvage estimates from 1996 to 2005 from the JC Boyle power canal. Redband trout, suckers (including federally listed species) and thousands of nongame and warmwater species were salvaged in the canal during 12 fish salvage events between 1996 and 2005 for an average of 136 trout per event (Table 4).

Table 4. Number of redband trout salvaged from JC Boyle powerhouse diversion canal.

Year	Trout (N)
1996	81
1997	365
1998	63
1999	106
2000	NA
2001	78
2002	6
2003	88
2004	92
2005	750

The canal is approximately 2 miles long with a height of 18 feet and 60 feet wide which yields a total volume of 7,128,000 cubic feet for a canal at one turbine discharge (9 foot height of the canal). If we assume the Project has a peaking cycle of 12 hours, of which 6 hours is at an average peaking discharge of 1,500 cfs (a one-turbine discharge), and the volume for a foot of canal is 540 cubic feet, then flow averages approximately three feet per second. At that velocity, it would take a particle of water approximately 1 hour and 20 minutes to travel from the top to the bottom of the power canal. Therefore, when the canal is turned off for salvage events, approximately 1 hour and 20 minutes of flow is in the canal and must be discharged through the forebay spillway to conduct the salvage safely in a largely dewatered canal.

An average of 136 trout was salvaged in each event although capture ranged from 6 to 750 trout. The following assumptions are made 1) assume conservatively that no fish are entrained in the 6 hours of the peaking cycle when upramping and downramping for the peak, 2) assume the peaking cycle at 1,500 cfs lasts 6 hours, 3) assume as many fish were lost when the canal was dewatered over the spillway (for a total of approximately 270 fish), and 4) each salvage event represents 1 hour and 20 minutes of power canal volume, then the total number of trout entrained in a daily peaking cycle of 6 hours is 4.5 times the number of fish entrained during a salvage event. These calculations yield an estimated 1,224 redband trout are entrained in a daily peaking cycle. At an estimated 40% average mortality rate for high head Francis turbines (average of 33 and 48% mortality at high head dams), then approximately 500 redband trout are killed every day, or over 180,000 redband trout are killed every year at the JC Boyle Project, more than double the estimate developed by the Licensee.

ODFW staff concludes that there are many factors caused by the hydroelectric facility that have contributed to the decline in abundance and size of adult migratory redband trout in the Klamath River above and below JC Boyle Dam (ODFW 2006). Oregon's management of native fish is founded on the Native Fish Conservation Policy (OAR 635-007-0502-0509) which established in goal the effort to 1) prevent the serious depletion of any native fish species by protecting natural ecological communities, conserving genetic resources, managing consumptive and non-consumptive fisheries, 2) maintain and restore naturally produced native fish species, taking full advantage of the productive capacity of natural habitats, and 3) foster and sustain opportunities for sport, commercial, and tribal fishers. Implicit in the policy is a set of scientific assumptions and information that is concerned with the native fish stocks and health of the aquatic ecosystems that support them (Buchanan et al. 1991). Native fish from the Klamath basin exhibit different a variety of history traits including different tendencies to migrate, resistance to fish diseases, and different reactions to acute stress events and changed environmental conditions (Hemmingsen et al. 1992). Hence, the protection of different life histories that are migratory such as riverine, fluvial, and adfluvial populations is essential to protect the long-term sustainability, and underscores the importance of protecting all strains within a basin against the loss of diversity they provide.

Hemmingsen et. al. (1994) documented that the close genetic similarity of rainbow trout from Spring and Trout creeks (above Upper Klamath Lake) to Spencer Creek and the Klamath River below Upper Klamath Lake and to steelhead in Bogus Creek in California below Iron Gate Dam suggests that some of these populations were once associated with runs of anadromous rainbow trout. ODFW Research staff documented that redband trout from the dewatered reach are now more strongly associated, during the spawning period with known spawning areas in the lower dewatered reach and possibly unknown spawning locations in the peaking reach (ODFW 2006). Redband trout from the upper peaking reach downstream to Copco Reservoir are strongly associated with spawning locations in Shovel Creek or the dewatered reach. From 1988 to 1991, the observed numbers of adult redband trout that entered Spencer Creek were clearly larger than the estimated numbers that passed JC Boyle Dam in respective years. Redband trout from as far upstream as Upper Klamath Lake have been observed spawning in Spencer Creek. ODFW concludes that the above information and results of the site-specific studies provide the evidence that fish passage has been highly impacted and is causing significant adverse affects on resident fish populations in the Klamath basin. The gradual loss of a life history of redband trout that migrated the length of the Klamath River and spawned in Spencer Creek is occurring primarily due to lack of passage and operations at the JC Boyle facility. Therefore, restoration of this migratory life history and diversity of Klamath River redband trout via safe and effective fish passage facilities is essential for the long-term sustainability and productivity of the species.

5. Fish Passage Implementation Committee

5A. ***Fish Passage Implementation Committee.*** *The Licensee shall establish a Fish Passage Implementation Committee (FPIC) for the purpose of guiding implementation of fish passage at Project facilities. The FPIC shall consist of the Licensee; and to the extent of their interests in participating, the NMFS, USFWS, USFS, BIA, BLM, ODFW, CDFG, CSWRCB, ODEQ, affected Tribes including the Klamath, Karuk, Hoopa and Yurok, and two representatives of NGOs. The Licensee's development and implementation of fish passage, including the fish passage resource plan, reports, facility designs, and operating and implementation plans submitted to the FPIC pursuant to the terms of this license shall comply with these license conditions. The Licensee's implementation of measures pursuant to this license shall be reported to the FPIC as provided in any applicable implementation plan or license condition. Copies of all filings with the Commission following consultation with the FPIC shall be provided to each member of the FPIC.*

5B. ***Consultation with the FPIC.*** *Unless a different time period is specifically established pursuant to another provision of this license, the Licensee shall, where consultation with the FPIC is required, allow a minimum of 60 days for the FPIC members to comment, work to achieve consensus, and to make recommendations before filing any study, operating or implementation plan, report, or facility design with the Commission. The Licensee shall include with the study, operating or implementation plan, report, or facility design: documentation of consultation with the*

FPIC, copies of committee member comments and recommendations on the study, operating or implementation plan, report, or facility design after it has been prepared and provided to the FPIC, and specific descriptions of how the comments are accommodated by the study, operating or implementation plan, report, or facility design.

5C. *Fish Agency Authority.* *NMFS, USFWS, ODFW, and CDFG are collectively referred to as the Fish Agencies. Each Fish Agency has separate and distinct statutory authorities and no agency is deemed, by virtue of concurrent approvals, to be sharing its statutory authority with any other agency or to be conceding that the approval of any other agency is required for exercise of that agency's authority. Where consultation with the FPIC and approval by the appropriate Fish Agencies pursuant to their respective statutory authorities is required, the Licensee shall allow the Fish Agencies a minimum of 60 days to provide such approval prior to submitting the final study, operating or implementation plan, report, or facility design to the Commission. If a Fish Agency disapproves a study, operating or implementation plan, report, or facility design, the Licensee shall not file the disapproved study, operating or implementation plan, report, or design with the Commission until a dispute resolution process has been completed; in which case no further dispute resolution shall be required before such study, operating or implementation plan, report, or design is filed with the Commission.*

Issue and Rationale

Establishment of a FPIC will provide an efficient mechanism for coordinating consultation by the Licensee to ensure that safe, effective upstream and downstream fish passage for native potamodromous and anadromous fish species are implemented. Decisions regarding developing the Fish Passage Plan, implementing specific measures for fish passage including considering passage options, design and specifications, and effectiveness monitoring for each species and life stage will be made in consultation with the FPIC and, where specified, with the approval of ODFW.

Implementation committees have been established at other FERC projects (i.e. Pelton Round Butte, FERC #2030) to facilitate implementation of license conditions and coordination between resource agencies and the Licensee of the project. Implementation committees are particularly effective in coordinating professionals from a variety of backgrounds, such as biology, engineering, hydrology and water quality to provide a high level of expertise that, in the long run, may increase the success of fish passage programs.

All reporting requirements of the new license regarding progress on fish passage implementation will be met by the Licensee in conjunction with ongoing FPIC activities. Nothing in the proposed Fish Passage Plan expands or diminishes any existing authority or confers approval authority or regulatory jurisdiction that does not already exist under applicable federal, state, or Tribal law. Each Fish Agency has separate and distinct statutory authorities and that no agency is deemed, by virtue of concurrent approvals, to be sharing its statutory authority with any other agency or to be conceding that the approval of any other agency is required for exercise of that agency's authority.

6. Instream Flow in Dewatered, Peaking and Regulated Reaches

6A. ***Target Flow Requirements in Project Dewatered and Regulated Reaches*****.** *The Licensee shall discharge a continuous instantaneous minimum flow from the Project for flows for native fish species for the following reaches. The allowed minimum flow shall either be the recommended minimum flow or project inflow when the inflow is less than the minimum flow. If natural inflow to the Project is less than the minimum flow needed in the dewatered reaches for fish and wildlife and water quality, then all flow shall be discharged into the dewatered reaches.*

- *Link River: The Project proposal is to decommission Eastside and Westside powerhouses. In the event that the Licensee elects to operate these facilities, the Eastside and Westside diversions shall not be operated at any time until a minimum flow of 500 cfs is met below Link River Dam. To ensure compliance, the Licensee shall install a gage below Link River Dam within the dewatered stream channel below Link River Dam.*

- *Keno Reach: Keno Dam shall be managed as a modified run of the river facility and the Licensee shall discharge a minimum flow of 625 cfs or inflow as available* *(from Link River and upstream US Bureau of Reclamation project facilities), below Keno Dam. Keno Dam shall not be used to reregulate flows to peak hydroelectric power at downstream Project facilities. On a 24 hour basis, when flows are above 625 cfs, the Licensee shall manage river flows below Keno Dam to within ±10 percent of the measured Project inflow. Project inflow shall be measured as the sum of the daily flow from Link River and the USBR projects including Straits Drain, Lost River, and North/Ady Canal.*

- *<u>JC Boyle Dewatered Reach</u>: The Licensee shall discharge an instantaneous minimum flow of 640 cfs <u>or</u> 40% of the combined inflow from the Keno reach (gage #11505900) and Spencer Creek (gage #11510000) whichever is the greater of the two flows, into the JC Boyle dewatered reach. When the proportional flow of 40% of inflow is greater than 640 cfs, the required proportional instream flows are the average of the previous three days of the combined daily flow. If inflow to the JC Boyle development is less than 640 cfs, PacifiCorp shall release all inflow into the dewatered reach. Inflow shall be computed as a three day running average of flows at the Keno gage (US Geological Survey (USGS) #11509700) combined with flows at the Spencer Creek gage (USGS #11510000). To ensure compliance, the Licensee shall install a gage below JC Boyle Dam within the dewatered stream channel. The explanation for the 40% is provided on pages 65-68 of this document.*

- *JC Boyle Reach below the Powerhouse: The Licensee shall provide a minimum flow of 720 cfs into the Klamath River below the convergence of the JC Boyle powerhouse outlet and the JC Boyle dewatered reach.*

- *Copco 2 Dewatered Reach: The Licensee shall discharge an instantaneous minimum flow of 730 cfs or 40% of the inflow from the JC Boyle powerhouse gage (gage #11510700) whichever is the greater of the two flows, into the Copco 2 dewatered reach. When the proportional flow of 40% of inflow is greater than 730 cfs, the required proportional instream flows are the average of the previous three days of the combined daily flow. If inflow to the Copco 2 development is less than 730 cfs, PacifiCorp shall release all inflow into the dewatered reach. Inflow shall be computed as a three day running average of flows at JC Boyle Powerhouse gage (USGS #11510700) added to the flow of Shovel Creek. A gage shall be installed on Shovel Creek to quantify this contribution to inflow.*

- *Fall Creek: The Licensee shall discharge a minimum of 40% of the instantaneous flow measured above the Fall Creek power canal diversion into the dewatered reach. To ensure compliance, the Licensee shall install gages in Fall Creek above the power canal diversion and within the dewatered stream channel.*

- *Spring Creek: The Licensee shall provide a minimum target flow of the following: Full un-diverted flows from June 1 through September 15, and 50% of the flow* *above the diversion to remain instream during the remainder of the year, regardless of flow volume, in the dewatered reach. To ensure compliance, the Licensee shall install gages in Spring Creek above the diversion and within the dewatered stream channel.*

- *Below Iron Gate Dam: The Licensee shall discharge an instantaneous minimum flow (modified from the "Hardy Study" Institute for Natural Systems Engineering (INSE) (2001)) instream flow regime recommendations for the Klamath River below Iron Gate. These recommendations are summarized in Table 5.*

Table 5. Minimum flow releases below Iron Gate Dam in cfs.

Month	Dry	Below Average	Average	Above Average	Wet
October	1200	1200	1470	1660	1900
November	1200	1400	1710	1970	2200
December	1300	1600	2030	2400	3500
January	1500	2000	2400	2970	4200
February	1600	2200	2720	3500	5000
March	1600	2400	3400	4300	5400
April	1600	2200	3300	4100	5200
May	1600	2100	3100	3700	4500
June	1350	1800	2300	2900	3800
July	1200	1250	1530	1970	2300
August	1200	1000	1250	1470	1800
September	1200	1100	1350	1570	1840

Water Year Types are defined by the following exceedance values for inflow at Iron Gate Dam:
Critically Dry - 90 per cent exceedance
Below Average - 70 per cent exceedance
Average - 50 per cent exceedance
Above Average - 30 per cent exceedance
Wet - 10 per cent exceedance

6B. *Gages for Monitoring Streamflow*. *Within six months after license issuance, the Licensee shall measure and record inflow above all Project reservoirs or diversions, and* *outflow below each Project dam in each dewatered reach. These records shall be made available to tribal, federal and state resource agencies upon request as defined in the gage installation and data reporting plan. The gaging stations shall be located at the head of each dewatered reach at a location determined in consultation with ODFW, ODEQ, OWRD, and USGS and serve as the compliance points for ramping rates and minimum flow requirements in the dewatered reaches. The gages shall measure the full range of stage and flows that may occur at each site. Gage installation shall include radio, telephone, or other telemetry systems to provide recording and transmission of hourly streamflow data to the Klamath Project control room. The installation of the gage stations and the data acquisition shall conform to applicable USGS standards. The Licensee shall develop, in consultation with state, federal and tribal agencies, a coordinated gage installation and data reporting plan. The FERC shall review and approve the plan prior to installation of gage stations.*

6C. Seasonal High Flow: *At a minimum, once annually between February 1 and April 15, the Licensee shall not divert water to the JC Boyle power canal or the Copco 2 power canal when inflow to JC Boyle reservoir exceeds 3300 cfs (the sum of the flow from the Keno gage (USGS #11509700) and Spencer Creek gage (USGS #11510000)). The cessation of diversion shall be maintained for at least seven full days. The down ramp rate for the seasonal high flow shall not exceed two inches per hour and 300 cfs per 24 hour period, measured at the gage below JC Boyle Dam at RM 225 (Condition 6B for new gage installation).*

6D.***Timing of Project Maintenance*****.** *The Licensee shall consult with state, federal, and tribal agencies to identify the preferred timing of facilities maintenance for Project dewatered reaches. The Licensee shall minimize impacts in dewatered reaches by planning Project maintenance and outages in one of the two following flow periods: 1) during high flow conditions so that resulting high flows will coincide with the high-flow period of the natural hydrograph identified by the agencies and to prevent water-quality standard violations or 2) during the extreme low flow period when diversion canals will be at their lowest diversion rate and may already be shut down to meet minimum stream flow requirements, thereby minimizing or eliminating resulting stream flow stage changes and any concomitant adverse effects on aquatic resources.*

Resulting changes in stream flow in the dewatered reaches are subject to ramping requirements (See License Condition 7). The Licensee may perform maintenance required by operating emergencies beyond its control at any time to remedy the emergency. Upon completion of emergency maintenance, ramping is subject to the ramping restrictions. The timing of maintenance activities that do not result in returning flows to natural stream channels are not limited by this license condition.

6E. *Instream Flow and Instream Habitat Enhancement Program to Mitigate for Cumulative Impacts to Aquatic and Riverine Resources.* *As part of Project-related mitigation for cumulative impacts, the Licensee, in consultation with state, federal, and tribal stakeholders, shall identify and fund instream flow and habitat enhancement measures in mainstem reaches and tributaries containing native fish and wildlife* *species. These measures shall focus on appropriate reaches within and above the Klamath Hydroelectric Project. These shall include PM&Es such as instream flow restoration, land acquisition, and working with other cooperative landowners on land and water management improvement projects to improve instream habitat. This measure is further defined and explained in the Fish and Wildlife Habitat Enhancement Plan (License Condition 12A).*

Issue and Rationale

Compliance with Management Direction, Administrative Rules and Basin Plans: The Oregon Plan for Salmon and Watersheds provides direction to state agencies to restore natural flow conditions to restore native fish population productivity and distribution to historic habitats. The intent of these flow recommendations is to provide a flow regime of sufficient quantity to allow native fish, aquatic and riparian species to be restored, productive and sustainable within the wetted channel and along the river's edge.

Establishing appropriate minimum flows in Project-affected reaches is critical to restoring the physical and ecological processes that support fish and wildlife populations and influence aquatic and riparian habitat conditions in the Klamath River. Flow restoration will sustain well-connected and functional riparian and aquatic habitats to restore fish populations that have been impacted by Project operations that reduce flows. Under the present license, PacifiCorp is entitled to divert almost all stream flow from the Link River, Klamath River, and Fall Creek, during much of the year except during spring high flows. Dewatered reaches have a very small amount of flow remaining the stream channel to support aquatic life. Severely reduced habitat has harmed native fish populations by reducing spawning, incubation, rearing, and migration habitat. Frequent flow oscillations in the Keno Reach and daily peaking in the JC Boyle Peaking Reach cause many fold differences in stream flows for aquatic and fish life. As a consequence, much of the natural streambed in Project-affected reaches is exposed or rendered marginal for support of aquatic life. A small amount of streamflow remains in these reaches at a time of the year when maximum biological production should occur.

The original license favored power production to the great detriment and harm of fish and aquatic life. To correct this imbalance, the Licensee must provide significant increases in flows in the dewatered and regulated reaches to support aquatic life and to improve water quality.

Diversion of Instream Flows: The Licensee diverts a high proportion of the instream flow at each Project Facility:

- Link River: Diversions at Eastside and Westside appropriate up to 1200 and 250 cfs, respectively, while the dewatered flow is 90 cfs below Link River Dam. Since the USFWS Biological Opinion was adopted for federally listed suckers in 2001, the dewatered flow recommendation was increased to at least 250 cfs from June to October, when needed.

- Keno Reach below Keno Dam: Flows generally range from as low as 200 cfs up to 1700 cfs during the summer although there is no generation at Keno dam. Flows at Keno Dam are reregulated to maximize generating efficiency at JC Boyle and other downstream peaking facilities, and also to keep the Keno pool within one foot of the high water mark to allow irrigation pumping facilities to operate. The Licensee did not conduct an instream flow study in this reach.
- JC Boyle: Diversion at JC Boyle Dam appropriates up to 3,000 cfs while the dewatered flow is 100 cfs below the dam. Spring inflow approximately half way down the dewatered reach adds an additional 220-250 cfs for a total discharge of approximately 320-350 cfs from the dewatered reach.
- Copco 1: Diversion at Copco 1 is 100% of the instream flow below 3,200 cfs.
- Copco 2: Diversion at Copco 2 is 97-99% of the instream flow below 3,200 cfs. The dewatered reach flow is 10 cfs below Copco 2 Dam.
- Fall Creek: The Licensee's diversion on Fall Creek has a 50 cfs capacity, which leaves only a minimum flow of 0.5 cfs in the dewatered Fall Creek channel. The Licensee diverts 99% of the streamflow except during the infrequent and brief storm events when flows exceed 50 cfs.
- Spring Creek: Diversion at Spring Creek is 16.5 cfs to augment flows into Fall Creek hydroelectric plant. Approximately 0.22 cfs is bypassed into Spring Creek below the diversion.
- Iron Gate: Diversion at Iron Gate Dam is 100% below 1,735 cfs. Flows in excess of 1,735 cfs are spilled.

Project Impacts: Flow restoration will increase instream habitat and support well-connected and functional riparian and aquatic habitats necessary for productive and sustainable fish populations. Under the present license, the Licensee is entitled to divert almost all stream flow from the Link River, Klamath River, Spring Creek, and Fall Creek, during much of the year except during spring high flows. Frequent flow oscillations in the Keno Reach and daily peaking below JC Boyle powerhouse cause widely fluctuating stream flows which adversely affect aquatic and fish life. As a consequence, much of the natural streambed is exposed or rendered marginal to support fish and aquatic life. A small amount of streamflow remains in these diverted, regulated and peaking reaches at a time of the year when maximum biological production should occur. Increasing minimum flows in dewatered and other project-affected reaches is essential to restore the physical and ecological processes that support fish, aquatic and riparian habitat conditions in the Klamath River.

Link River Project Impacts: The Link River is impacted by Project operations that chronically turn on and off East and West side diversions located at Link River Dam. The minimum flow requirement below Link River Dam is 90 cfs. During site visits in recent years, such as the PacifiCorp-led tour on September 26, 2000, barely an estimated 25-30 cfs was flowing downstream from the dam, primarily dam leakage and flow via the fish ladder. However, even the current 90 cfs minimum flow is inadequate and only provides some flow for passage and little flow for rearing native fish.

Numerous fish kills have been documented in the Link River, particularly when flows drop below 300 cfs. One resident along the Link River documented in a letter to “Pacific Power and Light” (the Licensee) a large fish kill due to numerous flow changes and the river height falling from 3-4 feet in a period of 3-4 minutes. The resident commented that only the residents that live along the river observe stranded and dead fish because “twenty minutes later the river rose in a rapid fashion, washing away the dead fish” (letter from Terry Wagstaff to Jerry Rope at Pacific Power and Light, April 12, 1992). The resident indicated that this was not an isolated incident and this situation had occurred repeatedly for the past 13 years and when he contacted the Licensee, he was given the comments that ranged from “we are working on that problem” to “those aren’t game fish”.

While large river flow changes have been responsible for numerous fish kills, inadequate low flows have reduced physical habitat. Currently, the Biological Opinion requires instream flows of at least 250 cfs during summer, and below 300 cfs, fish salvages are required as fish become stranded in side channels and bedrock channels.

The Link river flows appear to fluctuate wildly; in fact, the flows do not follow a seasonal pattern and reflect a de facto peaking pattern as the Eastside and Westside diversions are turned on and off for power generation. For example, for the period May 1 to August 30, 2005, the flow below Eastside powerhouse ranged from 437 to 3,790 cfs, with no apparent cause for high or low flows (Figure 1). These chronic low flows continue to stress native fish populations and reduce habitat for rearing redband trout and sucker larvae and adults.

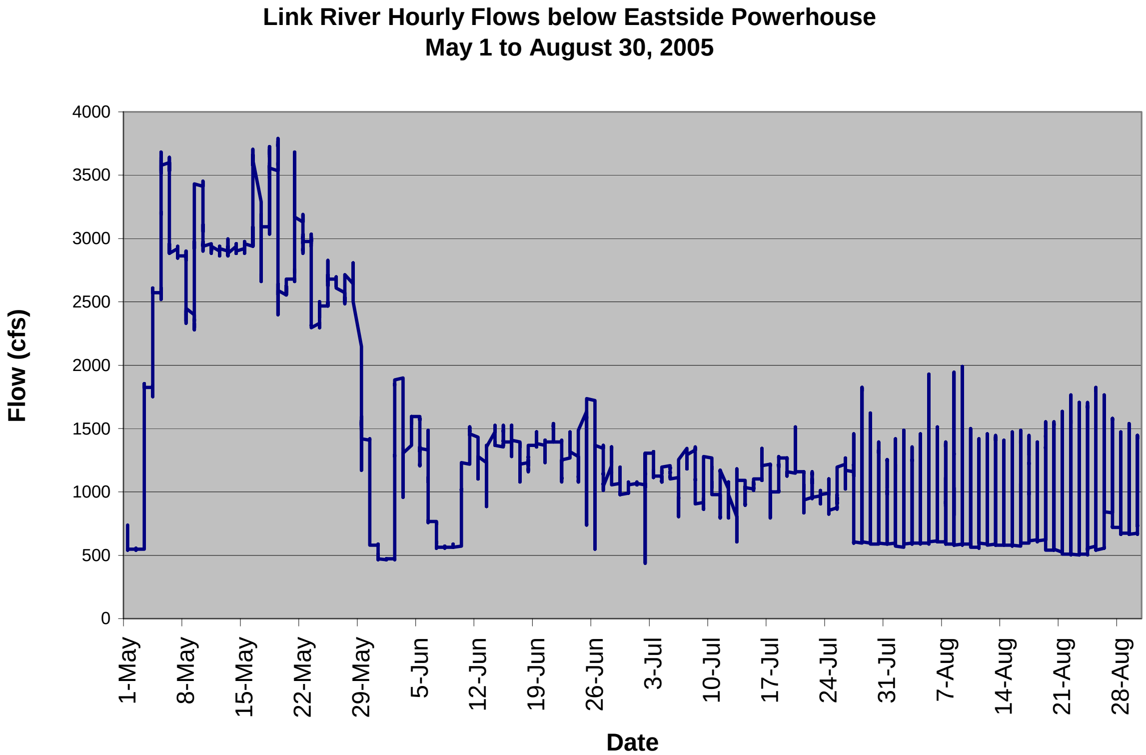

Figure 1. Hourly flows at the Link River Gage below Eastside Powerhouse, May 1 to August 30, 2005

Keno Reach Project Impacts: The minimum flow requirement below Keno Dam, per FERC license article 58 and ODFW agreement is 200 cfs. The Licensee states that flows below Keno Dam, in the Keno reach, are dependent entirely on what is delivered to the Keno Reservoir by the USBR and other irrigation operations and that PacifiCorp has no discretion or control over flows in the Keno Reach. This is contradicted by the fact that 80% of the inflow to Lake Ewauna is from Link River while approximately 20% is from agricultural returns with a very small amount from municipal and industrial inputs (PacifiCorp 2004, FLA WTR). The Licensee can and does alter flows in the Link River and Keno Reach for hydroelectric Project purposes, including power production at the Link diversion, maintenance actions at Link and Keno project facilities, and to manipulate flows to maximize power generation at downstream Project peaking facilities.

While the Keno Reach is not as severely impacted as the dewatered or peaking reaches downstream, flows are ramped up and down to reregulate flows to maximize peaking at downstream facilities and to regulate incoming flow from USBR irrigation. Flows generally range from as low as 200 cfs up to 1700 cfs during the summer although there is no generation at Keno dam.

The practice of using reservoir storage to follow short-term peaks in power demand – known as load following – results in rapid and significant changes in river flow and reservoir elevation. The larger storage at Keno Dam (than at JC Boyle Reservoir), with a 6 inch daily reservoir fluctuation, has given the Licensee more options to maximize peaking at the downstream JC Boyle and the Copco peaking facilities. The Licensee describes Keno Dam: “The steady reservoir elevation allows Reclamation to manage its irrigation water through its diversion channels from Keno reservoir, and enables PacifiCorp to more effectively plan downstream load following operations at the JC Boyle powerhouse” (PacifiCorp 2004, Water FTR).

Although the Keno Reach has some of the better remaining conditions for native redband trout among the Project-affected reaches, the trout fishery is impacted by the low flows and frequent flow fluctuations from Licensee and USBR flow regulation. Effects of these flow fluctuations are of the types described for the peaking reach, but of much less magnitude. Institution of a minimum flow and combination with a more restrictive ramp rate will reduce the incidence of fish kills, and increase habitat, survival and productivity of native fish.

Project impacts occur from a combination of periodic low flows in combination with a high ramp rate. Impacts are greatest during very high and cold water temperatures and often lead to fish die-offs. For example, in June 2003 flows in the Keno Reach were reduced by PacifiCorp in order to limit the amount of inflow to the JC Boyle Reservoir during a Project outage for maintenance at the JC Boyle Powerhouse. Due to both rapid declines in flow, the sustained low flow of 250 cfs and hot weather and water temperatures, a fish kill occurred in the Keno Reach. The large fish and macroinvertebrate die off occurred due to the rapid de-watering in combination with the high water temperatures of the Klamath River which stranded fish and caused stressful conditions. An unknown amount of macroinvertebrate abundance was lost but was significant considering abundance ranges from 11,000 to 21,000 m^2 in the Keno reach of the Klamath River.

A second large fish die off occurred later that summer in late July and early August and was caused by a combination of algae die off, very warm water, and low flows (flows in the Keno reach ranged from 413 cfs to 521 cfs during the die off), and resulting lack of dissolved oxygen for fish, that occurred during the previous nights. The stressful conditions (low dissolved oxygen, warm water temperatures, and low flows) probably resulted in an epizootic of columnaris which appeared to be the immediate cause of death of most fish sampled. The factors that led to the Keno and Topsy Reservoir die-off were the same combination of factors that caused the September 2002 fish adult chinook salmon kill in the Lower Klamath River – the combination of low flows, high water temperatures and increased incidence of disease in fish exposed to these conditions.

Many fish die-offs have occurred in the Keno Reach since ODFW staff began to keep records in their monthly reports. ODFW concludes that in most cases, when fish die-offs occur in the Keno Reach, that PacifiCorp, not the USBR, alters flows in the Keno Reach, for Project purposes, which results in adverse impacts to fish and aquatic resources. Die-offs are more severe during episodes of very warm or cold water temperatures, in combination with low flows or cumulative down ramps that reduce the river to low flows. For this reason, a substantially increased minimum flow over the existing flow regime along with a reduced ramp rate needs to be established as part of the new license to protect fish and aquatic life from Project operational impacts.

<u>JC Boyle Dewatered Reach Project Impacts:</u> Dewatered reaches have severely reduced habitat for fish and wildlife providing a small fraction of the flow needed to support spawning, rearing, incubation and migration of native fish species. This has severely impacted productivity and sustainability of redband trout, ESA-listed suckers and other native fish.

The JC Boyle dewatered reach currently has a minimum flow of 100 cfs below the dam. Approximately half way downstream through the reach it is augmented by spring flow of 220 cfs. Current operations provide 75% to 97% of flow to the JC Boyle power canal and only 3% to 25% of flow to the Klamath River dewatered channel annually (USGS gage station #11510700). The exception to this flow occurs during spill events when flows exceed 3,000 cfs at JC Boyle Dam. Since the majority of water available is diverted for power generation, only a small fraction of the inflow is available for aquatic and riparian resources.

Project operations have reduced flow to a fraction of historic flows, and truncated flood flows, limiting fish and aquatic habitat to a small fraction of the natural flow condition, preventing ecological functions of scour and deposition, and a natural seasonal hydrologic regime. Meanwhile the dam has prevented gravel recruitment, resulting in a modified channel with riparian vegetation that is growing along the stream margin at the low flow of 100 cfs from the dam to the springs and approximately 320 cfs below the spring input to the powerhouse.

In the JC Boyle dewatered reach, dewatering the channel has severely limited the growth and productivity of native riparian species that support fish. The existing riparian vegetation, composed of primarily non-native riparian species, grows along the edge of the severely reduced wetted channel. Reduced base and peak flows from Project operations have created conditions suitable for the establishment and survival of undesirable riparian vegetation, and species such as reed canarygrass encroach on the stream channel (PacifiCorp 2004, Exhibit E 5-149). Because of lack of channel and riparian function, non-native reed canarygrass out competes the native species and dominates the riparian habitat. The minimum flow release of 6% of the mean annual flow in the JC Boyle dewatered reach has facilitated the invasion and encroachment of riparian vegetation and transformation of a major river into a wadable stream. Reed canarygrass is well-suited to survive in excessively coarse substrate (areas that lack gravel and smaller sized material) and gains a competitive advantage over other native riparian species that do not establish in these conditions.

Diverting the majority of the inflow to optimize flows for power generation reduces flows available for sediment transport and hydrologic processes to support fisheries habitat and habitat for other aquatic species in the 4.3 mile long JC Boyle dewatered reach. Project operations have reduced the seasonal and annual variability of peak flows which has reduced the habitat diversity and stream productivity essential for fish life. High flows and scouring and deposition are essential for fish habitat to redistribute sediment to maintain quality spawning gravels, provide water and nutrients to riparian areas and increase the amount of mainstem and side channel rearing habitat. The magnitude, frequency, and duration of seasonal high flows in the JC Boyle dewatered reach have been reduced due to Project operations with the magnitude of the 1.5-year flood event reduced by 80%, the two-year flood event reduced by 51%, and the five-year flood event had been reduced by 33% (PacifiCorp 2004, Water Resources FTR, 5-46).

Channel scour and deposition, which are essential for fish habitat, have been reduced by Project operations. Reductions in the magnitude and frequency of peak flows have contributed to reducing the recurrence interval of flows needed to support bed mobility. Under Project operations, in the upper portion of the JC Boyle dewatered reach 1,450 cfs flows are currently needed to mobilize the streambed. In the lower portion of the dewatered reach, the recurrence interval of bed mobilizing flows has increased from approximately 1 year without the Project, to 2 years with the Project. JC Boyle Dam reduces the input of gravel, sand, and silt to this reach (PacifiCorp 2004, Exhibit E 5-148; PacifiCorp 2004, Water Resources FTR 6-111, 145). Essentially, flow diversions and changes in the flow regime have reduced scouring and sediment deposition of the very limited material transported downstream of the dam (PacifiCorp 2004, Water Resources FTR 6-135), while the dam has virtually eliminated new gravels and cobbles for channel deposition.

Further, since the streamflows, sediment supply, and bed mobility are reduced, the extent of substrate appropriate for establishment of willows and other native riparian plants is decreased. Riparian hardwoods typically germinate and establish on “freshly deposited alluvium in channel positions low enough to provide adequate moisture but high enough to escape scour” (Scott et. al. 1993). The Project, however, maintains static hydrologic and geomorphic conditions that do not provide alluvium over a large portion of the area where willows have the best potential to establish.

In the dewatered reaches, the year-round base flows have substantially reduced the amount of stream for aquatic species and riparian area. Since current Project operations reduce the base flow as well as the magnitude and frequency of flood flows in the dewatered reach, this has resulted in a narrow riparian area that is defined by the base flow. The loss of stream channel and native riparian vegetation reduces habitat important to rearing fish. The minimal channel width and location and type of native riparian vegetation have reduced the fish habitat along the entire length of the dewatered reaches.

Project operations including low and static flows have produced changes in the stream channel resulting from reductions in the supply of sediment and alteration of the frequency of flows capable of transporting sediment. The Licensee documented “significant changes to geomorphology were observed in the JC Boyle dewatered reach” (PacifiCorp 2004, FLA Exhibit E, pp. 5-25). Geomorphic changes caused by current Project operations reduce the extent and quality of aquatic habitat and impair riparian ecological processes.

Project operations in the JC Boyle dewatered reach negatively impact the redband trout fishery and habitat, including food availability (City of Klamath Falls 1986), fish production, and overall fish size. Macroinvertebrates are essential food resources for fish life and have been severely reduced by dewatering the channel. Macroinvertebrate drift data show much lower drift density in the dewatered reach compared to the Keno reach above JC Boyle Dam. Drift density in July was 11 times higher in the Keno reach and in September 2.4 times higher than the dewatered reach. (Addley et. al. 2005, page 5). This dramatic difference in density does not include the much lower total productivity that results from less and habitat area available due to lower base flow (about 6 times less flow than in the Keno reach in June, July, and August).

The largely static flows in the dewatered reach contributes to low drift density and may help explain the lower fish growth and survival observed relative to the Keno reach. The studies show fish growth, fish survival of older age classes, and fish size at age class in the dewatered reach is less than observed in the Keno reach (PacifiCorp 2004, FLA Fish Resources FTR). Similar patterns in population structure were observed by Beak (1986). Trout age distributions (few trout over three years of age and of smaller size at age) and macroinvertebrate drift data suggest that existing flow conditions limit both habitat and forage productivity, thus affecting redband trout growth and productivity. The evidence from redband trout studies (Addley et. al. 2005, ODFW 2003) document that the minimum flows of 100 cfs in the JC Boyle dewatered reaches do not adequately provide for a healthy productive fish community.

The lack of flow in the dewatered reach also has impacted upstream fish migration. The fish passage and movement study conducted by the Licensee (PacifiCorp 2004, Fish Resources FTR, page 5-36 to 37) showed that, in ten instances, downstream migrating fish pass quickly by the JC Boyle Powerhouse. However, information on five upstream-moving fish showed that the two longest delays observed (213 and 24 hours) occurred near the powerhouse. These fish moved into the vicinity of the JC Boyle powerhouse during an extended period of power generation and remained for up to 213 hours. This fish data represents 20 percent of the observations of upstream passage past the JC Boyle Powerhouse. These observations indicate that flow alterations, including low minimum flow in the dewatered reach may affect fish movement.

JC Boyle Peaking Reach Project Impacts: Hydroelectric peaking operations are used to maximize revenues by maximizing power generation when demand is greatest. Storage at JC Boyle Reservoir is used to manipulate flows through the powerhouse to a constant, elevated level during the afternoon and early evening and to minimum levels at night and in the morning. The peaking operations at JC Boyle powerhouse result in large, artificial, daily fluctuations in flows in the peaking reach. These large flow fluctuations in the peaking reach result in high mortalities of many fish and aquatic populations from physiological stress, wash-out during high flows, and stranding during rapid dewatering (Cushman 1985, Petts 1984). Frequent dewatering can result in massive mortality of bottom-dwelling organisms and subsequent severe reductions in biological productivity (Weisberg et. al. 1990). Frequent flow fluctuations severely impair the rearing and refuge functions of shallow shoreline or backwater areas for small fish species or young life stages of larger fish (Bain et al. 1988, Stanford 1994).

Comparison of fish populations in the different segments of the Klamath River impacted by Project operations, the Keno, JC Boyle dewatered, and JC Boyle peaking reaches, documents the impacts of the large flow fluctuations caused by hydroelectric peaking operations on native fish populations. The ODFW Klamath Basin Fish Management

Plan (1997) identifies the primary objective for these Klamath River reaches as wild trout management for native redband/rainbow trout. The Bioenergetics Report (Addley et. al. 2005) reported that trout were significantly larger in the Keno reach than either the peaking or dewatered reaches. The Bioenergetics Report indicated that the larger size of trout in the Keno reach is due to greater numbers of older fish and higher growth rates in older fish. Growth and survival rates of trout in the dewatered and peaking reaches were lower due to the lower availability of food and other habitat effects in both of these reaches in comparison to the Keno reach.

ODFW conducted a biological assessment of redband trout in the three reaches as well (ODFW 2003). The relative weights of redband trout caught in the three reaches by ODFW staff showed that redband trout in the peaking reach and dewatered reach are smaller in size and have significantly lower condition factors compared to the Keno reach. Also, as the summer progressed into earl fall, redband trout in the peaking reach lost weight when fish should be putting on weight to survive the winter. Summer and early fall is a critical period for recovering from spring spawning and for replenishing body fat reserves in order to grow during the summer and develop gametes through the non-feeding winter. ODFW (2003) attributed the lost condition to the peaking process causing catastrophic losses to shoreline macroinvertebrates and lack of food availability. Further, with these fish having a poor condition factor going into winter, the authors indicated that the fish in the peaking reach are subject to high mortality rates as evidenced by large fish over 375 mm rarely captured in the peaking reach. Fish in the

Keno reach, however, were consistently larger at the same age, and lived longer than fish in the peaking reach.

ODFW research from 1988-91 (Buchanan et. al. 1991, Hemmingsen et. al. 1992) and the FERC 1990 Final Environmental Impact Statement (EIS) for the proposed Salt Caves Project (FERC 1990) also noted low adult trout densities in the upper end of the peaking reach. The FERC EIS reported that trout in the upper peaking reach, where peaking impacts would be most visible, had relatively low growth rates and that large trout were under represented in the age structure. The FERC EIS cited five years of investigation compiled by the City of Klamath Falls. The FERC EIS concluded that flow fluctuations below the JC Boyle powerhouse caused chronic stress on trout and stranding of eggs, fry, and juveniles. Stress occurred from daily flow fluctuations and related changes in water temperature and water quality. These flow fluctuations caused trout to continue to seek new feeding and resting habitat while water temperature changed metabolism and feeding rates.

Another effect of peaking operations is that water temperatures have greater diurnal fluctuations than they would without peaking. The Licensee provided water quality modeling results showing that, in the peaking reach, a steady flow alternative would provide slightly lower daily maximums and higher minimums, and a without project alternative would provide even lower daily maximums and similar minimums, in comparison to the existing condition (PacifiCorp, August 2005 Peaking study, p. 27 and Addley et. al. 2005, Bioenergetics report). Research on rainbow trout has shown that large daily fluctuations in temperature compromise growth and survival rates (Hokanson et. al. 1977). The thermal effects of peaking are a concern because temperatures in the summer months are at or above thermal tolerances for salmonids in the Project area, and the increase in diurnal fluctuations likely cause additional impacts.

Similar to the JC Boyle dewatered reach, the peaking reach has severely limited the growth and productivity of native riparian species that support fish. The existing riparian vegetation, composed of primarily non-native riparian species, grows along the edge of the highest point of the varial zone. To various extents, the JC Boyle, Copco 1, Copco 2, and Iron Gate reservoirs trap sediment, which likely alters the amount of fine substrate available for riparian vegetation establishment for some distance downstream of the dams (PacifiCorp 2004, Exhibit E 5-148). Project operations appear to have created conditions that are favorable to reed canarygrass in the JC Boyle peaking reach (PacifiCorp 2004, Exhibit 5-150). Within the JC Boyle peaking reach, approximately 74% of the reed canarygrass plots occurred in the varial zone; overall reed canarygrass occurred in nearly half of all riparian plots in the JC Boyle peaking reach. Because of lack of channel and riparian function, non-native reed canarygrass out competes the native species and dominates the riparian habitat by preventing establishment of willow seedlings. The peaking flows in the JC Boyle peaking reach have created a varial zone that favors the invasion and encroachment of native riparian vegetation. Reed canarygrass is well-suited to survive in excessively coarse substrate (areas that lack gravel and smaller sized material) and gains a competitive advantage over other native riparian species that do not establish in these conditions.

PacifiCorp proposes to increase the minimum instream flow release and alter peaking operations at JC Boyle powerhouse (PacifiCorp 2004, Exhibit E, p. 3-196). The Licensee proposes that a minimum of 200 cfs plus the JC Boyle dewatered reach accretion will be provided at the USGS gauge downstream of the powerhouse for a total minimum flow of 420 cfs in the peaking reach. In addition, peaking operations will not exceed a 1,400 cfs maximum change in a 24-hour period. The Licensee justifies this adjustment in peaking to provide flow stability for aquatic resources while continuing to provide a balance of whitewater boating and angling opportunities. The change in peaking will provide only very small benefits to the aquatic system, and it is not clear how the change will affect whitewater boating and angling opportunities. A 1400 cfs rate of change is still a very extreme peaking event that will continue to cause significant impacts to fish and aquatic resources. Even with the proposed future operation of peaking with slightly higher minimum flows and an altered peaking schedule, the lower portion of the varial zone (which is inundated by one-unit peaking flows of 1,400 cfs, increased inundation associated with longer on-unit peaking durations could increase reed canarygrass abundance (PacifiCorp 2004, Exhibit 5-150). The proposed future operation of continued peaking by the Licensee is not likely to change the pattern of peak flows and thus will not cause any significant change in willow distribution without the addition of artificial mechanical manipulation of river banks to create bare mineral soil.

On September 23, 1959, the Federal Power Commission (FPC) issued a decision on the application for amendment of license by the California Oregon Power Company to construct Iron Gate Dam. The decision was based on the impacts caused by fluctuations in flow between 200 and 3,300 cfs on a daily basis below Copco #2 powerhouse. These flow fluctuations were having a significant impact on navigation and fisheries in the river and "The evidence shows that fluctuating water levels such as this have a decidedly detrimental effect on fish and aquatic life." Clearly, in both the justification to reduce peaking impacts below Copco 2 Dam by the FPC and in FERC's analysis of peaking impacts in the JC Boyle reach below the powerhouse for the Salt Caves reach, flow fluctuations caused chronic stress and harm to fish populations for spawning, incubation, and stranding of eggs, fry, and juveniles.

Copco 2 Dewatered Reach: The Copco 2 dewatered reach is approximately 1.4 miles long, and extends from Copco 2 Dam to the Copco 2 powerhouse. The powerhouse discharges directly into Iron Gate Reservoir. The channel is in a deep, narrow canyon with a steep gradient, and consists of bedrock, boulders, large rocks, and occasional pool habitat. Water quality is likely poor in summer because its source, Copco Reservoir, has high temperatures and blue green algal blooms in summer (PacifiCorp 2004, Fisheries FTR).

The Copco 2 dewatered reach is the most strongly affected of all river reaches impacted by the Project. Except during spill events, between 98 and 99.5 percent of the flow into this reach is diverted. The existing minimum flow is 10 cfs, from leakage and a minor fish bypass pipe, which means that less than 0.5% of the mean annual flow is available for aquatic and riparian resources.

The following picture illustrates the lack of water in a boulder field of the Copco 2 dewatered reach.

Copco 2 Dewatered Reach (10 cfs)

The exception to this flow occurs during spill events when flows exceed 3,200 cfs at Copco 2 dam. Since the majority of water available is diverted for power generation, only a small fraction of the inflow is available for aquatic and riparian resources.

Project operations have reduced flow to a fraction of historic flows, and skimmed flood flows, limiting fish and aquatic habitat to a small fraction of the natural flow condition, preventing ecological functions of scour and deposition, and a natural seasonal hydrologic regime. Meanwhile the dam has prevented gravel recruitment, resulting in a modified channel with riparian vegetation that is growing at the low flow of 10 cfs.

In the Copco 2 dewatered reach, riparian hardwoods have encroached on what were once the active channel and stream bars. In the dewatered reaches, the year-round base flows have substantially reduced the amount of stream for aquatic species and riparian area. Since current Project operations reduce the base flow as well as the magnitude and frequency of flood flows in the two dewatered reaches, this results in a narrow riparian area that is defined by the base flow. The loss of stream channel reduces habitat important to rearing fish. The minimal channel width and location have reduced the fish habitat along the entire length of the dewatered reaches, limiting survival and productivity of native fish species.

Iron Gate Dam and Project Impacts in the Lower Klamath River: The Klamath River once sustained large runs of steelhead and salmon, and was described as the third greatest salmon and steelhead river on the West coast, only behind the Sacramento River and Columbia Rivers. All of the anadromous fish in the Klamath River are protected by designated beneficial uses (cold fresh water, spawning, reproduction, and/or early development; migration or aquatic organisms; and rare, threatened or endangered species beneficial uses), which the CSWRCB and the North Coast Regional Water Quality Control Board (NCRWQCB) have the responsibility to implement. Reduced flows in combination with poor water quality from reservoir Projects has caused several major fish kills for both juvenile and adult salmon.

Modeling by the Licensee shows the project decreases water temperature in the spring/early summer and increases water temperature during the late summer/fall, creating a thermal lag downstream of Iron Gate Dam. While the water quality is affected below Iron Gate Dam, project dams have inundated and blocked access to important historic salmonid spawning and rearing habitats. The cumulative effects of impaired water quality and reduction of critical habitat has resulted in significant impacts to anadromous fish.

Fish disease and mortality in the Lower Klamath River have been implicated as a direct result of low summer flows in combination with high water temperatures. Fish disease among anadromous fish has been documented in recent years in both adults and outmigrating juveniles in the Lower Klamath River (Williamson and Foott 1998; Foott et al. 1999, 2002, 2003; Nichols and Foott 2005). During the September 2002 fish kill, at least 33,000 adult fish, mostly Chinook salmon, died subsequent to infection by two pathogens (*Ichthyophthirius multifiliis* and *Flavobacterium columnare)* (CDFG 2004). In 2004, juvenile outmigrating salmon were estimated to be 94% infected by myxozoan parasites (*Ceratomyxa shasta and Parvicapsula minibicornis)* on the Klamath River, which may have rivaled the loss of 33,000 adult fish two years earlier in impact to the population of Chinook salmon (Nichols and Foott, 2005). In both these instances, flow, with its direct impact on water quality and fish migration, emerges as a controllable contributing factor.

PacifiCorp's response to Additional Information Request AR-2 contains charts that compare the existing condition with four different modeled dam removal scenarios. The charts show that under certain conditions the Project increase water temperature as much as 9°C in the late summer early-fall period, a critical time period for upstream migrating chinook. The Licensee provided model results for five scenarios; existing conditions (EC), without project (WOP), without Iron Gate Dam, without Iron Gate Dam, Copco 1 and 2 Dams, and without Iron Gate Dam, Copco 1 and 2 Dams, and JC Boyle Dam. Under the EC compared to the WOP condition, the Project increases water temperature as much as 9°C under certain conditions in the July-August-September time period. Increase in temperature in the late summer/fall may impact returning adult fall run Chinook, Chinook egg incubation, and other species present in the river (PacifiCorp 2004, Exhibit E p.3-8). Transport of organic matter and nutrients under WOP takes 2 to 3 days from Link River, compared with 6 to 8 weeks in the EC. In addition, delay of assimilation of nutrients occurs many miles downstream than would have occurred without the Project in place.

In addition, modeling documents that the project decreases water temperature below Iron Gate Dam in the spring and early summer. The decrease in water temperature in the spring/early summer may cause a retardation of juvenile salmonid development.

<u>Fall Creek Project Impacts:</u> Over 20 years of streamflow data from the USGS gage (1933 through 1959) indicates mean monthly flows in Fall Creek (augmented by unspecified diversions from Spring Creek) range from 33 to 50 cfs. Currently

PacifiCorp's diversion on Fall Creek has a 50 cfs capacity and only 0.5 cfs is passed into the natural stream channel. The Licensee diverts roughly 99 % of the streamflow except during the infrequent and brief storm events when flows exceed 50 cfs. This severely impacts the hydrology of the creek and as a consequence, harms fish resources of Fall Creek, by severely reducing habitat and flow for spawning, incubation, and rearing and migration life histories.

Spring Creek Project Impacts: Spring Creek is an important tributary to Jenny Creek, which supports native populations of redband trout and Jenny Creek suckers (*Catostomus rimiculus*), both state sensitive species. The Licensee's diversion of flow from Spring Creek increases stream temperature and reduces habitat in Spring Creek below the diversion dam and in Jenny Creek below its confluence with Spring Creek. Diverted water from Spring Creek reduces the amount of water available for redband trout habitat and substantially increases thermal heating of the water. On a hot August day in 2004, a comparison of with and without diversion revealed that Spring Creek effectively reduced the maximum stream temperature of Jenny Creek 3°C (5.4°F) approximately one mile downstream of Spring Creek (USDI BLM 2004). Temperatures in Jenny Creek ranged from 22-25°C (72-77°F) while the diversion was not in use and 27-28°C (80-82°C) with the diversion actively withdrawing water from Spring Creek. These temperatures are near the lethal limit for fish species and demonstrate that the diversion has a physiologically and biologically significant impact to native redband trout and Jenny Creek suckers. When water temperatures are near a fishes' critical thermal maxima, small increases can negatively impact fish health or reproductive fitness, or even cause death (Moyle and Cech 2000). Summer is a critical period for recovering from spring spawning and for replenishing body fat reserves in order to grow during the summer and develop gametes through the non-feeding winter. The cooling effect of Spring Creek on Jenny Creek when the diversion was not operated was measured definitively one mile downstream from the mouth of Spring Creek and is projected to improve water quality an additional two miles downstream from this site. BLM snorkel data shows that Jenny Creek downstream of Spring Creek is important summer habitat for adult suckers and trout (USDI 1999). An additional impact is that when PacifiCorp diverts water, it dries approximately the downstream third of Spring Creek. Although small, Spring Creek provides important cool-water summer fish habitat in the Jenny Creek Watershed. The Licensee's diversion compromises the water quality, connectivity and amount of that habitat.

Natural Hydrology and Developing Flow Recommendations: The Project has significantly altered the natural hydrologic pattern and functioning of the Klamath River within the project reaches and downstream. The literature consistently illustrates the adverse effect of inadequate flow on aquatic organisms (Annear et. al. 2004). Research also indicates that beyond prescribing a minimum flow, managers should determine an appropriate flow regime based on season and water year type (Richter et. al. 1997, Stanford et. al. 1996). The artificial manipulation of flow without reference to a baseline hydrograph can profoundly impact habitat and fish communities. The flow regime proposed by PacifiCorp perpetuates significant peaking and dewatering operations and will not protect native salmonid habitat from future adverse impacts. Instream flows are recommended in all Project-affected reaches to protect and restore native fish species, move the reaches toward a more natural flow regime, and restore and reconnect riparian, wetland and aquatic species.

The ecological structure and functioning of aquatic, wetland, and riparian ecosystems depend largely on the hydrologic regime, or pattern and quantity of water flowing through the system (Gorman and Karr 1978, Junk et. al. 1989, Poff and Ward 1990, National Research Council 1992, Sparks 1992, Mitsch and Gosselink 1993, Poff et al. 1997). Intra-annual variation in hydrologic conditions plays an essential role in the dynamics among species within such communities through influences on reproductive success, natural disturbance, and biotic interactions (Poff and Ward 1989). Modifications of hydrologic regimes can indirectly alter the composition, structure, and functioning of aquatic, riparian, and wetland ecosystems (Stanford and Ward 1979; Ward and Stanford 1983, 1989; Bain et al. 1988; Lillehammer and Saltveit 1984; Dynesius and Nilsson 1994).

Native species evolved in an environment of natural variability. Spawning, incubation and rearing of native amphibians and fish are timed to natural cycles and processes and are impacted by out of season disturbances. The project has greatly impacted and modified these seasonal flows. The Instream Flow Council (IFC) set a policy that recommends flow prescriptions that provide inter- and intra-annual variable flow patterns to mimic the natural hydrograph (Annear et al. 2004). The Project's manipulation of variation of flows beyond the magnitude, duration, frequency, or season found in unimpaired systems disrupts ecological processes and degrades aquatic habitat. While periodic disturbances such as flood and drought are inherent in natural systems, the frequent artificial manipulation of flows beyond the range of normal variation overwhelms the resiliency of native species and reduces productivity and survival of aquatic life.

The IFC recommends developing instream flow prescriptions that address five riverine components: 1) hydrology, 2) habitat, 3) geomorphology, 4) water quality and 5) connectivity (Annear et al. 2004). The Project operations and facilities have profoundly impacted all five of these components. As a result, data must be carefully evaluated in the context of multiple interacting parameters. No one tool should be considered definitive, but rather employed in conjunction with other sources of information to provide perspective and guidance in developing recommendations.

The IFC notes that utilizing a percentage of unimpaired hydrology can serve as a robust and reasonable starting point in preparing a flow recommendation where site specific data is problematic (page 161, Annear et. al. 2004). The caveat to using this standard setting approach is the need to augment it with site specific assessments of how biological and geomorphic processes respond to flow. This essential validation phase provides the rationale for the adaptive management component of our recommendation.

Two aspects of using a percentage of inflow approach lend themselves to the Project in particular. First, this approach translates into a simple and direct flow prescription.

Requiring the Licensee to bypass a percentage of inflow eliminates the complexities of other water users and regulators in the upper Klamath basin. Second, this approach provides flexibility to accommodate ongoing watershed restoration. ODFW, federal agencies, tribal entities, and many other stakeholders are working towards enhancing instream flows in the Klamath River through efforts such as wetland restoration and water conservation. By avoiding a static flow prescription, this approach will allow impacted resources to benefit from future restoration successes both within and upstream of the Project.

The objective for all Project-affected reaches will be to restore channel stability, restore flows that develop and maintain native riparian vegetation in the quantity and appropriate places for a natural river channel, and flows that provide good habitat for all fish life stages (fry, juveniles, and adults, and sucker larval stages).

PHABSIM Analysis and Results: The modification of the hydrologic regime alters the functioning of aquatic, riparian, and wetland ecosystems. The Licensee conducted a Physical Habitat Simulation (PHABSIM) analysis for the dewatered reaches and the JC Boyle peaking reach (PacifiCorp April 2005 HSC report), but limited their analyses to non-anadromous species (only redband/rainbow trout and suckers).

<u>PHABSIM Results Indicate Flow Alteration:</u> The PHABSIM analysis conducted by the Licensee in the Klamath River reflects the results of a highly modified flow alteration and impacts on channel shape in both the regulated dewatered and peaking reaches. The

combination of four major factors, 1) Project flow alteration, 2) lack of gravel recruitment, 3) lack of seasonal flood flows, and 4) growth of riparian vegetation either along the low flow channel of dewatered reaches or at the high water mark of the peaking reach, result in a highly modified channel. ODFW recommends implementing an instream flow regime based on flows that meet the objective of restoring instream habitat for fish in the Project reaches.

The project-affected dewatered and peaking reaches flow regimes have been highly modified from their natural states through project flow manipulation. Flow manipulation has altered the channel configuration which results in different Weighted Usable Area (WUA) relationships to discharge than would have occurred under a more natural flow regime. Given that our goal is to restore many of the lost aquatic values to Project-affected reaches by providing appropriate flows and other measures (i.e. gravel augmentation and seasonal flushing flows), the instream flow analysis provided by PacifiCorp on the existing channels has limited utility for prescribing instream flow recommendations for restored stream habitat, but rather defines the Project reaches as they are now.

In general, fry prefer shallow and slow habitats when they first emerge, but move to faster and deeper habitats as they grow to different life stages (Stacy Li, NMFS instream flow specialist, pers. comm.) There are several factors to consider in evaluating the proportion of stream habitat that normally would be expected to provide habitat both horizontally and longitudinally. These factors include:

1) Stream order (stream size). Generally, first order streams provide from 25% to 100% of proportional habitat relative to the wetted channel. There is a scale effect since stream edges dominate in small streams. As stream order goes up, proportion of fry habitat declines.

2) Stream gradient. Very Low gradient streams (<0.25% gradient) provide a greater proportion of fry habitat, up to 100% in small streams, declining with size of stream. As gradient increases, proportional fry habitat decreases. For example, in a hypothetical case, a 1% gradient may provide up to 50% fry habitat, a 2% gradient may provide up to 30% fry habitat, (low gradient riffles), while a high gradient riffle of 4% may only provide 20% proportional habitat (high gradient riffles). In each case, stream velocity is a dominant factor, affecting availability of fry habitat.

3) Relative substrate size. Substrate affects fry habitat because it also depends upon distribution pattern (broad areas or discontinuous distribution), sedimentation level and local gradient. For example, large boulders have shelter behind them with shallow boundary layers (low velocity areas) and high interstitial space that may provide up to 10% fry habitat. Conversely, rubble and cobble have high roughness, therefore tall boundary layers and ample interstitial space. If it is relatively free of sediment, it can be good habitat for rearing fry and juveniles and also provide good benthic habitat production for food. While gravel is good for food production, its relatively small diameter diminishes the boundary height and amount of interstitial space. Cobble and rubble habitat may provide up to 100% fry habitat while gravel may provide only 20% fry habitat. Small-grained substrate, such as sand, is poor fry habitat since there is no boundary layer, little interstitial space, and the substrate is constantly moving.

Therefore, it generally provides less than 5% fry habitat. Since substrate is generally a mixture of sizes, the distribution and abundance of the different habitat types affects the quality and quantity of fry habitat.

4) Cover (also complexity). Low cover provides a low proportion of fry habitat while high cover provides a high proportion of fry habitat.

5) Food availability. High food abundance helps to ameliorate physical habitat that is in short supply for different life stages; and

6) Water temperatures. When water temperatures are high, it magnifies the limiting effects of physical habitat, especially velocity.

Taking all these factors into combination, typically streams the size of the Klamath River would normally be expected to provide fish habitat in the range of at least 25-30% proportional habitat of the wetted river channel (Stacy Li, NMFS instream flow specialist, pers. comm.). However, the surprising results of the PHABSIM in the JC Boyle dewatered and peaking reaches and the Copco 2 dewatered reach show that no lifestage approached 10% physical habitat of the river channel.

The WUA estimates for rainbow trout juvenile and adults presented by the Licensee in their April 2005 addendum to the instream flow study show that microhabitat is unresponsive to changes in flow. While the total surface area appears to be reasonably correlated with flow, the amount of suitable habitat remains very low (ranging from less than one to less than ten percent of total surface area), regardless of flow.

The “peaks” in the Weighted Usable Area (WUA) curves are not meaningful for determining flow recommendations since the WUA curves are so broad over the range of flows. The fry curves are probably the most useful because they appear much more sensitive to flow changes, given the current modified habitat conditions and therefore seem to provide the only useful WUA information on which to assess incremental changes in habitat due to project induced flow changes.   For the most part the WUA curves provided by the Licensee are not sensitive to differences in flow amount and so do not provide useful information for determining how much water is necessary to achieve the goal of restoring habitat and fish populations. Currently the Project-affected dewatered and peaking reaches flow regimes have been highly modified from their natural states which can have detrimental effects on native fish populations.

However, many of the WUA curves demonstrate that as flow is increased, habitat increases for fry, particularly as flows reach edge habitat provided by shoreline riparian vegetation. Therefore, similar to the flow setting method recommended by the IFC, our recommendations do not rely solely on a PHABSIM analysis but also hydrology-based flow recommendations and the wetted perimeter analysis, supplemented by other license conditions to restore a natural river channel for aquatic species (i.e., License Condition #9 Stream Geomorphology). Finally, Hill et al. (1991) emphasizes that that IFIM may be useful to assist in determining the base flow requirement but is not appropriate for determining flows that are necessary for maintaining channel habitat and riparian ecological processes.

The fry stage is likely one of the more important life stages to manage for because this life stage determines successive productivity in subsequent life stages and may ensure the best potential for all three stages. The PHABSIM does not conduct a cohort analysis but evaluates the microhabitat found at different flows for each life stage. The fry stage appears to be the most sensitive to flow regulation. For example, these are demonstrated in the following two WUA curves for redband trout fry for the JC Boyle dewatered and peaking reaches.

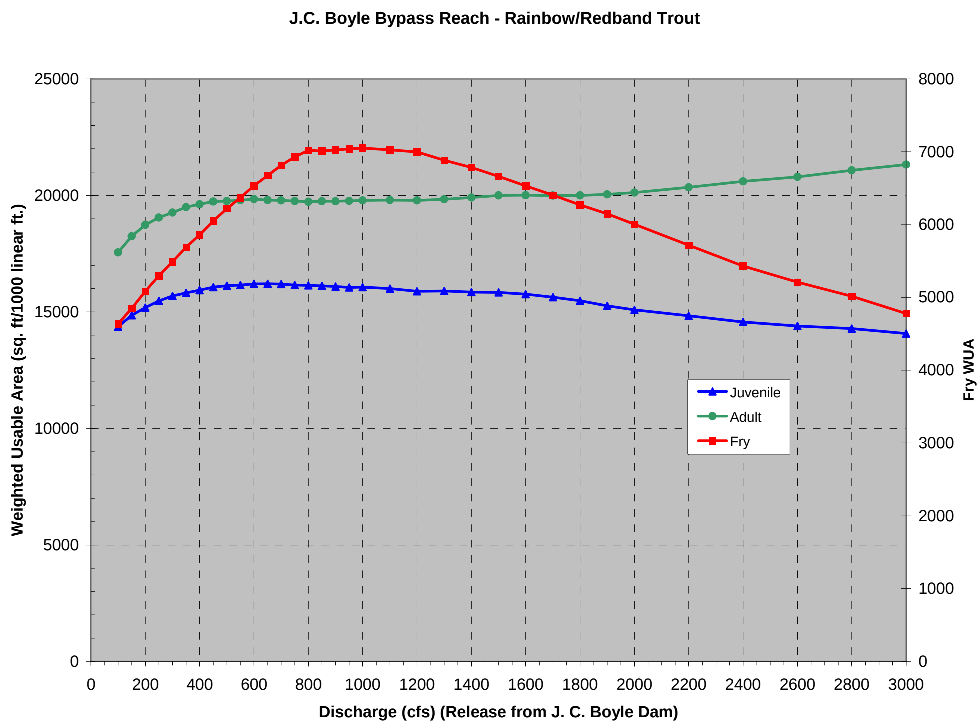

Figure 2. Weighted Useable Area (WUA) curve for redband trout in the JC Boyle dewatered reach.

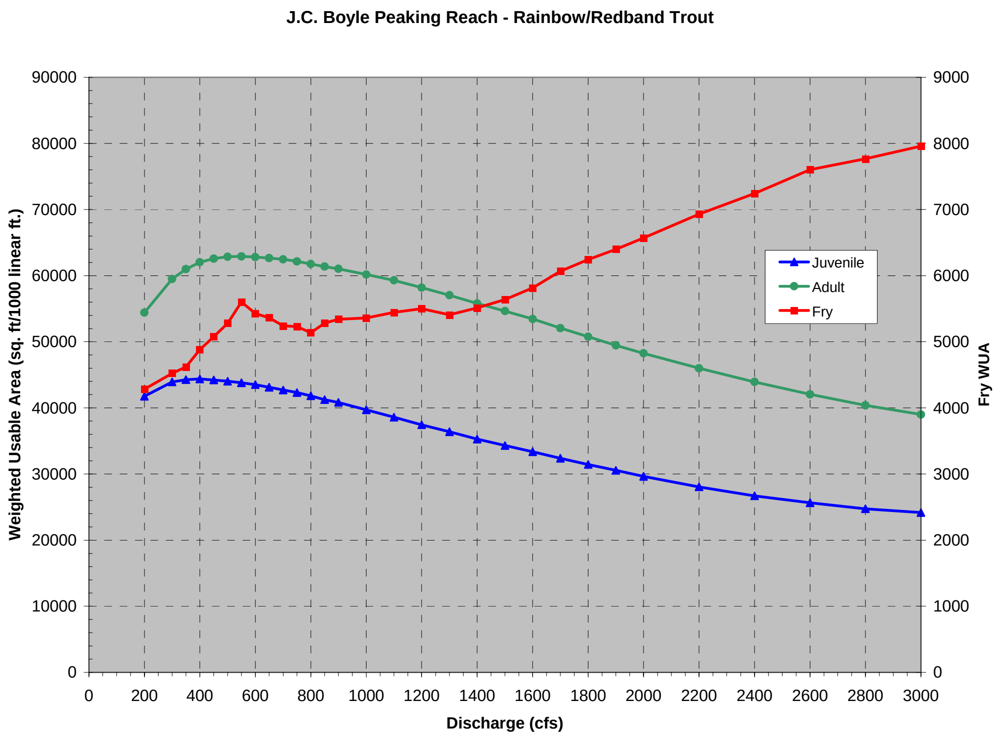

Figure 3. Weighted Useable Area (WUA) curve for redband trout in the JC Boyle peaking reach.

The Project flow manipulation has altered the channel configuration and has resulted in different WUA relationships to discharge than would have occurred under a more natural flow regime. Given that our goal is to restore many of the lost aquatic values to Project-affected reaches by providing additional flows and other measures (i.e. gravel augmentation), the instream flow analysis provided by PacifiCorp on the existing channels has limited utility for prescribing instream flow recommendations in the Project reaches.

In the case of the JC Boyle peaking reach, flows change daily from below the powerhouse down to Copco reservoir. Flows range from a low flow of approximately 300 cfs to either a high flow of 1,500 cfs (1 turbine) or 3,000 cfs (2 turbines). The

PHABSIM analysis shows that WUA for fry occupies generally less than 5% of the habitat provided which is a very low amount of habitat. The fry WUA curves generally increase as flow increases. One of the reasons for the lack of fry habitat is that daily peaking operations below JC Boyle powerhouse scour river margins with no recruitment of gravel materials. Daily peaking has reduced fry habitat to virtually zero (BLM 2002). Therefore, as a result of daily peaking flows, fry habitat has been modified to such an extent that very few fry survive in the peaking reach.

In the case of the Copco 2 dewatered reach, the riparian encroachment of large alder trees in the riverine channel reflects artificial WUA curves of fry habitat. The “blip” of habitat at 50-100 cfs is generally located where the encroached riparian vegetation would be inundated and creates some suitable edge habitat. In the dewatered Copco 2 dewatered reach, the minimum flow release is 10 cfs which is less than 0.5 % of the mean annual flow and has transformed a major river into a wadable stream and boulder field. Similar to the other two reaches described above, almost 100 years of flow alteration has created an artificial channel that limits the applicability of PHABSIM WUA curves for developing appropriate instream flows.

Recommended Flows in the Project-Regulated Reaches: ODFW will base its flow recommendations for the future license on a composite of flow methodologies. In this case the Licensee’s PHABSIM curves have limited applicability to the development of reasonable flows that will move the stream channels to a more natural configuration. As stated above the PHABSIM analysis conducted by the Licensee in the Klamath River reflects the results of a highly modified flow altered channel which has impacted channel shape and configuration in both the regulated dewatered and peaking reaches. These flows are not necessarily conducive to ODFW's objectives of restoring channel stability, developing and maintaining native riparian vegetation, and providing flows for good habitat at all life stages. ODFW considers the Licensee's PHABSIM curves are useful for flows needed to define fry habitat, but are not useful for establishing other life stage flows since the WUA curves are so broad over the range of flow regimes. ODFW's flow recommendations using the PHABSIM analysis for the dewatered reaches, based on redband trout fry needs, are in the range of 600 to 800 cfs (see figure 1).

Since the PHABSIM results are not useful for other stages ODFW will need to augment its recommendation with the use of other flow methods and other observations. ODFW recommends using a composite of flow methods that begins with a hydrology-based method and then is supported by wetted perimeter analyses for the Link River and JC Boyle peaking reach, USBR natural flow estimations, the BLM and PacifiCorp PHABSIM analysis, and the BIA PHABSIM results for the Link and Keno reaches.

Although perhaps not the most widely acknowledged methods, hydrologic based methods provide guidelines to develop appropriate flows needed to provide for maintaining stream channel shape and configuration. The Tennant Method (1976a and b), is a basic hydrologic method giving generalized habitat needs through a percentage-of-hydrology analysis. The Tessman (1980) method adapts the Tennant method to provide for a monthly minimum flow that is structurally beneficial flow for the dewatered reaches. In simple terms, the Tennant's method involves reserving a percentage of the unimpaired annual hydrology for aquatic resources, generally in the range of 30 to 50%, whereas, the Tessman (1980) allows a greater response to real time hydrology. Tessman's formula essentially requires a monthly minimum flow of either 40% of the mean annual flow (MAF) or 40% of the mean monthly flow, whichever is greater. By combining annual flow statistics with monthly variability, this approach provides both inter- and intra- annual variation based on an unimpaired hydrology.

The IFC advocates regional adaptations to increase the relevancy of the Tennant and Tessman instream flow methods. Our recommendations include important modifications of the hydrology-based formula to accommodate the realities of the Klamath River. The Tennant strategy uses natural hydrology to provide good habitat that recommends restoring flow in dewatered reaches to between 30 to 50% of the mean annual flow. The Tessman method modifies the Tennant method to local hydrologic variability, using a flow prescription based on the percentages of monthly flows. Using these parameters, ODFW recommends a flow prescription that adopts a base flow for the JC Boyle dewatered and Copco 2 dewatered reach and then adds a percentage of inflow above the base flow that is allocated to the dewatered reach.

The ODFW recommendations include an important modification of the Tennant and Tessman formulas to accommodate the local hydrologic variability of the Klamath River. This approach uses a smaller time step of 3 days rather than a monthly time step, to facilitate Project operations and accommodate the relatively small storage capacity of the Project reservoirs.

The Klamath basin has a long history of competing water uses. Upstream storage and diversions have impacted flow into the Project since construction began on Link River Dam and Copco Dam early in the century. As a result, there is no "naturalized" hydrograph. However, USGS gage data over an extended period of record (i.e. the past 44 years) is available that includes a range of water year types as well as a variety of regulatory constraints and provides a foundation for the recommended minimum base flows in the dewatered reaches.

Given that the period of record is not a natural pattern of hydrology for the basin, we recommend the higher percentage of MAF recommended by Tennant (1976), of 40%, for the minimum flows in each reach or 40% of the inflow whichever is the greater of the two flows. Whenever the three day running average drops below the required minimum releases, diversion at that facility shall cease and all inflow shall be directed to the respective dewatered reach.

The recommended flows from Link River Dam to Copco 2 Dam generally fall between 500 cfs to 730 cfs, which is in the higher range of the PHABSIM redband trout fry flows. The recommended minimum flow releases based on 40 percent of the mean annual inflow is summarized in Table 6 below.

Table 6. Minimum Flow Requirements for Mainstem Reaches Based on 40 Percent of Mean Annual Flow as Measured at USGS Gages (1961 through 2004)

Mainstem Project Reach	Required Minimum Flow (cfs)
Below Link River Dam	500
Below Keno Dam	625
Below JC Boyle Dam (a.k.a. Boyle dewatered reach)	640
Below JC Boyle Powerhouse (a.k.a. peaking reach)	720
Below Copco 2 Dam (a.k.a. Copco dewatered reach)	730

The recommended reservation of at least 40 percent of the mean annul flow is supported by the hydrologic methods proposed by Tennant (1976), Tessman (1980), Estes and Orsborn (1986), and the IFC (Annear 2004). Reserving at least 40 percent of the mean annual flow for aquatic resources is also supported by site specific information from the PHABSIM results; wetted perimeter analysis, an unimpaired hydrology approach, and water temperature modeling information (see discussions below).

Project inflow is derived from a combination of natural flow, tributary inflow, spring accretion flow, irrigation return flows and releases made by the USBR from its irrigation project. To date, PacifiCorp has been unclear and not entirely responsive in providing information on Project operations. However, it is clear from flow records that the Licensee uses storage to “shape” releases and has the ability to provide minimum flows, on a daily, weekly, or even monthly basis that differ from the real-time inflow from Link River dam. The recommended minimum flow releases in conjunction with run-of–river operations constitute a flow regime that 1) protects aquatic resources whenever the Licensee has operational discretion and 2) acknowledges that “fish flows” will not always be available for release by the Licensee.

ODFW staff base our flow recommendations on a 44 year hydrologic record of flows impaired by the Project, USBR’s irrigation project, and other irrigation diversions in the upper Klamath Basin. By using 40% of the MAF received by the Licensee over the past 43 years, these minimum flows will, on average, be available to the Licensee. ODFW staff acknowledges that during drier months and drier water year types, these flows may not always be available. This is not unique to the Klamath River. These recommendations are similar to the flow recommendations adopted for the Pelton Round Butte Project (FERC #2030) on the Deschutes River, in that a monthly minimum flow was established, recognizing that in drier years and drier months, actual flow may be less than the minimum flow recommendation.

<u>Flow Recommendation for the Link River:</u> In the event that Eastside and Westside diversions are not decommissioned, ODFW recommends a minimum flow of 40% of the MAF which is 500 cfs, below Link River Dam. For flows less than 500 cfs, all inflow shall be passed to the Link River. This recommendation is based on the best information available which includes the hydrology based method, the wetted perimeter analysis, and the BIA PHABSIM instream flow recommendation. For the Link River reach, no gage data is immediately available for the dewatered reach below Link River dam. The nearest gage is located below the Licensee’s Eastside diversion and includes flow into the Eastside power canal along with Link River flows. It does not include flow

to the Westside diversion of 250 cfs since the gage is located above the Westside powerhouse.

Increasing the minimum base flow from 90 cfs to 500 cfs (or inflow as available from the Upper Klamath Lake and the USBR project) will restore fish habitat and fish populations in the Link River below the dam. Redband trout and ESA-listed suckers are currently impacted by low flows and ramping fluctuations that de-water the Link River below Link River Dam. Restoration of flows will substantially improve habitat and water quality for native potamodromous fish species.

In addition, the US Bureau of Indian Affairs (BIA) also conducted a PHABSIM analysis in the Link River and Keno reaches. The BIA filed on behalf of the Klamath Tribes a claim for anadromous fish flows of 700 cfs from January to December. The Proof of Claim submitted to the OWRD for the Use of Surface Waters of the Klamath River and Tributaries for BIA (April 1997) requested a natural flow up to 700 cfs year round from Upper Klamath Lake to Lake Ewauna. The Proof of Claim also stated that the flow claims were developed based on IFIM, and the flows will provide conditions to ensure adequate migratory passage of anadromous salmonid fishes into and out of the Upper Klamath River Basin. The intent of federal and state fishery managers and tribal interests are to restore anadromous fish to historic habitat in and above the Project. In order to restore anadromous fish, adequate fish passage and flows must be implemented in order to mitigate for Project impacts.

Flow Recommendation for the Keno Reach: ODFW proposes the base flow of 40% of the MAF or inflow as available from the USBR irrigation project for a minimum flow recommendation of 625 cfs. This flow recommendation is to provide greater protection and greater certainty of flows for fish and aquatic life in the Keno reach of the Klamath River. Flows received at Keno Dam are a combination of flows from Link River and irrigation return water from canals downstream from Link River that return water to Lake Ewauna. USBR controls these flows and calculates estimates of accretions between Link River and Iron Gate Dam to total their Biological Opinion obligations for coho downstream from Iron Gate Dam. In the Keno reach, the minimum recommended flows equal 40 percent of the estimated MAF entering the reaches using a 44 year record of gage data and adjustments for accretions between gages (Nancy Parker pers. comm). These flows are estimated to be feasible during most periods except extremely dry years. This percentage is consistent with the Tennant method and provides a continuity of flows from reach to reach down the Klamath River through the Project. These flows are dependent upon the availability of inflow to Keno Reservoir. If the recommended flows are not available, then inflow to Keno Reservoir is to be provided.

The flow recommendation for the Keno reach also allows a +/- 10% of inflow within the irrigation season to allow for adjustments due to changes in inflow and outflow from the USBR irrigation project on a daily basis. The intent is to provide some “smoothing” of flows in the Keno reach to accommodate the one inch per hour ramp rate under the Licensee’s control, and also accommodate flow fluctuations due to the USBR project above Keno Dam.

Similar to the Link River discussed above, increasing the minimum base flow from 200 cfs to 625 cfs (or inflow as available from the USBR project) will substantially restore aquatic and riparian resources toward a more natural condition that supports redband trout and ESA-listed suckers. The BIA conducted a PHABSIM analysis in the Link River and Keno reaches. The BIA filed on behalf of the Klamath Tribes a claim for anadromous fish flows of 700 cfs from January to December. Although the claim was denied by OWRD based on the state attorney's advice that the Klamath Tribe could not claim water for anadromous fish since there were none in the basin at the time of the claim, there was no question about the PHABSIM methodology used to develop the claim. The Proof of Claim submitted to the OWRD for the Use of Surface Waters of the Klamath River and Tributaries for BIA (April 1997) requested a natural flow up to 700 cfs year round from Upper Klamath Lake to Lake Ewauna, Keno Dam to JC Boyle Reservoir, and JC Boyle Res to the Oregon/California border. The Proof of Claim also stated that the flow claims were developed based on IFIM, and the flows will provide conditions to ensure adequate migratory passage of anadromous salmonid fishes into and out of the Upper Klamath River Basin

<u>Flow Recommendation for the JC Boyle and Copco 2 Dewatered Reaches</u>: For dewatered reaches, ODFW proposes that the expected inflow shall be estimated using a running average of the gaged inflow for the prior three days in order to smooth the unnatural variability in the hydrologic pattern yet provide for tracking of natural fluctuations. When inflows are less than the minimum target flow, all of the inflow shall

remain in the dewatered channel. By using the two factors of a minimum target flow or a percentage inflow, whichever is greater, the minimum flow creates a naturally shaped flow regime while requiring a simple operational protocol.

The flows proposed for the dewatered reaches are an increase in the minimum base flow from 100 cfs to 640 cfs in the JC Boyle dewatered reach, and from 10 cfs to 730 cfs in the Copco 2 dewatered reach, or 40% of inflow, whichever is the greater flow. The purpose of the increased flow recommendations are to provide greater protection to aquatic, fish and riparian resources and mitigate for the impairment of loss of flow to the river that has been impacted by Project operations. The WUA estimates for the dewatered reach suggest that trout fry and sucker larvae habitat availability increase with increasing flows up to 800 cfs before leveling off, because more edge habitat is available at higher flows. In addition, these flows come into contact with existing riparian vegetation (PacifiCorp 2005 - Instream Flow Addendum Report). These flows will substantially restore aquatic and riparian resources toward a more natural condition that supports productive redband trout and ESA-listed suckers, and anadromous fish when passage facilities are implemented.

The flow recommendation will alter the current Project flow regime in the two dewatered reaches from a low static base flow (except for spills) to a proportional flow with a higher overall minimum base flow. When the base flow is not available, then the total inflow from the Klamath River above each dam is required to be released to the dewatered reach. This provision of the recommendation addresses water availability, especially for dry years, and variability in the annual flow regime.

As can be seen these recommended flows encompass flow recommendations from three distinct sources: PHABSIM flows for redband trout fry, IFIM flow requirements for redband trout and hydraulic stream flow needs as defined by the Tennant/Tessman methods. Flows from these methods fall within our recommended flows. Thus a combination of techniques, in conjunction with other sources of information, provided perspective and guidance in developing the flow recommendations for the dewatered reaches. The more natural seasonal low flows provided to the dewatered reach during this time will create conditions important to the establishment of riparian vegetation and subsequent fish habitat. Using the IFC's recommendations to develop instream flow prescriptions based on the five riverine components of 1) hydrology, 2) habitat, 3) geomorphology, 4) water quality and 5) connectivity (Annear et al. 2004), these flows will mimic a balanced flow condition along with seasonal natural flows. Minimum base flows, coupled with a flow regime that includes inter-annual and intra-annual variation, is necessary for maintaining fish habitat and riparian processes.

The literature consistently illustrates the adverse effect of inadequate flow on aquatic organisms (Annear et. al. 2004). Therefore, the minimum base flows for fish and macroinvertebrates in the recommendation are required, except when this minimum inflow to the system is unavailable. Research also indicates that beyond prescribing a minimum flow, an appropriate flow regime based on season and water year type should be determined (Richter et. al. 1997, Stanford et. al. 1996). By requiring proportional flows based on the average of the previous three days of inflow, the flow recommendation adjusts discharge to account for water availability through the seasons. By providing 40% of flows averaged from the previous three days, seasonal patterns based on water availability are integrated and abrupt fluctuations due to operations from no-Project diversions are avoided.

As an example, Figure 4 shows an approximation of the proposed flow recommendation for the JC Boyle dewatered reach in an average water year in comparison to average inflows to the reach. When inflows are less than the minimum flow of 640 cfs, all of the inflow shall remain in the natural channel (see flows for July). The flow data for this illustration comes from Water Year 2000, an average water year.

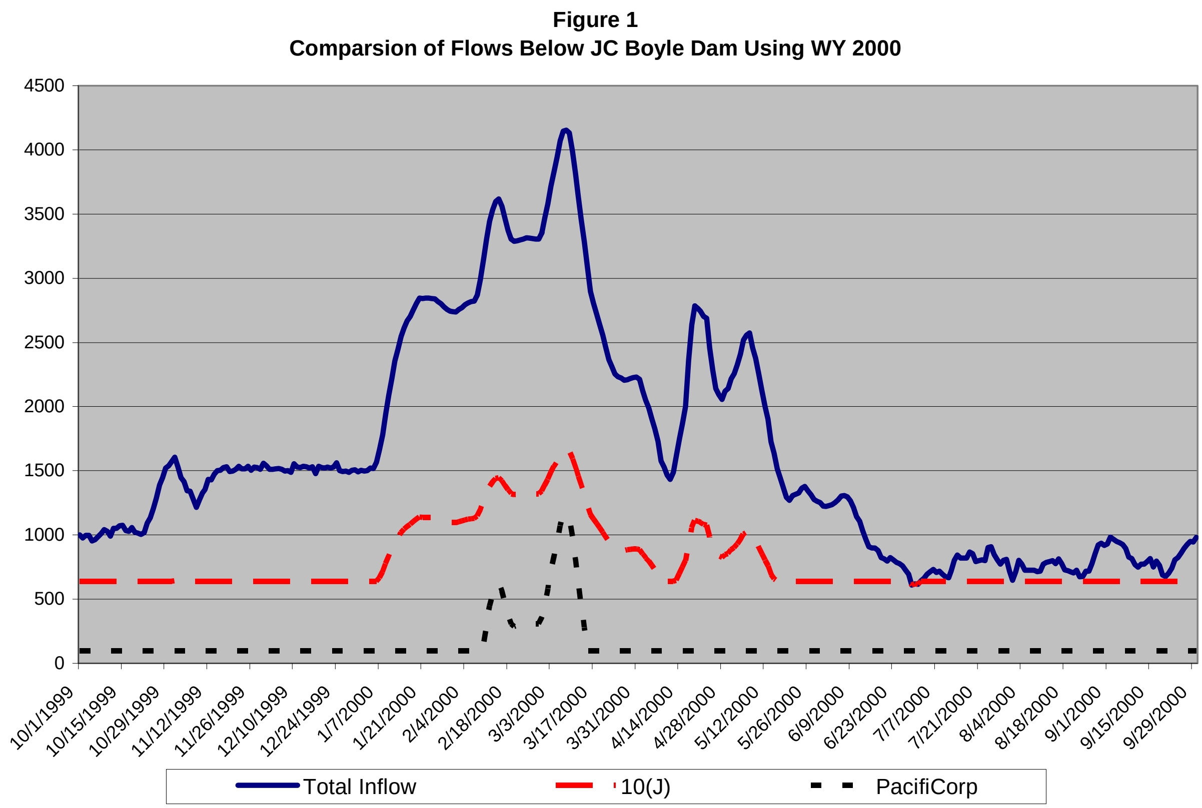

Figure 4. Flow recommendation for JC Boyle dewatered reach.

Since these flows may not be available during drier months and drier water years, ODFW recommends providing for actual flow if monthly minimum flows go below the recommended flows. As Tessman (1980) notes: “There will be circumstances when the actual flow is less than the minimum flow value. The minimum flow is not intended to suggest that stream flow should be augmented when naturally occurring flows are less. Minimum flows simply serve as a constraint on withdrawal.” (Tessman 1980, p. 7-8).

<u>Flow Recommendation for the JC Boyle peaking reach:</u> The increased minimum flow in the JC Boyle peaking reach from a daily base flow of 320 cfs to 720 cfs will provide substantially greater protection to fish and aquatic resources and move the river toward a more balanced hydrology while sharing some flow for power generation. In the JC

Boyle peaking reach, recommended flows equal 40 percent of the estimated mean annual flows entering the reach using a 44 year record of gage data and adjustments for accretions between gages (Nancy Parker pers. comm.). This percentage provides a continuity of minimum flows from reach to reach down the Klamath River through the Project. Flows in this reach above the minimum recommendation are expected to approximate a natural pattern due to the run-of-river mode of operations recommended at this facility.

Flow Recommendation for Fall Creek: The PacifiCorp instream flow study presented in the FLA provides some preliminary documentation of the habitat impact. The results depict increasing habitat for adult rainbow trout with increasing flow throughout the range of the simulation (up to 30 cfs), with no appreciable flattening of the curve (PacifiCorp 2004). To address flow requirements in Fall Creek, ODFW recommends the Licensee implement an instream flow regime based on the best available information for this tributary. Over 20 years of streamflow data from the USGS gage (1933 through 1959) indicates mean monthly flows in Fall Creek (without augmentation via diversions from Spring Creek) range from 50 to 32 cfs (PacifiCorp 2004, Water Resources FTR, Appendix 5B). The Licensee's diversion on Fall Creek has a 50 cfs capacity and a 0.5 cfs bypass flow requirement. The Licensee diverts 99 % of the streamflow except during the infrequent and brief storm events when flows exceed 50 cfs, and causes harm to aquatic and fish resources of Fall Creek.

Given the best available information and the IFC recommendation for developing appropriate minimum flows, ODFW recommends using the Tennant method to develop an appropriate flow to protect fish and aquatic resources in Fall Creek. To adapt the Tennant method to this relatively small and unstudied watershed, ODFW recommends reserving a minimum of 40% of the instantaneous flow to mimic an acceptable level of intra-annual variability and provide good aquatic habitat. Applied to the historic USGS flow data this would range from 13 to 22 cfs. The WUA curves provided in the FLA indicate this range of flows will provide roughly 50% of the simulated adult rainbow trout habitat and 95% of the simulated juvenile rainbow trout habitat.

Flow Recommendation for Spring Creek: ODFW recommends a minimum flow that does not allow diversion from June 1 to September 15 and split 50% of the flow between the diversion and the stream for the remainder of the year. This minimum flow will provide protection to fish and aquatic resources currently impacted by the diversion. The recommendation will both mitigate the water quality impact to Spring and Jenny creeks and provide sufficient habitat for fish and aquatic resources.

The BLM has gage information available for the headwater portion of Spring Creek. Currently the Licensee’s diversion of flow from Spring Creek impacts stream temperature and habitat in Spring Creek below the diversion dam and in Jenny Creek below its confluence with Spring Creek. Diverted water from Spring Creek reduces the amount of water available for redband trout habitat and substantially increases thermal heating of the water. BLM collected water temperature data in 2004 and summarized in a report that was filed with FERC on April 25, 2005. The report documented the Project's Spring Creek diversion impacts stream temperature in both Jenny and Spring Creeks. Specifically, when the Licensee diverts water from Spring Creek, the water temperature in Spring Creek below the diversion increases along with the number of days which the temperature exceeds the State of Oregon water quality standard (ODEQ 2003). This impact continues downstream, evidenced by increases in water temperature in Jenny Creek below the confluence with Spring Creek. This impact is particularly adverse during the warmer months as the native aquatic species evolved under a flow regime influenced by cool spring inflows. Beyond impacting water temperature, PacifiCorp's Spring Creek diversion also reduces aquatic habitat. However, PacifiCorp has yet to present data that quantifies this impact. If and when such information becomes available, ODFW may modify the flow recommendation for Spring Creek.

<u>Flow Recommendation Below Iron Gate Dam</u>: Minimum flows below Iron Gate Dam are dictated by the flows released by the USBR irrigation project at Link River Dam. USBR controls these flows and coordinates with the Licensee to estimate accretions between Link River and Iron Gate Dam to total the Biological Opinion obligations for coho below Iron Gate Dam. In some dry years, USBR may not release additional flows above those necessary to meet coho Biological Opinion coho obligations. The minimum flows recommended here are target flow recommendations that are premised on the understanding that they are to be provided as long as inflow into Iron Gate Reservoir is

sufficient to support the recommended flow. If the target flow is not available, then the Licensee shall pass inflow to Iron Gate Reservoir downstream of Iron Gate Dam.

Developing appropriate flow recommendations for the Klamath River below Iron Gate Dam has been an important objective of multiple Tribal, Federal and State agencies for many years. The DOI requested Dr. Thomas Hardy of the Utah Water Research Laboratory to work with professionals from Klamath region federal and tribal agencies to develop flow recommendations for below Iron Gate Dam that have the single objective of restoring anadromous fish. This effort produced a Phase I document that was based on information that was available (Hardy 1999) and a Phase II document that was based on a flow model developed with site specific hydrologic, hydraulic, habitat, and fisheries information (Hardy and Addley 2001).

At this time, the best available information for the flow requirements of native aquatic species in the Klamath River below Iron Gate dam is contained in the 2001 Evaluation of Interim Instream Flow Needs in the Klamath River, Phase II, Final Report prepared by Hardy and Addley for the US DOI in 2001. Specifically, this report recommends minimum instream monthly flows at Iron Gate dam for 90, 70, 50, 30 and 10 percent exceedance ranges corresponding to the USBR designation of Dry, Below Average, Average, Above Average and Wet water year types.

Currently, Hardy and Addley's work is undergoing review by the National Academy of Science (NAS) and the Phase II report will be finalized in the near future. ODFW reserves the right to adjust the minimum flow recommendations below Iron Gate dam based on the outcome of the NAS review and subsequent finalization of Phase II.

ODFW suggests the same modification to the 2001 flow recommendations as proposed by CDFG to reduce the disease risk and incidence of fish kills for adult salmonids in summer months during drier water year types. CDFG (2004) and USDI Fish and Wildlife Service (2003a, 2003b) reported on factors that contributed to the September 2002 Klamath River fish kill of over 30,000 adult salmon. The USFWS report concluded that low river discharges, in combination with an early return of a high density of salmonids, warm water temperatures, and possible extended residence time caused the extreme mortalities (USFWS 2003a). CDFG (2004) identified flow as "the only controllable factor and tool available in the Klamath Basin . . . to manage risks against future epizootics and major adult fish-kills" (page iii). ODFW recommends increasing the minimum flow below Iron Gate Dam to 1200 cfs from July to November to minimize high disease risk conditions.

Currently, for flows below Iron Gate dam, the FERC minimum release flows are 1,300 cfs from September to April, 1,000 cfs in May and August, and 710 cfs in June and July. However, since 1997, USBR's annual project operations plans for the irrigation project in the upper basin have prescribed instream flow releases below Iron Gate Dam. These flows are dictated by the estimated amount of storage and flow based on water year type. However, these instream flows could be as low as 500-600 cfs in June, July and August, depending on the water year type. However, at these FERC minimum and recent USBR flows, salmon mortality for juveniles and returning adults is regularly recorded. The condition that killed 30,000 adult salmon in the Lower Klamath River in September 2002 was strongly attributed to low stream flows, high water temperatures and related diseases exacerbated by stream temperature and flow.

To avoid fish kills due to late summer and early fall low flows, CDFG (2004) recommended a combined flow at the Orleans and Hoopa gages of 2200 cfs as a minimum to reduce the risk of a disease outbreak. NMFS modeled the expected flows in the Lower Klamath River for the August and September 1961-2004 period of record with the following assumptions: 1) flows at Lewiston were 450 CFS (minimum ROD flows) and, 2) flows at IGD were 1000 CFS (Hardy's "floor" recommendation for Aug/Sept flows). The model results indicated that for 16 out of 80 months mean flows would have been below 2200 CFS, and 39 out of 79 months, flows would have been below 2500 CFS. As a result of this model exercise, ODFW recommends a minimum flow of 1200 CFS below Iron Gate Dam. The additional 200 cfs above the 1,000 cfs recommended in the INSE (2001) report will substantially reduce the number of months (16 to 8) flows would fall below the flow recommendations. Therefore, ODFW's target flow recommendation below Iron Gate Dam will provide for the needs of fish, based upon the DOI's Phase II analysis of instream flow needs of anadromous fish in the Lower Klamath River and modified to minimize disease risk during summer months during drier water year types.

Three other studies specific to the Lower Klamath River support the recommended range of flow recommendations for salmon, steelhead and other native fish below Iron Gate Dam:

1. Trihey and Associates (1996) recommended higher summer flows than the Iron Gate Dam FERC license minimums, as these additional flows are expected to "(1) reduce the growth of aquatic plants and algae, (2) provide additional wetted and surface turbulence in riffles, and (3) provide a larger volume of water in the river channel to decrease the amplitude of daily stream temperature cycles." Trihey and Associates (1996) employed a modified Tennant (1976) method and used 60% percent of the average pre-Project annual stream flow volume and the recommended minimum Iron Gate Dam release schedule was "shaped" to more closely resemble the pre-Project hydrograph. The recommended monthly instream requirements for Tribal Trust species were estimated to be: 1,200 CFS in October, 1,500 CFS between November and March, 2,000 CFS in April, 2,500 CFS in May, 1,700 CFS in June, and 1,000 CFS between July and September.

2. Biologists with the CDFG conducted habitat measurements and visual estimates and concluded that any reduction in discharge below about 1,000 cfs would lead to a diminished fishery (Wales 1944). Wales (1944) also noted that any reduction in flows below 2,000 CFS, as measured around Fall Creek, would be expected to materially affect salmon and steelhead populations downstream to the Shasta River. In 1955, a CDFG biologist estimated that 1,000 CFS provided

year-round would be required to maintain game fish at 1955 levels (Sletteland 1995).

3. More recently, the Institute for Natural Systems Engineering (INSE 1999) (Hardy Phase I study) developed estimated the appropriate flow regime needed to meet the habitat requirements of salmon and steelhead. Results of two techniques, hydrology-based methods and field-based methods were averaged (on a monthly basis). The resulting flow regime was forwarded as an interim recommendation, until additional analyses can be completed. The INSE (1999) recommended the following interim monthly instream flows below IGD: 1,476, 1,688, 2,082, 2,421, 3,008, 3,073, 3,307, 3,056, 2,249, 1,714, 1,346, and 1,395 CFS, during October through September, respectively.

PHABSIM WUA Results using the ODFW Flow Recommendations: While the PHABSIM curves indicate that microhabitat and the amount of suitable habitat remains low (ranging from less than one to less than ten percent of total surface area); regardless of flow, the total surface area appears to be reasonably correlated with flow. Using the PHABSIM results, the amount of habitat relative to total available habitat can be estimated for the flow recommendations for each reach. The recommended minimum flows of 640 cfs in the JC Boyle natural river reach that is currently dewatered will provide approximately 95%, 100%, and 93% of maximum available WUA for redband fry, juveniles, and adults, respectively. The recommended flow of 730 cfs in the Copco 2 dewatered reach will provide 94%, 98%, and 88% of maximum available

WUA for the fry, juvenile, and adult redband trout, respectively. The recommended flow of 720 cfs for the JC Boyle peaking reach will provide 66%, 96% and 99% of maximum available WUA for fry, juvenile and adult redband trout, respectively. While the PHABSIM analysis is limited, it provides independent, habitat-based support for the recommended minimum target flows and predicts redband trout habitats persist during the periods when minimum target flows are met.

Feasibility: Portions of the USBR irrigation project are upstream of PacifiCorp's Eastside and Westside diversions at Link River Dam and above Keno Dam. Therefore, inflow to Upper Klamath Lake and the irrigation project operations largely determine the flows that are incoming to the Project. USBR consulted with NMFS under section 7 of the Endangered Species Act in 2002 to address adverse effects of the irrigation project to federally listed (threatened) coho salmon. The biological opinion established minimum flows of 1,000 cfs below Iron Gate Dam during the dry months of the year (July to September) to be met by the year 2010. Some aspects of this biological opinion were challenged in court, and it is expected that a new biological opinion will be completed in 2006. At this time, our best estimate of the flows that will be required in the new biological opinion is 1,000 cfs for the dry months. Accretions between Keno Dam and Iron Gate Dam are approximately 300 cfs during dry months. To meet the flows at Iron Gate Dam, it is likely that USBR will need to make 700 cfs available to be released by PacifiCorp at Keno Dam. Therefore, it is expected that the recommended minimum flows will be attainable most of the time, except in extremely dry circumstances.

Other Supporting Methods and Analyses: Several methods including a Wetted Perimeter Analysis in the JC Boyle peaking reach and Link River below Eastside powerhouse, the USBR Natural Flow Study, the BIA PHABSIM flow study for the Link and Keno reaches, the BLM PHABSIM (BLM 2002) in the peaking reach, and Side Channel Analysis in the JC Boyle dewatered and peaking reaches support the ODFW flow recommendation for the various Project-affected reaches. These analyses indicate that that our flow recommendations are appropriate because they fall within the general flow recommendations made by ODFW. Additional studies that support recommending higher flows are the Indicators of Hydrologic Alteration (IHA) analysis (Huntington 2004) and the bioenergetics study (Addley et. al. 2005).

<u>Wetted Perimeter Analysis (Link River below Eastside Powerhouse):</u> The Licensee conducted a wetted perimeter analysis in the Link River above and below the Eastside powerhouse. The Licensee's analysis of wetted perimeter in the Link River was a total of 11 transects in different habitat types that evaluated change in wetted perimeter under different flow regimes, with 4 transects below the Eastside powerhouse discharge and 7 above the Eastside powerhouse discharge. The wetted perimeter analysis presented in Figure 5 is the 4 individual wetted perimeter transects (dotted or dashed lines) located below the Eastside powerhouse and a combined summary of the four transects (solid line).

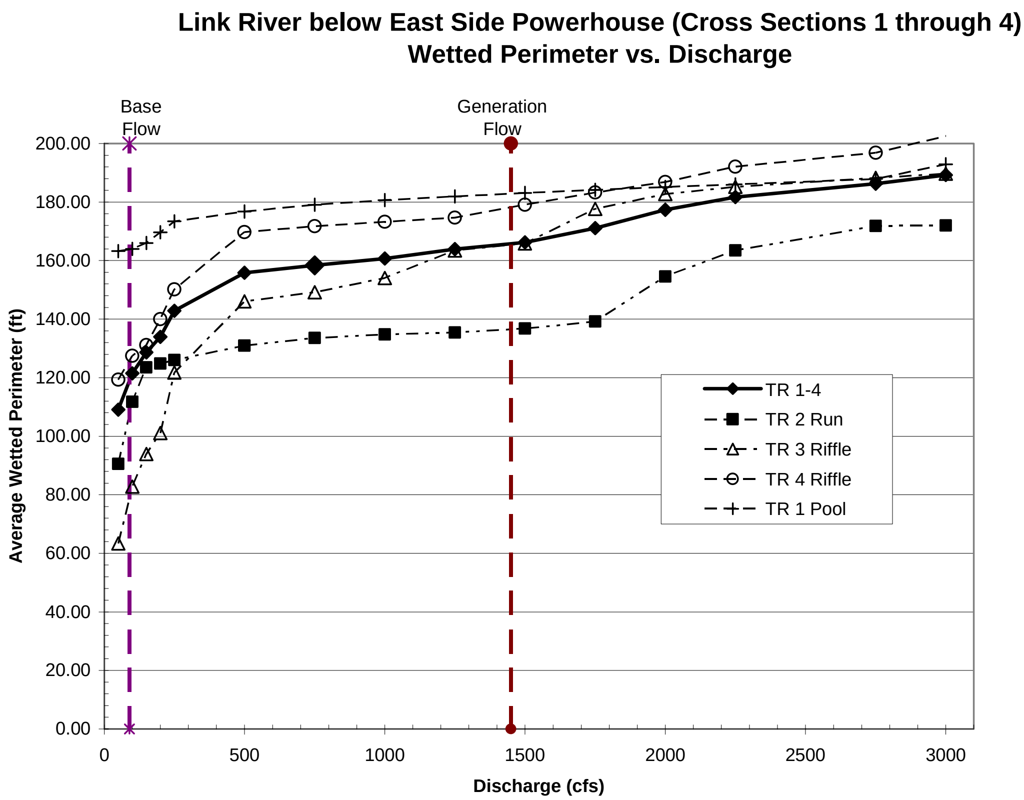

Figure 5. Wetted perimeter versus discharge for the combined and 4 individual habitat transects of Link River flows below Eastside powerhouse.

The minimum flow below Link River Dam is 90 cfs. Since there is no gage data below the dam, the only gage data that can be evaluated to assess minimum flow needs is the Link River flow data below the Eastside powerhouse, approximately one mile downstream of Link River Dam. While the "minimum flow" below the Eastside powerhouse is 450 cfs, this reach of the river frequently fluctuates between less than 450 cfs and greater than 3,000 cfs. For example, from the period May 1 to August 30, 2005, the flow ranged from 437 to 3,790 cfs, with no apparent cause for high or low flows. The full range of fluctuation flow impacts occurs over the lowest to highest flows. Meanwhile, flows below Link River Dam have been observed as low as 25 cfs although the minimum flow required is 90 cfs.

The wetted perimeter analysis in the Link River below Eastside powerhouse indicated that the percent of wetted perimeter change from 50 to 3,000 cfs is 42% for all types of habitat and 62% in riffle habitats. Even with flow changes from 450 to 3,000 cfs, the wetted perimeter change is 18% for all habitats and 31% in riffle habitats. These are very substantial changes and represent severe dewatering of the channel bed.

Inflection points on the wetted-perimeter analysis indicate areas of rapid changes, especially in sensitive habitat types and/or specific areas within those habitats. Representation of an overall average curve does not adequately permit examination of these changes as they are obscured when melded with all the non-sensitive areas. The greatest amount of wetted perimeter change in the Link River below the Eastside powerhouse occurs over the range of 100 to 500 cfs, indicating the highest degree of impact in this range. Figure 4 suggests that the flow in the dewatered reach below Link River Dam should generally range above 500 cfs in order to avoid the most extreme dewatering and associated impacts, since the wetted perimeter habitat based analysis indicates an inflection point occurs at approximately 500 cfs. Better habitat protection occurs at the higher flow recommended by the BIA PHABSIM of 700 cfs for anadromous fish. The inflection point appears to occur at 500 cfs for the most sensitive habitats (riffles), 300 cfs for intermediate habitats (runs and glides) and 300 cfs for least sensitive habitats (pools). The flow recommendation derived from the wetted perimeter analysis for the Link River is very similar to the flow recommendation provided by ODFW using the hydrology-based method.

Wetted Perimeter Analysis (JC Boyle Peaking Reach): The Licensee also conducted a wetted perimeter analysis in the peaking reach. The Licensee's analysis of wetted perimeter in the JC Boyle peaking reach was limited to a comparison of the peaking cycle base flow (lowest flow reached during a peaking cycle) against a single, assumed continuous flow under undefined "Run of River" (ROR) flow regime (Figure 5). However, the full range of peaking impacts occurs over the lowest to highest flows occurring during peaking cycles, including both single- and two-turbine operations, with a range of approximately 350 cfs to 1500 cfs and 350 cfs to 3000 cfs.

The wetted perimeter plots provided by the Licensee (PacifiCorp 2005, Peaking Impacts Report) indicate that a break in channel bank slope occurs at about 700-800 cfs. This is an indication of the flow at which the active channel is full and thus typically provides usable habitat that is within 5-10% of optimal (Hill et. al. 1991). The wetted perimeter analysis in the peaking reach indicated that the percent of wetted perimeter change for a single turbine peaking operation is 32% for all types of habitat and 47% in riffle habitats. Over the range of two-turbine peaking operations the changes are 48% and 61%, respectively. These are very substantial changes and represent severe dewatering of the channel bed on a daily basis due to peaking.

Inflection points on the wetted-perimeter analysis indicate areas of rapid changes, especially in sensitive habitat types and/or specific areas within those habitats.

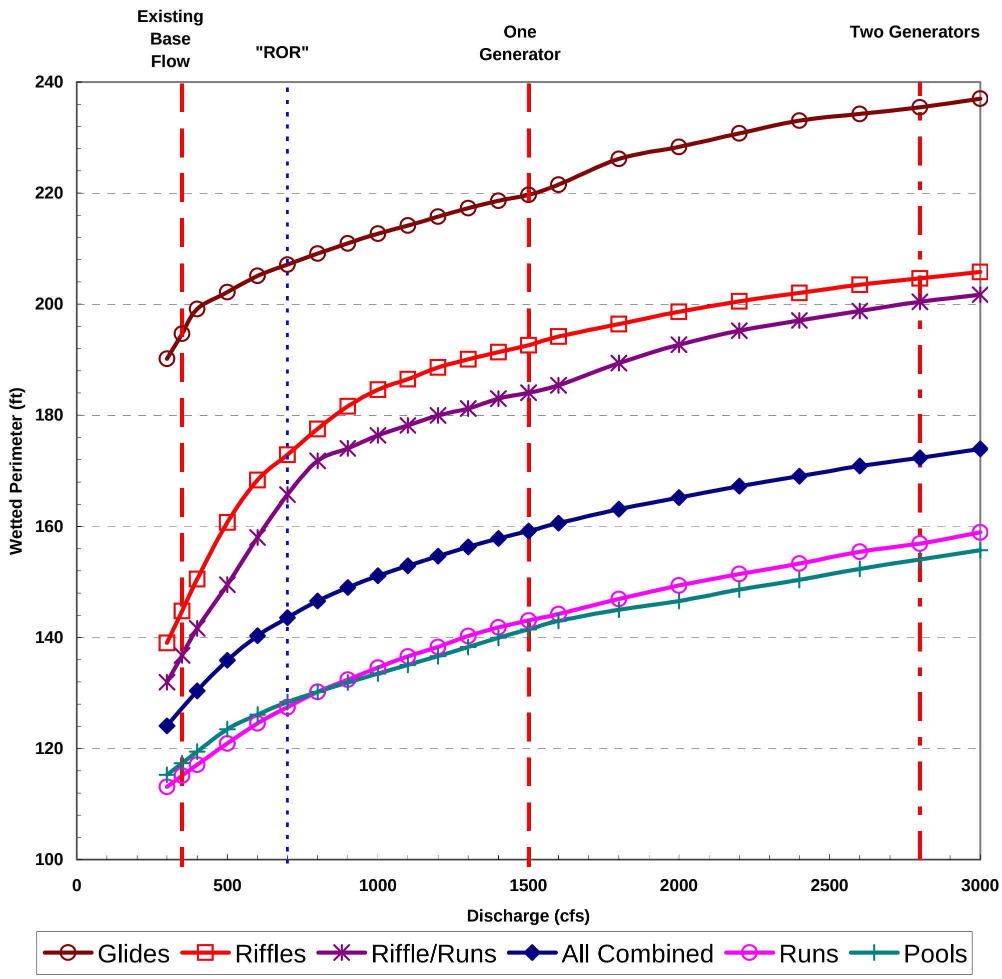

Figure 6. Wetted perimeter versus discharge for all habitat types in the JC Boyle peaking reach.

Representation of an overall average curve does not adequately permit examination of these changes as they are obscured when melded with all the non-sensitive areas. The greatest amount of wetted perimeter change occurs over the range of 350 to 800 cfs, indicating the highest degree of impact in this range. Figure 6 suggests that the flow in the peaking reach should generally range above 700 – 800 cfs in order to avoid the most extreme dewatering and associated impacts. This habitat based analysis indicates an inflection point in average wetted perimeter occurs at roughly 700 cfs. The inflection point appears to occur at 800-1,000 cfs for the most sensitive habitats (riffles), 400-600 cfs for intermediate habitats (runs and glides) and 500 cfs for least sensitive habitats (pools). The flow recommendation derived from the wetted perimeter analysis for the JC Boyle peaking reach is very similar to the flow recommendation provided by ODFW using the hydrology-based method.

USBR Natural Flow Study: Another line of evidence in support of the minimum recommended flows utilizes the recently developed Natural Flows of the Upper Klamath River (USBR 2005, http://www.usbr.gov/mp/kbao/). The Tessman method recommends a minimum of 30% of unimpaired or natural flows be used as a base flow to provide good aquatic habitat conditions. USBR's Natural Flows provide a 51 year hypothetical record of the flows at Keno Dam under natural, unimpaired conditions. The mean annual flow using this hypothetical record is 1,810 cfs at Keno Dam. Accretions from the Keno gage to JC Boyle Dam and Copco 2 Dam were estimated from the actual 44 year gage records (Nancy Parker's model) and added to this hypothetical mean annual flow, yielding an estimated mean annual flow at JC Boyle Dam of 1,844 cfs and 2,074 cfs at Copco 2 Dam. Our recommended minimum flows in these dewatered reaches are 34.7% and 35.2% of the mean annual unimpaired flows estimated in this way. These methods provide good validation of the minimum flows selected.

As restoration efforts continue to be implemented in the upper basin, these flow recommendations along with implementation of other Project recommendations, including gravel augmentation and flushing flows, will allow flows in the dewatered reaches to evolve to a more natural shape. In addition, restoration of the hydrograph in the dewatered reaches will have a more prolonged period of seasonal high flows. With restoration, natural seasonal flows will persist longer into the spring and early summer and overall increase annual flow, resulting in a shorter period when minimum target flow recommendations are in effect.

While still undergoing peer review, the USBR estimate of unimpaired flows provides independent support for the minimum target flow requirements of 640 cfs in the Boyle, 720 cfs in the JC Boyle peaking reach, and 730 cfs in the Copco dewatered reach. The USBR's estimated flow at Keno in the driest months (July through October) in the driest water year type (90 % exceedance), averages roughly 590 cfs. This estimate constitutes the "worst case" summer flow scenario experienced by native aquatic resources prior to the implementation of the basin's major water use projects. The ODFW recommended minimum target flows are comparable to this historic lowest flow condition (once consistent accretions from springs and tributaries are included).

<u>BIA PHABSIM Flow Study:</u> The BIA conducted a PHABSIM analysis in the Link River and Keno reaches. The BIA filed on behalf of the Klamath Tribes a claim for anadromous fish flows of 700 cfs from January to December for 3 reaches of the Klamath River from Link River Dam to the Oregon-California state line. Larger flows were recommended for spawning and rearing portions of the life history. Although the claim was denied by OWRD based on the legal ground that the Klamath Tribe could not claim water for anadromous fish since there were none in the basin at the time of the

claim, there was no question about the PHABSIM methodology used by BIA to develop the claim.

The Proof of Claim submitted to the OWRD for the Use of Surface Waters of the Klamath River and Tributaries for BIA (April 1997) requested a natural flow up to 700 cfs year round from Upper Klamath Lake to Lake Ewauna. The Proof of Claim also stated that the flow claims were developed based on IFIM, and the flows will provide conditions to ensure adequate migratory passage of anadromous salmonid fishes into and out of the Upper Klamath River Basin. The results of the PHABSIM for fish habitat demonstrated that 700 cfs is the minimum flow needed to support native fish species.

<u>BLM 2002 PHABSIM Results:</u> The BLM also conducted a PHABSIM analysis of transect data previous collected within the peaking reach for the proposed Salt Caves Project (BLM 2002). The BLM analysis incorporated key life history strategies, such as the use of stream margin vegetation and shallow water habitats by fry and velocity shelters by adults and juvenile life stages. Fry habitat was absent at about 300 cfs and increased steadily and rapidly to a maximum at 1700 cfs. The BLM analysis further showed that when flows fluctuate between 363 cfs and 1530 cfs, no effective fry habitat is available. Adult and juvenile habitats were lowest at 300 cfs and increased rapidly to peaks at about 1400 cfs for juveniles and 1800 cfs for adults, after which habitat leveled off. An analysis incorporating velocity shelters, an important bioenergetically efficient strategy, the shape and peaks of the juvenile and adult habitat relationships were essentially the same, except for showing approximately one-third less habitat overall.

The BLM analysis also considered flows for benthic macroinvertebrates and examined flow regimes through the use of habitat time series analysis. The BLM's conclusion, considering a balancing of life stage requirements, was that a flow of 1700 cfs would best protect all life stages. While the 1,700 cfs flow is substantially higher than the instream flow recommended by ODFW, the flow recommendation for the BLM PHABSIM was developed exclusively for meeting the needs of redband trout fry while our recommendation is a composite of flows for all life stages.

ODFW Instream Water Right for the Klamath River: The State of Oregon holds in-stream water rights of 550 cfs for the Klamath River to maintain fish and other aquatic resources. These flows are based on in-stream flow studies using the Instream Flow Incremental Methodology (IFIM) procedures undertaken by Pacific Power and Light and the City of Klamath Falls as part of the Salt Cave Hydroelectric Project (FERC# 10199) licensing effort in the early 1980’s. The flows were established for redband/rainbow trout. The instream water right application was protested by PacifiCorp and Klamath Drainage District. One of the issues that OWRD will sort out is the contribution from storage versus natural flow, so the application is still "in process". The flows requested were adopted as part of scenic waterway flows.

Side Channel Habitat Analysis: Side channels are important areas for rearing and spawning fish and often have slower velocities and high quality microhabitat (Bowen et. al. 2003).

JC Boyle dewatered reach: The Licensee (PacifiCorp 2004, Fish Resources FTR) identified nine side channels below the JC Boyle Powerhouse but did not identify any in the JC Boyle dewatered reach. BLM identified six side channels in the dewatered reach between JC Boyle Dam and the powerhouse using aerial photograph reconnaissance. It is expected that base flow increases approaching 640 cfs would result in water flowing in many of these side channels based on results of the peaking reach analysis.

JC Boyle peaking reach: Further support for meaningful increases in flow to improve habitat quality and quantity for fish resources is provided in the analysis of side channel inundation flows (PacifiCorp 2004, Fish Resources FTR, Table 4.7-7). Side channels are important areas for rearing and spawning fish and often have slower velocities and high quality microhabitat (Bowen et. al. 2003). The Licensee identified nine side channels below the JC Boyle powerhouse and estimated the river flow at which flow would begin in the side channels. Six of these side channels begin to flow with flows greater than the current minimum flow (approximately 330 cfs). Of these, four would begin to flow at flows greater than 700 cfs. According to this analysis, seven of these side channels could be potentially dewatered following peaking flows that recede to a base flow of 330 cfs. In contrast to the Licensee’s nine side channels, BLM identified 36 side channels between JC Boyle Dam and Copco Reservoir using aerial photograph reconnaissance, indicating that there is more potential for increased habitat than indicated by the PaciCorp analysis.

Indicators of Hydrologic Analysis: Huntington (2004) completed an Indicators of Hydrologic Analysis (IHA) using a paired comparison between the unaltered and modified flow regimes of the Klamath River in the JC Boyle dewatered and peaking reaches. The purpose of the IHA was to document the nature of hydrologic changes caused by the influence of Project flow regimes on the biotic composition, structure, and function of the Klamath River. The analysis compared the central tendency and dispersion of 35 hydrologic parameters such as magnitude of monthly flow conditions, magnitude and duration of high and low pulse flows, timing of annual extreme water conditions, frequency and duration of high and low pulse flows, and rate and frequency of water condition changes.

Huntington (2004) used the years 2000 and 2001 of hourly flow data to examine the two scenarios, Existing Condition (EC) and Without Project (WOP). The analysis was not based on gage data but used the RMA-2 hydrodynamic flow model provided by the Licensee in the graphical comparison of WOP and EC river flows. A comparison of the median monthly flow for each of 12 months for the two years analyzed for the JC Boyle dewatered reach documented that the Project reduced the magnitude and variability of monthly flows. Median flows from WOP to EC were reduced by an average of 75%. It should be noted that the comparison was for the reach below the springs which augments an additional flow of approximate 225 cfs and likely minimized the relative comparison between EC and WOP conditions. In the case of the JC Boyle peaking reach, the Project reduced the magnitude of median flows by an average of 19% although the magnitude of deviation between WOP and EC ranged from +2% to -44%

for individual months of the year. While the impact of flow removal was not as great in the peaking reach as the dewatered reach, the impacts of peaking itself, in terms of pulse flows, were far greater.

While Huntington's study focused on hydrologic impacts, the resultant affects to aquatic life are long-term chronic stress to fish populations, which affect spawning, incubation, fry emergence, rearing, migration and productivity and abundance of native fish. Quality and quantity of habitat in the Klamath River below JC Boyle Dam and the powerhouse are severely reduced by a combination of lack of flow and physical habitat, compounded by unnatural peaking events and changes in water quality.

<u>Bioenergetics Study</u>: The bioenergetics analyses performed by Utah State University represent the most comprehensive assessment of peaking impacts (Addley et. al. 2005). This study assessed bioenergetics and trout growth based on empirical data from the JC Boyle dewatered and peaking reaches and the Keno reach. Use of a bioenergetics foraging model also allowed comparison of trout growth under existing peaking conditions and two hypothetical scenarios: without-project and run-of-river. The predicted trout growth for both non-peaking scenarios significantly exceeded growth under existing conditions.

In the bioenergetics analysis, macroinvertebrate drift data showed much lower drift density in the dewatered reach compared to the Keno reach above JC Boyle Reservoir. In the Keno reach, drift density was 11 times higher in July and 2.4 times higher in

September than drift density in the dewatered reach (Addley et. al. 2005). This difference in density does not include the much lower total productivity that results from less habitat area available due to lower base flow (approximately six times less flow in the JC Boyle dewatered reach than in the Keno reach in June, July, and August.) The low static flows in the dewatered reach may be a contributing factor to low drift density and may help explain the lower fish growth and survival observed relative to the Keno reach.

The Licensee's PacifiCorp's studies show that fish growth, fish survival of older age classes, and fish size-at-age in the dewatered reach is less than observed in the Keno reach (PacifiCorp 2004, Fisheries FTR). The foraging model over-predicted observed growth in the JC Boyle dewatered reach. It would be necessary to decrease the temperature and/or observed drift density inputs to the model to match the slow growth observed in the JC Boyle dewatered reach (Addley et. al. 2005).

Trout age distributions (few trout over three years of age and of smaller size at age) and macroinvertebrate drift data suggested that existing flow conditions limit both habitat and forage productivity, thus affecting redband trout growth and productivity. The evidence from redband trout studies (Addley et. al. 2005 and ODFW 2003) suggests that the minimum flows of 100 cfs in the JC Boyle dewatered reach and peaking impacts in the reach below JC Boyle powerhouse harm fish populations in these flow-affected reaches.

Seasonal High Flows: The reduced magnitude and duration of peak flows due to the Project has removed the high flows that provide the fluvial geomorphic processes which are known to be important in forming and maintaining fish habitat (Hill et al. 1991; Hess and Sheets 1993). Flood flows are needed to restore fish habitat by seasonally scouring and depositing native alluvial material. These processes are important for fish habitat to provide the physical and biological components for spawning, incubation, rearing and migration of native fish species.

A seasonal peak flow to the dewatered reach is also needed in sufficient quantity and duration to mobilize and distribute sediment to support riparian and geomorphic processes. An annual flushing flow is often required to clean and redeposit gravel to provide quality spawning habitat (Wilcock et al 1996). High flows flush out fine sediments redistribute gravel to maintain quality spawning beds (Wilcock et. al. 1996), provide water and nutrients to riparian areas (Stromberg 2001), and increase the amount of rearing habitat by inundating the vegetated riparian zone. To achieve desired ecological effects, the peak flow should to be of adequate duration and frequency to mobilize and redistribute sediments, flush fine sediments from spawning beds, deposit riparian plant seeds and fine sediment (Tessman 1980), wet the riparian area at the beginning of the growing season (Junk and Wantzen 2004), and provide a disturbance regime for germination of riparian plants (PacifiCorp 2004, Water Resources FTR, page 3-107; Hill et al 1991).

The Project has altered the natural annual hydrograph of the JC Boyle dewatered and Copco 2 dewatered reaches by reducing the frequency and magnitude of flood flow events (PacifiCorp 2004, Exhibit E, Water Use and Quality, Figures E3.1-12 and 1-17). While the Klamath Project reservoirs are not operated for flood control, the magnitude and frequency of flood flows have been decreased and flood flows less than 3,000 cfs do not pass through the dewatered reaches. Reduced flows in the JC Boyle dewatered reach have resulted in channel constriction and elimination of native riparian vegetation (PacifiCorp 2004, Water Resources FTR). Project facilities have increased the magnitude of flow required to mobilize streambeds (PacifiCorp 2004, Water Resources FTR). High flows in the Klamath River naturally occur from about December through June. Flood flows at bank full levels or above are needed to provide natural scour to the channel that serves to maintain natural levels of sediment transport, shallow aquatic habitats, and riparian vegetation. All of these features are important fish habitat components.

The recommendation for the timing, magnitude, and duration of the peak seasonal flow was determined based on historical seasonal peak flows and riparian vegetation needs in the JC Boyle dewatered and peaking reaches. The timing of the flushing flow (available between February 1 and April 15) coincides with the early growing season and germination of riparian species. The peak flow duration of one week was derived from an analysis of peak flows at the Keno gage (#110050500). One week was the minimum duration of peak flows over 3,000 cfs (analysis of USGS gage records from 1990 to 2004). A flow of greater than 3,000 cfs after February 1 occurred in six of the last 15 years. The duration of continuous flows over 3,000 cfs averaged 28 days with a maximum 78 days and a minimum of seven days. Between the years 2000 and 2004, flows never exceeded 3,300 cfs after March 1. Since the water year types between years 2000 and 2004 were all average, below average, or dry water years according to USBR determinations, the gage data suggests that the recommendation will only be applicable in relatively wet years. According to PacifiCorp analysis, in the peaking reach, 3,300 cfs to 5,800 cfs "riparian vegetation maintenance flows" are required to inundate riparian vegetation (PacifiCorp 2004, Terrestrial Resources FTR, pages 3-105 to 3-106). Flows above 3,300 in the dewatered reach will increase the frequency and magnitude of sediment bed mobility (PacifiCorp 2004, Water Resources FTR, pp 6-134). Since these flows apply to the dewatered reach, the magnitude of the peak flow (i.e. 3,300 cfs minimum) will be sufficient to support riparian processes and mobilize the bed maintain the quality and quantity of spawning habitat.

Minimum Flows and Water Quality: The JC Boyle dewatered reach currently has cool water temperatures due to a large volume (~225 cfs) of cold water springs that supply 11-12^{0}C water combining with only 100 cfs of warmer water inflows. Increasing flows in this reach will warm water temperatures because the JC Boyle Reservoir releases are relatively warm. Thermal history of redband trout appears to influence thermal tolerances of local populations (Behnke 1992, Zoellick 1999). Redband trout have an enhanced capacity to function at warmer temperatures than most salmonids (24^{0}C) (Rodnick et. al. 2004). Because redband/rainbow trout are surviving well at higher temperatures in the Keno reach, increased flows in the JC Boyle dewatered reach is not likely to result in adverse effects due to temperature on redband/rainbow trout.

Anadromous salmonids are more sensitive to warm water temperatures than redband/rainbow trout. Maximum recommended temperatures for salmonids are 16–18^{0}C depending on the life stage (EPA 2003). However, Torgersen et. al. (1999) documented that spring Chinook salmon can persist in rivers with high water temperatures (greater than 25^{0}C) by seeking thermal refugia during warmer periods. Indeed, adult spring Chinook salmon migration in the Klamath River Basin was inhibited when mean daily river temperatures equaled or exceeded 22^{0}C, at which time they would seek out and reside in thermal refugia (Strange 2005), and juvenile salmonids heavily utilize thermal refugial areas during July and August in the lower Klamath River (Belchik 1997, 2003). Belchik (2003) found that thermal refugia in the Lower Klamath River varied greatly in size, and are significant components of anadromous fish restoration on the Klamath (also see National Research Council 2003). The springs in the JC Boyle dewatered reach will likely provide important thermal refugia for migrating anadromous salmonids when they are reintroduced.

The level of increased flows recommended here is not likely to adversely affect thermal conditions for reintroduced anadromous salmonids because results of PacifiCorp's water quality model indicate that water temperatures are only moderately increased by flows of 600 to 800 cfs in the JC Boyle dewatered reach (M. Deas presentation, PacifiCorp Water Quality Meeting, March 4, 2004). Temperature conditions are only critical in the months of July and August, when flows are unlikely to exceed 800 cfs in the JC Boyle dewatered reach under the proposed flow recommendations. The addition of flows to this reach will improve food availability to this important thermal refugial area and increase habitat quantity available, and restoration of the natural hydrologic patterns will help to sustain native biodiversity and river ecosystem functioning as recommended by a variety of ecological researchers (National Research Council 1992, Poff et. al. 1997).

While the Klamath Project reservoirs are not operated for flood control, the magnitude and frequency of flood flows have been decreased and flood flows less than 3,000 cfs do not pass through the dewatered reaches. The reduction of flood flows has resulted in changes in the distribution of riparian vegetation due to changes in the availability of sediments. Riparian vegetation is important for providing stream edge habitats for juvenile rearing. In addition, lack of natural channel features such as scour, erosion, deposition, and channel migration can result in less fresh sediment surfaces which are necessary for colonization by seedlings of native riparian plants (Johnson 1992). These same features are also important for spawning salmonids, which are dependent on the gravel sediments that are normally maintained by flood events.

Cumulative Impacts to Fish and Aquatic Resources: The native fish of the Klamath River such as redband trout are unique, as they have adapted to water temperatures up to 27^0F in the summer and down to 0^0F in the winter, extremely alkaline pH, and high nutrient levels (Behnke 1992). Prior to the construction of JC Boyle Dam in the late

1950's, the Klamath River wild trout population was noted for its abundance and large fish. Trout migrated freely through all reaches to spawn in Spencer Creek, a principal tributary of the Klamath River. Spawning likely occurred in lower gradient reaches of the river such as the areas now inundated by JC Boyle and Copco reservoirs.

Endangered shortnose and Lost River suckers, endemic to the Klamath River Basin, were once extremely abundant and important food sources to tribal and recreational users, and are an important indicator of the aquatic health of the basin. However, the combination of alteration of seasonal and daily basin hydrology, ramp rates that cause direct and indirect mortality, the slowing and storing of warm, nutrient-rich waters, and installation of dams for hydroelectric facilities, has reduced habitat quantity and quality. Native fish are now faced with increased nutrient loading, more extreme, fluctuating habitat conditions and water quality, and limited ability to move to better habitat.

In recent years, documentation of fish kills from flow fluctuations and violations of water quality standards have demonstrated the cumulative impacts of the Project on fish populations. In June 2003 a scheduled general maintenance event at JC Boyle facilities resulted in flows being reduced to 250 cfs in the Keno Reach, causing a substantial fish kill from the extreme downramp rate and high water temperature conditions. The fish kill of 30,000 adult salmon in the Lower Klamath River during September 2002 due to low flows and high temperatures also documents changes in hydrology and water quality that affect aquatic life and may be partially attributable to low flow releases at Iron Gate Dam. While flow diversion and management in the upper basin directly contributed to the fish mortality, the retention time of water in Klamath hydroelectric reservoirs may have exacerbated thermal warming to the river below Iron Gate Dam. The Licensee was able to briefly send water downstream from Iron Gate dam to assist in alleviating the situation; however, these fish kill events in the Project reach and in the Lower Klamath River document the need to incorporate increased minimum flows in future operations of the FERC license.

Project Maintenance and Shut Downs: When routine maintenance of Project turbines occurs, all or a portion of the Project diversion capacity is typically discharged into the dewatered reaches. Turbine maintenance results in a temporary and substantial increase in dewatered reach flow that is, in most cases, not currently under any ramp rate restriction. The timing of these artificial and sudden high flow events impacts fish and aquatic species.

Conducting annual maintenance during periods when high flows would have occurred under pre-Project conditions is the most effective means of limiting negative ecological effects related to releasing full flows in dewatered reaches, because native species that are present in the affected reaches are adapted to high flows during such periods. During maintenance activities when turbines are not operating, or when less than full diversion capacity can be used, headgates should be closed at each point of diversion to maintain full streamflow in the respective dewatered reach.

7. Ramp Rates

7A. Ramping Rate Restrictions below all Project facilities except Iron Gate Dam. *All Project facilities with the exception of Iron Gate Dam shall be operated as run-of-river with no peaking operations (Link River, Keno, JC Boyle Dam, Copco 1 Dam, Copco 2 Dam, and Fall Creek). Controllable ramp rates below all facilities, including Keno, and with the exception of Iron Gate Dam shall not exceed one inch per hour any time of the day or night. Ramp rates shall apply to all hydroelectric flow-regulated operations including start-ups and planned Project shutdowns. A maximum daily controllable ramp rate of no more than 300 cfs per day upramp or downramp shall apply to all facilities. Ramp rates shall apply to all hydroelectric flow-regulated (controlled) operations including load following, re-regulating and Project start-up and planned project shutdowns.*

7B. Ramping Rate Restrictions below Iron Gate Dam. *Iron Gate Dam shall be generally operated as run-of-the-river. The ramp rate for Iron Gate Dam shall be 125 cfs per hour and 300 cfs per 24 hours when flows are greater than 1,750 cfs and 50 cfs per 2 hours and 150 cfs per 24 hours when flows are 1,750 cfs or less.*

7C. Flow Continuation Measure. *Within one year of license issuance, the Licensee shall implement a flow continuation measure at the JC Boyle canal and powerhouse to provide a minimum of 48 hours of continuous flow under powerhouse shutdown conditions.*

Issue and Rationale

Compliance with Management Direction, Administrative Rules and Basin Plans: ODFW's goals and objectives for the Klamath River fish populations are to maintain and restore habitat including instream flows and natural hydrology to support healthy native aquatic species including indigenous trout, sucker, lamprey and anadromous salmonids. Habitat parameters must remain within the range that maintains the biological requirements to support productivity, growth, reproduction, and migration of native fish. Fish survival, growth, egg incubation and emergence are related to quantity and quality of habitat, so if the Project impacts these parameters, fish populations and their health are affected.

Project Operations: The current FERC license does not include conditions that require the Licensee to apply specific ramping rates to operations, with the exception of the JC Boyle Peaking Reach, which has ramp rates of 9 inches per hour, and below Iron Gate Dam at 250 cfs or 3 inches per hour, which ever is less. Fish kills in the Klamath River have been documented at these high ramp rates.

- Link River Dewatered Reach: The current agreement is 20 cfs/5 minutes for 0-300 cfs, 50 cfs/30 minutes for 300-500 cfs, and 100 cfs/30minutes for 500-1500 cfs. There is no formal FERC ramp rate. Fish salvages are required per the USFWS 1996 biological opinion for ESA-listed suckers for flows below 300 cfs.

- Keno Reach: There is no formal FERC requirement for ramping flows. The Licensee indicated a self-imposed, non-regulatory ramp rate of 500 cfs or 9 inches per hour in the FLA. This ramp rate has not been discussed or formalized with ODFW or other fish management agencies. The number of hourly flow changes greater than 500 cfs per hour averages 28 for each year for water years 1995 to 2001.

- JC Boyle Dewatered Reach: The Licensee's FLA indicated a dewatered reach up and down ramp rate of 9 inches per hour. This ramp rate has not been formalized with ODFW or other fish management agencies.

- JC Boyle Peaking Reach: The existing ramp rate, incorporated in the FERC license, is an up and down ramp rate of 9 inches per hour. However, Huntington (2004) documented numerous compliance violations with some ramp rates exceeding 1.2 feet per hour for up ramping and 1.3 feet per hour for down ramping.

- Fall Creek and Spring Creek: There is no formal or informal ramp rate.

- Below Iron Gate Dam: The FERC ramp rate is 250 cfs or 3 inches per hour whichever is less. More recently, the NMFS Biological Opinion for ESA-listed coho revised the ramp rates to 125 cfs per hour and 300 cfs per 24 hours when flows are greater than 1,750 cfs and 50 cfs per 2 hours and 150 cfs per 24 hours when flows are 1,750 cfs or less.

Project ramping occurs at the Link River, Klamath River and Fall Creek diversions when adjustments are made at the canal headgates, and at Keno Dam when flow is adjusted to re-regulate for Project operations upstream and downstream of this control point. This occurs when operations require an increase or decrease in flow in power canals for power production or to maintain Keno Reservoir for other Project or flow operations in the basin and to accommodate irrigation interests. Ramping also occurs in these reaches when maintenance activities require dewatering or rewatering of the diversion canals.

Ramping during unplanned outages occurs in the Link River, JC Boyle and Copco 2 dewatered reaches of the Klamath River. For example, during an outage of the JC Boyle powerhouse, a maximum release of 3,000 cfs can occur at the emergency spillway forebay (which is not screened). Immediately a large amount of water is dumped (along with fish entrained into the power canal) over the spillway into a near vertical dirt and rock cliff (created by the spillway) into the lower half of the dewatered reach, augmenting flow from 320 cfs to as much as 3,000 cfs, instantly. Similarly, bringing the facility back on line, results in sudden reductions of flow in the dewatered reach as the power canal is re-watered.

Effects of Ramping: Project ramping occurs when operations require an increase or decrease in flow through the turbines to adjust for shifts in power demand. Ramping also occurs during project drawdown for flood control, as well as when outflow is reduced to facilitate reservoir refill. Ramping can also occur when maintenance activities require lowering Project reservoirs to access structures. Unplanned outages are an uncontrollable cause of project ramping. Project start-up after planned and unplanned outages also involves ramping.

Peaking, or load following, follows daily changes in power demand (Hunter 1992). Daily peaking occurs in both the Link River Eastside and Westside facilities and below the JC Boyle powerhouse. Peaking at the JC Boyle facility occurs whenever flows are below 3,000 cfs, which is majority of the time, except during occasional high spring flows. Hunter (1992) reports that peaking fluctuations that occur daily for weeks or months result in severe cumulative impacts to fish populations. Whenever possible, a powerhouse located at the head of a free-flowing river should not be operated for peaking, especially during fry emergence and early stream residence.

Sudden flow changes in stream reaches due to Project operations can adversely impact fish and aquatic resources. Significant rapid flow reduction in dewatered, peaking and regulated reaches affect a fish population by dewatering redds and stranding fry or juvenile fish. Rapid flow increases in dewatered, peaking and regulated reaches can wash out existing redds, displace fry, displace macroinvertebrates, or adversely impact amphibian populations. Down ramping of only 1 inch per hour can impact fish populations. One very significant ramping event at a very unusual time can cause a significant limiting condition for one or more age classes of fish, or a section of habitat to be impacted for a long period (Hunter 1992). Cushman (1985) reviewed effects on rapidly varying flows downstream of hydroelectric facilities and found flow fluctuations reduce fish and invertebrate density. Freeman et. al. (2000) found that five of six spring spawning fish species were significantly more abundant at an unregulated section of the Tallapoosa River than in the regulated peaking section of the Tallapoosa River. In another study of flow fluctuations of fish abundance, fish species and age classes that preferred shallow depth, slow current and occur along the stream edge became completely absent at a study sight with the greatest flow fluctuations (Bain et al 1988).

Large flow fluctuations can also result in increased erosion of important small substrate such as gravel and small cobble, which can reduce available habitat for spawning fish and macroinvertebrate species. ODFW identified in comments on the DLA and the FLA that the Licensee did not adequately address the effects of daily ramping and peaking operations on substrate, channel morphology and riparian shoreline habitats in the Klamath River or develop appropriate PMEs for impacts to these resources. Daily and hourly flow fluctuations increase the rate of erosion on shallow shoreline habitats, and with the cumulative effect of sediment recruitment blocked by dams, magnifies the affect on aquatic, terrestrial, riparian, botanical and recreational resources.

<u>Link River – Project impacts from Flow Fluctuations:</u> Numerous fish kills have been documented in the Link River, particularly in response to changes in flow. Fish kills and

stranding were documented in ODFW monthly reports for April 1983, January, May and September 1985, April 1986, April 1987, September 1988, September 1990, July 1990 and April 1992. The September 1990 ODFW monthly report documented the following incident:

> "PP&L (The Licensee) drained both the West and East side hydro canals for maintenance of the plants. The Westside canal was drained without notice. Thousand of dead fish were left, mainly blue chubs and sculpins. The eastside plant was drained with appropriate (three day notice). PP&L personnel were present to work on salvage. Thousands of fish died, mainly chubs and minnows, but there were many yellow perch, sculpins and suckers. Salvage efforts were directed toward the suckers and game fish. Only 2 small rainbow trout were seen. Many hundreds of suckers were not salvaged. No positive ID was made on the sucker species but a sample was retained for ID."

One resident along the Link River documented in a letter to "Pacific Power and Light" (the Licensee) of a large fish kill with numerous flow changes and the river height falling from 3-4 feet in a period of 3-4 minutes. The resident commented that only the residents that live along the river observe stranded and dead fish because "twenty minutes later the river rose in a rapid fashion, washing away the dead fish" (letter from Terry Wagstaff to Jerry Rope at Pacific Power and Light (the Licensee), April 12, 1992. The resident indicated that this was not an isolated incident and this situation had occurred repeatedly for the past 13 years and when he contacted the Licensee, he was given the comments that ranged from "we are working on that problem" to "those aren't game fish".

Currently, the Biological Opinion requires instream flows of at least 250 cfs during summer, and below 300 cfs with fish salvages required as fish become stranded in side channels and bedrock channels. However, fish salvages are only moderately effective, capture the fish that are obviously stranded, limited by available manpower, and require immediate action following drawdown. Fish salvages are not effective for fish that have already died, been removed by predators or not visible due to channel or vegetative conditions that block detection.

Keno Reach – Project impacts from Flow Fluctuations: The minimum flow requirement below Keno Dam, per FERC license article 58 and ODFW agreement is 200 cfs and the ramp rate is nine inches per hour. The Licensee states that flows below Keno Dam, in the Keno reach, are dependent entirely on what is delivered to the Keno Reservoir by the USBR and other irrigation operations and that PacifiCorp has no discretion or control over flows in the Keno Reach and they pass inflow to the Keno reach. This is contradicted by the fact that 80% of the inflow to Lake Ewauna is from Link River while approximately 20% is from agricultural returns with a very small amount from municipal and industrial inputs (PacifiCorp 2004, FLA WTR). The Licensee can and does alter flows in the Keno Reach using the six inch drawdown of storage in Lake Ewauna for hydroelectric Project purposes to maximize peaking at downstream facilities.

While the Keno Reach is not as severely impacted as the dewatered or peaking reaches downstream, flows are ramped up and down to reregulate flows to maximize peaking at downstream facilities and to regulate incoming flow from USBR irrigation. Flows generally range from as low as 200 cfs up to 1700 cfs during the summer although there is no generation at Keno dam. For example, from the 4-month period from May 1 to August 30, 2005, the gaged flow below Keno Dam ranged from 279 to 5,490 cfs, with no apparent cause for high or low flows.

Although the Keno Reach has some of the better remaining conditions for native redband trout among the Project-affected reaches, the trout fishery is impacted by the low flows and frequent flow fluctuations from Licensee and USBR flow regulation. Effects of these flow fluctuations are of the types described for the peaking reach, but of much less magnitude. Institution of a minimum flow and combination with a more restrictive ramp rate will reduce the incidence of fish kills, and increase habitat, survival and productivity of native fish.

Project impacts occur from a combination of periodic low flows in combination with a high ramp rate. Impacts from flow fluctuations are greatest during very high and cold water temperatures and often lead to fish die-offs.

For example, in June 2003 flows below Keno Dam were reduced to JC Boyle Reservoir during a Project outage for maintenance at the JC Boyle powerhouse. On 15 June at 0200 am PacifiCorp began to reduce flows from 1390 cfs and by 1200 pm flow was at 273 cfs, a change of over 1,100 cfs in 10 hours of down ramping. River flows remained at approximately 270 cfs until 21 June when flows were increased to 388 cfs. According to USGS gage data at Keno Dam, this is a ramp rate of approximately 110 cfs per hour with a stage change of 3 inches per hour. At 1290 cfs, 3 inches per hour equates to approximately a 10% change in flow each hour while at 270 cfs, 3 inches per hour equates to approximately a 30% change in flow per hour. Due to both the rapid hourly and cumulative daily decline in flow, the sustained low flow of 250 cfs and hot weather and water temperatures, a fish kill occurred in the Keno Reach as a consequence of the Licensee's flow and ramp rates. The fish and macroinvertebrate die off occurred due to the rapid de-watering in combination with the high water temperatures of the Klamath River which stranded fish and caused stressful conditions. An unknown amount of macroinvertebrate abundance was lost but was significant considering abundance ranges from 11,000 to 21,000 m^2 in the Keno reach of the Klamath River.

As recently as December 10, 2005, ODFW district staff observed fish mortality and heavy macroinvertebrate loss when river flows below Keno Dam were reduced from 1,140 cfs on 4 December to 333 cfs on 6 December 2005. This reduction of flow coincided shortly after the JC Boyle power canal failure on 2 December. Low flows of 358 cfs continued until 14 December when mean flows were increased to 770 cfs when the increase in flow coincided with the completion of repairs on the JC Boyle power canal on 15 December. Then flows again were increased to a mean of 1170 cfs on 15 December. Although ODFW staff was unable to be on sight in the Keno reach until December 10, 4 days following the drawdown for the canal repair, dead redband trout and tui chub were observed as well as thousands of blue chub and fat head minnow stranded in the shallows. The loss of macroinvertebrates was unquantifiable but significant and probably in the millions of organisms for the entire reaches. In summary the fish and macroinvertebrate stranding and die off occurred due to a drastic decrease in river flows during very cold water temperatures of 2º-3º C.

Many fish die-offs have occurred in the Keno reach since ODFW staff began to keep records in their monthly reports. ODFW concludes that in most cases, fish die-offs occur in the Keno Reach when the Licensee ramps flows in the Keno reach for Project purposes, which results in adverse impacts to fish and aquatic resources. Die-offs are more severe during episodes of very warm or cold water temperatures, in combination and cumulative down ramps that reduce the river to low flows. For this reason, a substantially increased minimum flow over the existing flow regime along with a reduced ramp rate needs to be established as part of the new license to protect fish and aquatic life from Project operational impacts.

JC Boyle Dewatered Reach – Project impacts from Flow Fluctuations: While fish stranding and mortality events due to ramping are less common in this reach due to the relatively constant flow of 100 cfs below JC Boyle dam, occasional fish kills occur due to high downramp rates. The 1958 ODFW report documented the following incident:

> "1958 ODFW Annual Report. Big Bend 1 and 2, California-Oregon Power Company Dam, was completed on the Klamath River in 1958 except for the free fall bypass on the screens and motors on the weirs of the fish ladder. The reservoir behind the dam was filled in August, cutting the flow of the river instantly from 700 cfs to 300 cfs for approximately 12 hours. The resultant low flow stranded many trout and trash fish. It was estimated that a loss of 500 to 1,000 trout occurred; Klamath River reached normal flow in approximately twenty-four hours. Angling on the Klamath River below the dam after the main gates were closed has been excellent since the river flow has been cut from approximately 1,700 cfs to 100 cfs from the dam downstream to the Powerhouse, a distance of 3 miles."

Angling was very good due when flow was dropped 94%, which made trout extremely available to anglers for a short period of time.

A downramp event in1989 after a month of spilling at JC Boyle Dam also resulted in a fish stranding and mortality:

> "On 11 April, the research crew (French and Malley) investigated reports of stranded fish in the Boyle (Bypass(Dewatered)) reach of the Klamath River. The spill at Boyle Dam had just been shut off after running for over a month. Twenty-two rainbow trout (83-283 mm) were salvaged, tagged, and released. Six rainbow [trout] were found dead. Ten live and one dead Klamath smallscale suckers, one dead 12 inch bass and many dace, fathead minnows and sculpins were also found. Evidence at the scene indicated that members of the public had found the stranded fish before the research crew. One citizen reported that he and his son had salvaged some of the stranded rainbow and returned them to the river."

Clearly, high ramp rates results in fish stranding and mortality in the JC Boyle dewatered reach. Fish kills are less obvious since river reaches below JC Boyle Dam have more remote access.

<u>JC Boyle Peaking Reach – Project impacts from Flow Fluctuations:</u> Peaking studies conducted by the Licensee were a scattered examination of different resources, with no complete analytical study. ODFW refers FERC staff to our letter of August 12, 2005 for detailed comments on the peaking analyses (ODFW Response to PacifiCorp's Partial Response to the Federal Energy Regulatory Commission (FERC) Additional Information Request (AIR) AIR GN-2 and AIR AR-5, Comments on the AR-5 for Instream Flow and Flow Fluctuation Effects, Klamath Hydroelectric Project, FERC No. 2082). Given the lack of an integrated site-specific analysis, we refer to the literature as well as those portions of the Licensee studies and FLA which have linkage to ecological processes.

Downstream dewatering and desiccation of spawning habitat were documented in the JC Boyle peaking reach (City of Klamath Falls 1986) and larval stranding was documented in a previous study (City of Klamath Falls 1987). Other supporting evidence is the FERC 1990 Final EIS for the proposed Salt Caves Project, which noted low adult trout densities in the upper end of the peaking reach (FERC 1990). The EIS reported that trout in the upper peaking reach, where peaking impacts would be most visible, had relatively low growth rates and that large trout were under represented in the age structure. The EIS cited 5 years of investigation compiled by the City of Klamath Falls. The FERC EIS concluded that flow fluctuations below the JC Boyle powerhouse caused chronic stress on trout and stranding of eggs, fry, and juveniles. Stress occurred from daily flow fluctuations and related changes in water temperature and water quality. These flow fluctuations caused trout to continue to seek new feeding and resting habitat while water temperature changed metabolism and feeding rates.

One of the most thorough studies of the effects of hydropower fluctuation on fish habitat was conducted in 2003 and 2004 by federal, state, tribal and private researchers in the Hanford reach of the Columbia River near Richland, Washington (Anglin et. al. 2005). The study integrated hydrodynamic modeling and Geographic Information System analyses with empirical physical and biological data. This study documented that flow fluctuations from hydropower operations caused significant mortality in juvenile fall Chinook. The following excerpt documents the relative impact of peaking operations:

> “Although rearing habitat varies with streamflow, stability is likely more important to juvenile Chinook than absolute flow level. Stable flows and habitat conditions require less movement and less energy expenditure than constantly fluctuating

> flows and spatially variable habitat conditions. Stable flows would also help to reduce the potential for stranding or entrapment of juveniles." (page 3).

The Hanford study on stranding and entrapment also provided insight into the stranding component of the Licensee's peaking analysis. The Hanford researchers stated that earlier efforts to quantify stranding and entrapment were confounded by low fish sampling probabilities. Anglin et. al. (2005) stated the following:

> "…most important, the sampling approach had problems with detecting stranded fish. Fish stranded on substrates within the Hanford Reach are inherently difficult to find (i.e. detectability is low, even when fish are present). On larger substrates fish tend to migrate downwards as water recedes, requiring excavation of the site to locate dead fish. On finer substrates, fish are exposed to predators and are often quickly removed. Because of the problems with detection of stranded fish, the estimates of stranding and entrapment impacts are likely biased low." (page 57).

The Hanford study focused on entrapped fish to counter the sampling bias inherent in surveys for stranded fry. These entrapped fish remained visible in isolated pools or channels longer, facilitating a more accurate count. However, while these fish may not die from outright desiccation, these fish are significantly impacted by predation and thermal mortality.

The Licensee's stranding and entrapment study are consistent with the findings from the Hanford study (PacifiCorp 2004, FLA Fish Resources FTR). Field surveys were unable to detect stranded trout fry and yielded small numbers of stranded sculpin, suckers and dace and are consistent with the low numbers of trout fry rearing within the peaking reach and the poor success of visual detection methods for stranded fish. However, examination of isolated pools and side channels found trapped trout fry, larval suckers and dace. Contrary to resource agency interpretation, the Licensee discounted these observations, since fish were not technically stranded and generally still alive. A different interpretation by federal and state agencies including ODFW is that fish populations are severely impacted by flow fluctuations since chronic stranding, and desiccation, predator and thermal mortality occur as result. The low abundance in the JC Boyle peaking reach of fry, which have a limited swimming ability, appears to be directly related to flow fluctuations that change available habitat by the hour.

The bioenergetics analyses performed by Utah State University for the Licensee for the Project area best summarizes an assessment of peaking impacts (Addley et. al. 2005). This study assessed bioenergetics and trout growth based on empirical data from the Boyle peaking, Boyle dewatered and Keno reaches. The bioenergetics foraging model compared trout growth under existing peaking conditions and two hypothetical scenarios: without-project and run-of-the-river. The predicted trout growth for both non-peaking scenarios significantly exceeded growth under existing conditions. These results support the findings from Hanford that instability of flow translates into a significant energetic cost for fish.

Many hydropower facilities limit ramping rates to reduce the impact of stranding and entrapment. Hunter (1992) recommends a ramp rate of one inch per hour when salmonid fry are present. Based on the periodicity information provided by the Licensee on the suite of native salmonids, fry are either emerging or rearing in the Klamath River below Iron Gate Dam every month of the year, and from March to August in the Keno, JC Boyle dewatered and JC Boyle peaking reaches.

Ramping also impacts water quality in the peaking reach. The City of Klamath Falls (1986) documented daily temperature fluctuations of up to 12^0C in the JC Boyle peaking reach during the middle of the summer as a result of daily peaking events. Fredd (1991) documented temperature variations during the course of a day in the summer in the "Salt Caves reach" that varied daily from June through October from a low flow while the powerhouse was turned off (18 hours) to approximately a one turbine peak flow of 1500-cfs (6 hours). The temperature differential which results from this alternation of flow was approximately 6^0C daily (from 14^0C to 20^0C on a typical summer day).

Ramping Recommendation: Ramping rates recommended by ODFW are to minimize the impacts to aquatic and fish populations that are caused by artificial flow fluctuations. These ramp rates are consistent with FERC conditions at other hydroelectric projects and are based on recommendations from Hunter (1992) and other ramp rates applied at hydro projects in the Pacific Northwest. The recommended ramping rates are feasible to apply at the Project, effective for protecting aquatic and riparian resources, and have been accepted for implementation at other hydroelectric projects by FERC.

Hunter (1992) recommended the following ramp rates in Table 7 as permanent ramping criteria for hydroelectric projects located on rivers:

Table 7. Recommended permanent ramp rates for hydroelectric projects.

Season	**Daylight Rates**	**Night Rates**
February 16 to June 15 [a]	No Ramping	2 inches/hour
June 16 to October 31 [b]	1 inch/hour	1 inch/hour
November 1 to February 15	2 inches/hour	2 inches/hour

[a] Salmon fry are present

[b] Steelhead fry are present

Since steelhead is an anadromous form of rainbow trout and fry are present in the Klamath River most months of the year, the one inch per hour is recommended to provide the most protection to native, resident fish.

Flow Continuation Measure: The Link River below Link River Dam and Klamath River below Keno Dam, JC Boyle Dam and JC Boyle powerhouse can be rapidly down-ramped and up-ramped during unit trips, causing both environmental and public safety concerns. FERC proposed resolving ramping issues in the Draft Environmental Impact Statement for the North Umpqua Hydroelectric Project (FERC No. 1927) as follows:

> "Because many disruptions in flow result from brief turbine shutdowns (e.g., because of load rejections), hydroelectric projects should be capable of providing several hours of continuous flow under powerhouse shutdown conditions. A flow continuation measure would allow the flow regime in both the dewatered reach and downstream from the powerhouse to remain essentially unchanged during intermittent shutdown."

Hunter (1992) reported that flow continuation is the mechanical capacity to maintain flow through the penstock during powerhouse failures. It is provided by a flow bypass valve which allows flow to pass around the turbine when in operation. With this type of equipment, power generation can be turned off and without ramping up or down in the dewatered and peaking reaches. Flow continuation can also increase human safety by reducing rapid changes in flow. Hunter (1992) recommended a minimum of 48 hours of flow continuation to avoid impacts to fry.

A flow continuation measure or a synchronous bypass valve for a minimum of 48 hours is needed to eliminate rapid water level fluctuations caused by load rejection at the Project to protect fish and wildlife and their spawning grounds and habitat (see Condition 9D(1)).

8. Water Quality in Dewatered, Peaking and Regulated Reaches

8A. ***Water Quality Monitoring Plan.*** *The Licensee shall implement mitigation measures and conduct water quality monitoring pursuant to the Water Quality Management and Monitoring Plan(s) (WQMMP) approved by the ODEQ and CSWRCB in connection with Clean Water Act Section 401 water quality certifications issued by those agencies. Any subsequent amendments to the WQMMP approved by ODEQ and CSWRCB must also be approved by the Commission prior to implementation.*

8B. Annual Water Quality Monitoring Reports. *The Annual Water Quality Monitoring Report shall include but not be limited to a report with narrative and graphs summarizing data demonstrating compliance with water quality requirements and standards for Project reservoirs and reaches, and an annual summary of Non-Compliance Reports. These parameters shall include but not be limited to: water temperature; DO; TDG; pH; chlorophyll a; nutrients including nitrogen, phosphorus; toxic algae; and an annual summary of Non-Compliance Reports. Copies of the water quality annual reports submitted to ODEQ and CSWRCB shall be filed with the Commission within 30 days of* *their filing with ODEQ and CSWRCB. Copies of the water quality annual reports shall also be filed with the Fish Passage Implementation Committee established by License Condition 5A and 5B.*

8C. Failure to Meet Water Quality Certification. *To the extent that it is infeasible to meet water quality objectives for water quality certification by ODEQ or CSWRCB through modification of Project facilities and operations, the Licensee shall prepare a decommissioning amendment for the subject facility in consultation with state, federal and tribal stakeholders in order to achieve compliance with the Basin Plan.*

Issue and Rationale

Compliance with Management Direction, Administrative Rules and Basin Plans: ODFW's goals and objectives for the Klamath River fish populations are to maintain and restore water quality to support healthy native aquatic species including indigenous trout, sucker, lamprey and anadromous salmonids. Water quality must remain within the range that maintains the biological, physical and chemical integrity and benefits survival, growth, reproduction, and migration of native fish. Fish survival, growth, and egg incubation and emergence are related to water temperature and other water quality parameters, so if the Project impacts water temperature or DO or other water quality parameters, fish populations and their health can be affected.

303(d) Listings of the Klamath River and Project Reservoirs: The ODEQ and CSWRCB administer the state water quality control programs for the states of Oregon and California, respectively. The Klamath River is listed as water quality limited under Section 303(d) of the Clean Water Act (PacifiCorp 2000, FSCD 4-23). There are approximately 55 miles of the Klamath River in Oregon affected by the Project, via dewatered reaches, minimum flows and flow fluctuations. All 55 miles of the Project reaches are managed by ODFW exclusively for wild fish. Many miles of the Klamath River in California from the Oregon state line to well below Iron Gate Dam are also affected by degraded water quality. Restoration of anadromous and potamodromous fish populations will be dependent on improved water quality in both states.

Project Impacts: While it is true that Upper Klamath Lake is a hypereutrophic lake with nutrient rich waters, and high temperatures throughout the summer, the Project reservoirs contribute to the already significantly impaired water quality conditions in the Klamath River. Water quality data documents that the reservoirs negatively affect quality parameters by slowing and storing water. For example, although there is no dewatered reach or withdrawal for hydropower at the Keno Dam, the presence of the dam for regulating flows slows water through the entire reach from Lake Ewauna to below Keno Dam, increasing retention time and solar exposure, thereby contributing to water quality problems.

The storage and release of water at the Project reservoirs continues to affect water quality in the river by increasing retention time, exposure to sunlight, and thermal stratification. Reservoir stratification also alters other water quality parameters including dissolved oxygen (DO), biological oxygen demand, pH, and production of toxic ammonia. Aquatic plants and algae in the reservoirs and river have a significant effect on fluctuations in DO and pH, which in combination with temperature-induced effects can cause acute and chronic health problems in fish. Reservoirs also modify nutrients by acting as a sink or source for nutrients and temperature, metabolism of organic compounds, and nutrient uptake by phytoplankton. Project impacts also include growth of aquatic plants and algae which create daily and seasonal fluctuations in DO and pH, which in conjunction with temperature can cause chronic and acute stress in fish populations.

All reaches of the Klamath River including Project reservoirs and riverine reaches were listed for 303(d) violations for temperature. However, all hydroelectric Project reservoirs were listed for other water quality violations in addition to temperature. These included but were not limited to dissolved oxygen, toxic ammonia, pH, and chlorophyll a. Nutrient assimilation occurs in free-flowing reaches of the Klamath River. Because of the water quality impacts caused by Project reservoirs, nutrient assimilation from Upper Klamath Lake releases is delayed many miles downstream of the hydroelectric Project than would normally have occurred upstream in the absence of the Project reservoirs.

Rivers normally process and assimilate nutrients as water flows downstream and attached algae in river systems can filter and clean water. At a meeting of the Western Division of American Fisheries Society, a water model consultant indicated that one of the greatest impacts of reservoirs can be the lack of assimilation of nutrients, or that reservoirs can act as nutrient and reservoir sinks. A recent analysis of empirical data by Russ Kanz, staff environmental scientist for the CSWRCB, documented the Project reservoirs trap total organic carbon, while the river quickly assimilates total organic carbon (Russ Kanz, pers. comm., March 2005 presentation to federal and state managers). His analysis of empirical data indicates that the reservoirs generate chlorophyll a and nitrogen while the river assimilates these nutrients below. The results of the analysis refute the Licensee's assertion that the reservoirs benefit water quality by trapping organic material. These results also document that the Licensee's water quality model does not adequately reflect the assimilative capacity of the river in a without project condition.

In addition, other project operations including peaking and significantly dewatered flows in river channels affect water quality. For example, daily temperature fluctuations of up to 12^0 C occur in the JC Boyle peaking reach during the middle of the summer (City of Klamath Falls 1986) as a result of daily peaking events. The JC Boyle dewatered reach is impacted by diversion and has severely reduced flow below JC Boyle Dam that is augmented by cold springs approximately half way down through the diversion reach.

Data collected on blooms of *Microcystis aeruginosa* in Iron Gate and Copco reservoirs in 2004 and 2005 documented a highly toxic hepatotoxin (liver toxin) called microcystin that originated in the Licensee's two Project reservoirs (Kann 2005a, 2005b). Data collected in the summer of 2005 along the 46 miles downstream of Iron Gate Dam, above the confluence of the Shasta River, confirmed the first time documentation of microcystin spores. This data shows that these toxic spores can survive and recur in backwater areas, side channels, or in downstream reaches as velocity and mixing decrease downstream. The staff toxicologist (Kaley, North Coast Regional Water Quality Control Board memorandum September 1, 2005) documented that:

> "The *Microcystis aeruginosa* cyanobacteria levels and resulting microcystin toxin concentrations detected in water samples collected from both shoreline and open water locations in the Copco and Irongate Reservoirs in California pose a significant potential threat of adverse health affects in human and animals exposed through direct ingestion of contaminated water as well as incidental ingestion during recreational water activities and bathing."

Water quality affects other life history characteristics such as fish migration. Temperature change may also affect fish passage, particularly at JC Boyle fish ladder, where fish may be delayed or passage eliminated because they must choose between warm water from JC Boyle Reservoir or cool, spring water in the dewatered reach. Studies have indicated that adult salmonids avoid temperature changes and prefer to remain in river temperature water. Migrating salmonids prefer cooler water when given an alternative, and take longer to pass through test facilities with water heated or cooled compared to river water (Weaver et al. 1972).

Below Iron Gate Dam, analyses provided by the Licensee indicate that the Project facilities and operations shift the timing of two critical and interrelated phenomena – water temperature and fish disease transmission. These shifts in temperature and disease risk below Iron Gate occur at vulnerable life stages for out-migrating juveniles and spawning adults. These disruptions of natural cycles exacerbate already challenging conditions for Klamath River resources and compound Project impacts on the downstream fishery.

9. Stream Geomorphology

9A. ***Gravel and Sediment Plan*****.** *Within two years after license issuance, in consultation with ODFW and affected agencies, the Licensee shall submit to FERC a Gravel and Sediment Plan, that identifies measures that shall be implemented to provide for the restoration of spawning habitat below each of the Project dams. The plan shall be approved by the federal, state, and tribal resource agencies and incorporate all recommendations provided by the agencies during consultation. The Gravel and Sediment Plan shall be filed with the FERC. The Gravel and Sediment Plan shall include the following measures: (1) develop a plan to map and characterize the character and distribution of gravels within Project reaches, (2) determine the approximate area of suitable spawning habitat, and (3) determine the depths and velocities of flows required for each mapped gravel deposit to assess suitability of gravels as spawning habitat.*

9B. ***Gravel Augmentation.*** *Within three years following license issuance, the Licensee shall develop and implement recommendations for gravel management for each Project-affected reach including the approximate size and volume of gravels needed to mitigate Project impacts and locations and timing for gravel introduction. The Licensee* *shall consult with ODFW and other resource agencies to determine the quantity, quality, timing and location of the gravel augmentation.*

9C. Gravel and Sediment Plan Monitoring*. Upon installation of gravel in Project reaches, the Licensee shall develop and implement a monitoring program to assess how introduced gravels are distributed and utilized under Project operations. If monitoring indicates that the Plan does not achieve the Plan objectives, the Licensee shall revise the Plan in consultation with ODFW and other resource agencies.*

9D. *JC Boyle Emergency Spillway and Canal Failure and Channel Restoration Plan.* *Within one year of the license issuance the Licensee shall develop a standard operating procedures plan for emergencies to address procedures, environmental permits, and subsequent mitigation measures for any emergency spill or canal or slope failure along the JC Boyle dewatered reach. This plan shall be developed in consultation with ODFW and affected agencies and be approved by ODFW. The plan shall include implementation strategies for agency coordination, restoration actions, monitoring and evaluation, and potential mitigation measures. The plan shall include the following measures:*

(1) Ensure that the JC Boyle Powerhouse has the capacity to maintain flow continuously for a minimum of 48 hours after an emergency shutdown. When a powerhouse failure occurs, flow shall be released at the powerhouse for the duration of the failure.

(2) Mitigation measures shall include revegetation of affected hillslope and riparian areas, monitoring surveys and photopoints or revegetation work, evaluation, and monitoring of affected reaches with channel transects and flow augmentation measures to eliminate channel impingements and to remove fine sediments in the spawning area of the JC Boyle dewatered downstream of the failure.

(3) Mitigation measures shall include actions to prevent further erosion in the area below the emergency forebay spillway. Stabilization plans shall consider structural, vegetative, and flow strategy methods to halt erosion and restore the damaged hillslope, riparian and channel areas to stop resource degradation and repair visual impacts. The emergency spillway and restoration plan shall include a detailed monitoring strategy based on development of channel cross sections that is implemented annually for ten years.

(4) Site-specific restoration plans for the JC Boyle Cannel Emergency Spillway and other canal and slope failures shall include the following:

- *A map depicting the location of the proposed activity.*
- *Designs for site stabilization, channel restoration, location of disposal sites and an erosion control plan.*
- *Implementation and effectiveness monitoring designed to meet restoration criteria that includes but is not limited to fish passage, channel bed and bank stability and appropriate riparian vegetation.*
- *Data collected from surveys, biological evaluations or consultation as required by regulations applicable to ground or habitat disturbing activities on BLM-administered lands in existence at the time the plan is prepared.*

Within three years of the license issuance the Licensee shall restore the Klamath River channel to mitigate the impacts due to the use of the JC Boyle Canal Emergency Forebay Spillway.

9D. ***Monitoring and Maintenance Plan***. *The Licensee shall develop in consultation with state, federal, and tribal stakeholders, and file for Commission approval, a written monitoring and maintenance plan incorporating agency recommendations that will eliminate or reduce failure of the water conveyance system and excess use of the forebay spillway overflow. The monitoring component of the plan shall include technology for early detection of waterway failure and protocols for stopping flows in the canal at the same time as restoring flows in the dewatered reach to maintain flows at the USGS gage below the powerhouse.*

9E. *Agency Notification of Potential or Actual Adverse Impacts*. *Should an accidental spill or discharge from the waterway system or other event occur the Licensee shall notify the Oregon Emergency Response System within 24 hours of the event with a verbal report on location, duration, and effect on water quality and aquatic life. If the Licensee observes or suspects that fish or wildlife or their habitat may be harmed, it shall immediately notify and consult with appropriate fish and/or wildlife District Biologist(s) at ODFW's Klamath Falls office and the hydropower coordinator at ODFW's Prineville office. In no case shall such contact occur later than the next business day. The Licensee shall file a written report with FERC, ODFW, ODEQ,* *BLM, and USFWS within two weeks of the event describing the location, duration and effect on water quality and aquatic life.*

9F. *Remediation Plans*. *The Licensee shall coordinate emergency response to spillway or waterway failure or other events, and the subsequent remediation planning and implementation process will be initiated within 24 hours of the event. The Licensee shall develop site-specific plans for remediation in consultation with, and approved by ODEQ, USFWS, BLM, ODSL and ODFW. Plans will include (1) immediate steps to remedy the failure and bring the waterway back into operation, and (2) timing and performance criteria to be met for completion of needed remediation after an event. Additionally, the Licensee shall provide an annual report to state, federal, and tribal resource agencies, by March 1 for the preceding calendar year, describing each event and action taken to remediate impacts and the operational changes taken or proposed to reduce the reoccurrence of the spill, discharge, or other event.*

9G. *Environmental Damage Action Plan*. *Within one year of license issuance, the Licensee shall develop in consultation with ODEQ, USFWS, BLM, ODSL and ODFW, and file for Commission approval, a written action plan that details protocols for assessing the environmental damage caused by flume failure, spillway overflow at the forebay and other events. The plan shall include protocols for assessing and documenting the immediate and long-term effects on water quality, fish and wildlife populations, riparian and aquatic organisms, and aquatic and riparian habitat. The Licensee shall consult with the ODFW and other Fish Agencies to develop a fish and* *wildlife habitat mitigation plan that ensures compensation for the short-term and long-term loss of individuals and habitat caused by unanticipated Project-related events that cause environmental damage. The plan shall identify requirements for mitigation measures to meet ODFW fish and wildlife objectives and standards. The plan shall also include a schedule for accomplishing these objectives and standards and shall identify any needs for additional studies.*

9H. *Agency Consultation*. *The Licensee, shall consult with ODFW, OPRD and other affected agencies 90-days before commencing any project-related land-clearing, land disturbing, or spoil-producing activities, and incorporate the agency recommendations into a comprehensive plan to control erosion, dust, and slope stability and to minimize the quantity of sediment or other potential water pollutants resulting from Project construction, spoil disposal, and Project operation and maintenance. The plan shall be based on actual-site geological, soil, slope, and groundwater conditions and on the final Project design, and shall include detailed descriptions and functional design drawings of control measures, topographic map locations of all control measures, a specific implementation schedule, and specific details of monitoring and maintenance programs for the Project construction period and for Project operation, and a schedule for periodic review of the plan and for making any necessary revisions to the plan.*

Issue and Rationale

Compliance with Management Direction: The Oregon Plan for Salmon and Watersheds provides direction to state agencies to restore channel morphology to more natural conditions so as to ensure interaction with the floodplain, presence of meanders, channel complexity, and recruitment of gravel and woody debris to support habitat for rearing, holding and spawning by salmonids and other species of concern.

Project Effects: Native species in the Klamath River evolved under the seasonal variability of an unregulated river, with a freely moving bedload. However, the Project's dams have been collecting and storing sediments for decades, while reaches below the dams have been deprived and scoured of gravel and finer sediments. PacifiCorp (2004) reported that the Project impacts alluvial features (and therefore potential salmonid spawning material) from Iron Gate Dam to the confluence with Cottonwood Creek.

In reaches below Project dams, the river bed has coarsened as a result of smaller gravels transported downstream without being replaced, and dominant larger gravels and cobbles remain that are unsuitable for use by spawning fish (Kondolf and Matthews 1993, from PacifiCorp 2004). The Project study on geomorphology and aerial photos documented a deficit of sediment for transport between dams and below the Project (PacifiCorp 2004, Water Resources FTR, Section 6.7.5). The reach below JC Boyle Dam is especially sediment supply limited. The report documents that "significant changes to geomorphology and riparian vegetation were observed in this reach"…"significant changes were observed in the location and configuration of bedforms" (PacifiCorp 2004, Water Resources FTR 6-66). The report also comments that "pebble count results indicate potential bed coarsening immediately downstream of Project dams and in the JC Boyle peaking and bypass [dewatered] reaches" (PacifiCorp 2004). In addition, the Project may have significantly coarsened the channel bed from downstream of Iron Gate Dam to the confluence with Cottonwood Creek (PacifiCorp 2004).

A summary of the studies conducted by the Licensee indicates that the Project has caused coarsening of the substrate and alteration of the short-term and long-term hydrograph, resulting in changes in the extent of riparian vegetation. Current Project impoundments, such as JC Boyle Reservoir and Dam, trap and block sediment movement downstream through the JC Boyle dewatered and peaking reaches (PacifiCorp 2004, Exhibit E, page 5-148 and PacifiCorp 2004, Water Resources FTR 6-111). According to the FLA, the primary project impact on geomorphology and sediment transport is the capture of bed load material delivered from tributaries by Project reservoirs (PacifiCorp 2004, Exhibit E, page 3-184). This, coupled with limited gravel recruitment from the presence of JC Boyle Dam (City of Klamath Falls 1986) (PacifiCorp 2004, Exhibit E, page 4-9), causes gravel to be scarce in the JC Boyle dewatered reach. Based on the PacifiCorp Sediment Budget Analysis, the average annual input of sediment from the tributaries between Keno Dam and JC Boyle Dam was 6,134 cubic yards per year with a potential deficit of 900,000 cubic yards per year that could be transported to the JC Boyle peaking reach if not for the dam (PacifiCorp 2005 - Master Sediment Budget, PacifiCorp 2004 Water Resources FTR 6-145). These results indicate that JC Boyle Dam captures bedload material and affects fish habitat below the dam, in both the dewatered and peaking reaches. Further results from historical photos documented the “local changes to channel features in the JC Boyle dewatered and full flow [peaking] reaches, the Copco 2 bypass [dewatered] reach, and in reaches downstream of Iron Gate dam” (PacifiCorp 2004, Water Resources FTR 6-61).

The JC Boyle dewatered reach habitat mapping from the instream flow study revealed that substrate composition was primarily boulder (60%) and cobbles (28%). This is very similar to the composition determined by an ODFW survey conducted in 1998, which found 64% boulder and 28% cobbles. Gravels are generally lacking except for an area below the forebay spillway where deposition has occurred from bank erosion. The description of this reach is consistent with impacts associated with stream habitat below a bedload-capturing dam; presence of bedrock, cobble and boulder, and few patches of spawning gravels. The effects of reduced bedload supply occur downstream to the confluence with the next major tributary, Shovel Creek, located many miles downstream of the powerhouse.

Flow in the lower half of the JC Boyle dewatered reach consists of high quality spring water (220 cfs), which is known to be conducive to spawning success and high egg survival (PacifiCorp 2004, Associated Fisheries Benefits) and is consistent with from Behnke’s (1992) findings on redband trout. The availability of spawning gravel however, is limited by lack of gravel recruitment. Most trout are observed spawning in marginally suited "patch gravels" behind boulders and in the area below the emergency spillway that contains gravel because of recruitment from hillside erosion below the emergency spillway. Thus, according to the Licensee's analysis, the lack of suitable spawning gravel in this reach is limiting trout production (PacifiCorp 2004, Associated Fisheries Benefits).

The Project dams have blocked recruitment of important sediment inputs such as gravel and small cobble. Below Project dams, with lack of sediment from flushing flows, the bedload composition becomes "armored" with material too coarse to be moved by the river, until in some cases, bedrock is exposed (Collier et al. 1996). Impacts that have been documented for other hydro Projects that likely occur at the Klamath Hydroelectric Project include sediment entrapment behind dams and peaking operations that coarsen the bedload and alter riparian vegetation recruitment. Dams can reduce spawning gravel availability in downstream reaches and cause development of a coarse, relatively immobile surface layer. Dams can cause a number of changes to channel morphology or fluvial processes that can have deleterious effects on stream and riparian habitats, including channel incision and/or widening, increased bank erosion, and reduced channel migration.

In addition to effects caused by the dams, the JC Boyle forebay spillway is sited approximately half way down the power canal. When an outage occurs, water backs up in the power canal and is released into the overflow spillway and drops to the dewatered reach. The overflow spillway has caused impacts to water quality, floodplains, riparian, and aquatic habitat. Spills have eroded an estimated 80,000 cubic yards of the hillside materials into the Klamath River, JC Boyle Dewatered Reach. Much of the sediment released in the river is a mixture of dirt, fines, sands, and coarse cobble, large rocks and pumice. Mid-channel deposition can cause the river to split into two streams thereby reducing the amount of water in each channel. In addition, road cast from the Project roads have also entered the Klamath River also causing impacts to the river, and in some cases, narrowing the channel. One site approximately 4,800 feet above the emergency forebay spillway has road sidecast that encroached into the dewatered channel, creating a dam that has since partially washed out. The mass of material has deflected the channel to the opposite bank causing an undercut for nearly 400 feet and has produced an estimated 10,222 cubic yards of sediment.

The sudden inputs of abundant sediment can cause adverse impacts to fish and wildlife populations and their habitat. The rapid erosion of sediment causes an immediate increase in total suspended sediment in the water column with a subsequent deposition of sediment as flow velocity decreases. While the impacts of increased suspended sediment could be of relatively short duration, the deposited sediment can cause long-term impacts to riparian and stream ecosystems.

Effects of Suspended Sediment on Aquatic Species: Suspended sediment may interfere with the essential functions of fish and other organisms. Fish may suffer clogging and abrasive damage to gills. Abrasion of gill tissues triggers excess mucous secretion, decreased resistance to disease, and a reduction or complete cessation of feeding. Suspended sediment may also affect predator-prey relationships by inhibiting predators' visual abilities. The number of filter feeding invertebrates will decline if their filter mechanisms are choked by suspended particles. Some zooplankton populations may decline due to clogged feeding mechanisms.

Effects of Deposited Sediment on Aquatic Species: Sediment can be deposited along pool edges and cause water turbidity. Sediment deposition results in direct and indirect impacts to stream habitat because it can alter spawning and rearing habitat by covering spawning gravel and filling stream pools. Depending on the timing of the sediment event and the duration of its effects, spawning success, incubation, and rearing habitat for emerging fry may be jeopardized by the shifting sediment environment. If eggs do hatch into fry, survival may be substantially reduced by the less-than-optimum stream conditions. The biota of an aquatic system has evolved to cope with the natural embeddedness of a stream. Fry may attempt to leave an area or die when embeddedness levels reach 50-60%. While spawning fish and fry have been recently documented in the dewatered reach, the quality of the spawning gravel is extremely limited. The majority of the spawning gravel is composed of a light way pumice material that is unstable and swept away under different flow regimes. Indeed, a recent high flow event in January 2006 removed much of the spawning gravel and has been deposited in small, scattered deposits downstream, many of which are above the wetted channel of Project-reduced flows in the dewatered reach. Therefore, fish in this reach are especially vulnerable to the adverse habitat impacts caused by the Project.

10. Project Operations and Hydrology

10A. Project Operations Plan. *Within one year of license issuance, in consultation with ODFW and affected agencies, the Licensee shall prepare a Project Operations plan to determine compliance with minimum flows and ramp rates for all Project-affected reaches. The Licensee shall allow a minimum of 60 days for ODFW and affected agencies to comment and make recommendations prior to filing the plan with the Commission. The Licensee shall include with the plan documentation of consultation and copies of comments and recommendations on the completed plan after it has been prepared and provide to ODFW, and specific descriptions of how ODFW's comments are accommodated by the plan. The Licensee shall implement the approved Project Operations Plan that shall include the following items:*

- *Daily Project inflow and outflow;*
- *Graphical plots of hourly data below the Link River (if retained in the Project boundary), Keno and JC Boyle dams, and the JC Boyle powerhouse;*
- *A graphical plot of hourly ramping rates;*
- *An annual summary of non-compliance reports;*
- *Improvements in flow monitoring at the gage stations below Project dams and JC Boyle powerhouse;*
- *Measurement of flows at the gage stations below the dams and JC Boyle powerhouse;*

- *A comparison of actual flows to minimum flows below each facility;*
- *Control of river stage changes below each Project dam and JC Boyle powerhouse; and*
- *Seasonal drawdown, refill and fluctuation limits for Project reservoirs*

10B. Annual Project Operations Report*. Before April 1 of each year the Licensee shall publish an Annual Project Operations Report that describes the operating history of the Project over the previous calendar year. Including summaries of data itemized in Condition 10A above, the Annual Reports shall provide specific information regarding compliance with these license conditions, and short and long term monitoring of activities conducted pursuant to these license conditions. These reports shall include a general summary of the hydrologic conditions, overall Project operation, and unusual events or conditions that occurred during the year. Charts shall be included which graphically show the Project's operating parameters over the prior year, such as: inflows; outflow; flows to the natural river channel; days of operation at "or inflow"; and lake levels. Operating incidents that occurred during the year shall be listed and briefly described, and Final Incident Reports for these events shall be included as appendices.*

Background and Rationale

Compliance with Management Direction, Administrative Rules and Basin Plans:

ODFW's goals and objectives for the Klamath River fish populations are to maintain and restore habitat, including instream flows and natural hydrology to support healthy native aquatic species, including indigenous trout, sucker, lamprey and anadromous salmonids. Habitat parameters must remain within the range that maintains the biological and requirements to support productivity, growth, reproduction, and migration of native fish. Fish survival, growth, and egg incubation and emergence are related to quantity and quality of habitat, so if the Project impacts these parameters, fish populations and their health are affected.

Project Effects: Huntington (2004) examined through an Indicators of Hydrologic Analysis (IHA) the degree to which the Licensee's hydropower operations alter streamflows within specific reaches of the Klamath River. A set of 35 hydrologic parameters were examined for the JC Boyle dewatered and peaking reaches. In the dewatered reach, the Project reduces the magnitude and variability of monthly flows from the median by 75%. Between-year variations in minimum flows have been virtually eliminated as flow releases from JC Boyle Dam are held at very low and constant levels except for occasional high runoff that exceeds the capacity of the powerhouse and causes spill into the dewatered reach. In addition, annual high flow occurs about two months earlier while low flows about five to six months earlier than compared to without Project conditions. High pulse flows have been eliminated while duration of low flow pulses has been dramatically extended.

In contrast, below the JC Boyle powerhouse, the Project reduced median flows, increased flow variability substantially during most months of the year, particularly for low flow conditions. The magnitudes of minimum flows were consistently and drastically reduced while maximum flows were consistently increased. Annual extreme high flows first occurred 2 to 3 months earlier while low flows were 4 to 6 months earlier. The frequency of high pulse flows increased by more than 3000% and that of low pulse flows by 850%. Large daily flow fluctuations have become the dominant feature of the river's hydrograph in this reach, nearly eliminating the monthly and seasonal patterns of natural variation in flow. All of these changes were to a without Project condition that is itself affected by upstream variations including irrigation projects.

Huntington (2004) also analyzed the half hourly stage data from 3 different water year types of 1994, 1995, and 1999 to compare the percentage of days on which a given hourly up or down ramp was exceeded. The results of the analysis documented daily maximum up and down ramp rates at the USGS gage site below the powerhouse that ranged from zero to well over 1.2 feet per house, with the highest rates experienced during the dry (1994) and wet (1999) years. The analysis demonstrated that the hourly ramp rate of 9 inches per hour (0.75 feet per hour) was exceeded from 30 to 38% of the time.

Hydrologic modeling should also consider the importance of riparian and wetland areas that are known for their natural ecological functions of storing water during high flows and release of water during low flows, thereby moderating extreme flows in river systems. With construction of Keno, JC Boyle, Copco 1 and Iron Gate dams, much of the mainstem riparian riverine and nearby wetland system along the Klamath River was inundated. In addition, peaking flows in the JC Boyle have coarsened the bedload and much of what was once the riparian along the mainstem has become a varial zone of alternately wetted and dried riverbed with little riparian function left.

11. Aquatics Monitoring Program

11A. Aquatic Monitoring Plan (AMP). *The Licensee shall, within one year after License issuance, file to the Commission, an AMP for the JC Boyle dewatered and peaking Reaches. The AMP shall require the Licensee to conduct monitoring of fish populations and habitat to assess the effectiveness of implementation of license conditions for flow, ramp rates, and gravel augmentation. The purpose of the monitoring is to ensure resource management objectives are met by implementing license conditions to improve aquatic resources along with utilizing adaptive management strategies as conditions change or improve. The Plan shall be developed in consultation and coordination with ODFW, other Fish Agencies, and the BLM. The Licensee shall allow a minimum of 60 days for ODFW and affected agencies to comment and make recommendations prior to filing the AMP with the Commission. The Licensee shall include with the plan documentation of consultation and copies of comments and recommendations on the completed plan after it has been prepared and provide to ODFW, and specific descriptions of how ODFW's comments are accommodated by the plan. The Plan shall describe study designs and methods to monitor key elements (See 11C below) to evaluate the effectiveness of implementing license conditions for streamflows, ramping rates, gravel management, and riparian* *mitigation. The Plan shall include monitoring of these key biological components to evaluate effectiveness of the minimum flow, ramp rate, and gravel plan to restore fish and aquatic habitat and productivity.*

***11B. Adaptive Management Strategy**. The AMP shall include an adaptive management strategy that addresses necessary changes and proposed actions for meeting resource goals for restoration of fish and aquatic life in the JC Boyle dewatered and peaking reaches. Every five years, the Licensee shall consult with ODFW, the Fish Agencies, and BLM to review and revise monitoring strategies in the AMP to adapt methods as new information is learned. The revised AMP shall be filed with the Commission upon a 60-day review by ODFW, other Fish Agencies, and the BLM. Monitoring will assess the effectiveness of the following Conditions in affecting the following aquatic resources:*

a) Minimum Flow Condition including base flow and seasonal peak flows for the JC Boyle dewatered and peaking reaches.

b) Ramp rate restrictions for the JC Boyle dewatered and peaking reaches.

c) Gravel and Sediment Plan.

d) Riparian vegetation.

***11C. Monitoring Elements.** The Aquatic Monitoring Plan shall describe implementation strategies, methods, and protocols for monitoring each of the listed monitoring study items. The geographic scope, species, monitoring frequencies, and duration are described below:*

a) *Fish health and condition: Fish disease monitoring shall include fish populations within the JC Boyle dewatered and peaking reaches. Overall fish health and condition monitoring shall be completed following accepted protocols for salmonid fish health examinations. Monitoring shall be required annually throughout the life of the License to determine if mitigation from Project impacts has been successful and the potential impacts to resident and migratory fish populations have been mitigated. The Licensee shall report the results of this monitoring annually to ODFW, other Fish Agencies, and the BLM.*

b) *Fish habitat condition: The Licensee shall implement fish habitat surveys in the JC Boyle dewatered and peaking reaches using ODFW-approved protocols for monitoring effectiveness in meeting physical habitat objectives as described in the Streamflow, Riparian Habitat Mitigation, and River Gravel Management Conditions. Surveys shall include the identification of potential new spawning areas, substrate composition and particle size distribution, degree of embeddedness, changes in aerial extent of riparian vegetation, riparian vegetation species cover. Surveys shall be conducted at five year intervals. Surveys shall be closely coordinated with ODFW, other Fish Agencies and BLM and consistent with other habitat monitoring efforts.*

c) *Reach productivity (bioenergetics): The Licensee shall implement a bioenergetics monitoring program in the JC Boyle dewatered and peaking reaches and use protocols and methods outlined in the PacifiCorp bioenergetics report for the peaking and dewatered reaches (Addley 2005). The Licensee shall* *begin monitoring reach productivity within two years after license issuance and implementation of the minimum flow, ramp rate and Gravel and Sediment Plan and repeat at five year intervals.*

d) <u>Population structure (age distribution, sex ratios, species assemblages)</u>: The Licensee shall monitor the change in distribution, annual growth, population structure, and abundance of resident and anadromous fish populations, including federally listed suckers, in the JC Boyle dewatered and peaking reaches. This monitoring shall be repeated at three-year intervals for the duration of the license. The Licensee shall use the sampling protocol in Markle et al (2000) and Simon et al (1995) for monitoring larvae, juvenile, and adult sucker populations.

e) <u>Spawning populations</u>: Monitor the number, size, and sex of spawning rainbow/redband trout and anadromous salmonids in the Klamath River Project reaches. Potential spawning areas will be identified by habitat surveys as described in ODFW reports (2003). This monitoring will occur at three-year intervals for the duration of the License. The Licensee shall test the proportion of resident and anadromous forms of O. mykiss in the tributary streams at three, seven and 15 years after reintroduction of anadromous fish. Surveys shall be coordinated with ODFW, other Fish Agencies, and BLM and consistent with other fish population monitoring efforts within the project boundary.

f) <u>Fish migration and movement</u>: Monitor native fish populations for effects of flow alteration on feeding behavior, possible delayed migration between the peaking and dewatered reaches, and survival. This monitoring will occur at three-year intervals for the duration of the License.

11D. Tri-Annual AMP Monitoring Reports. *Beginning three years after license issuance, and before April 1 of each third year the Licensee shall publish an Tri-Annual Aquatics Monitoring Plan Report that describes the annual monitoring of fish and aquatic resources over the previous three calendar years. Including summaries of data itemized in Condition 11C above, the Tri-Annual Reports shall provide specific information regarding compliance with these license conditions, and short and long term monitoring of activities conducted pursuant to these license conditions. These reports shall include a general summary of each of the monitoring elements, a summary of compliance with the instream flow, ramp rate, and Gravel and Sediment Plan, and unusual events or conditions that may have affected fish and aquatics resources during the year. Charts shall be included which graphically show all of the monitoring elements over the prior three years, including but not limited to: fish disease results, bioenergetics results, habitat surveys, population monitoring results, and riparian vegetation surveys.*

<u>Issue and Rationale</u>

Compliance with Management Direction, Administrative Rules and Wildlife Species Plans: ODFW's goals and objectives for Klamath River fish populations are to maintain and restore healthy, productive fish populations through restoration of habitat and connectivity. The Oregon Plan for Salmon and Watersheds provides direction to state agencies to restore natural flow conditions to restore native fish population productivity and distribution to historic habitats. The intent of the license conditions for flow restoration, reduced ramp rates, addition of gravel and restoration of riparian areas is to restore fish populations and their habitat.

Under the present license, PacifiCorp is entitled to divert almost all stream flow from the Link River, Klamath River, and Fall Creek, during much of the year except during spring high flows. Dewatered reaches have a very small amount of flow remaining the stream channel to support aquatic life. Severely reduced habitat has harmed native fish populations by reducing spawning, incubation, rearing, and migration habitat. Frequent flow oscillations in the Link River, Keno reach and daily peaking in the JC Boyle peaking reach cause many fold differences in stream flows for aquatic and fish life. As a consequence, much of the natural streambed in Project-affected reaches is exposed or rendered marginal for support of aquatic life. A small amount of streamflow remains in these reaches at a time of the year when maximum biological production should occur. JC Boyle, Copco 1, Copco 2, and Iron Gate reservoirs have trapped sediment, which has virtually eliminated the amount of sediment and gravel needed to provide for fish habitat, macroinvertebrate production, and riparian establishment and development downstream of each facility.

Project Impacts: The following is a brief summary of Project impacts to fish and aquatic habitat.

Aquatic Habitat Quantity and Quality: The Licensee reported that "…significant changes to geomorphology were observed in the JC Boyle dewatered reach…" (PacifiCorp 2004, Exhibit E, page 5-25). For example, reductions in the supply of sediment from lack of gravel recruitment due to JC Boyle dam in combination with altered low flows or peaking flows have caused changes in the stream channel. If hydrologic patterns, sediment availability, or streamside vegetation are altered, then channel morphology will subsequently adjust to these new conditions (Kauffman et al 1997). The channel change results in simplification of stream structure including loss of pools, decreased channel sinuosity, and loss of channel diversity (Kauffman et. al. 1997). The change in stream structure is documented by the fish habitat versus flow relationships (WUA) curves in the JC Boyle dewatered and peaking reaches, which indicate that sediment and flow regime changes have affected habitat availability (PacifiCorp 2005). The WUA curves reflect the loss of gravel point bars, benches, and spawning areas due to the loss of sediment supply; confinement due to side-cast material from the road and spillway forebay; more uniform bedforms; and reduced riparian width. The resulting simplified channel is not responsive to changes in flow at the microhabitat level. Reduction in these stream channel margin features reduces survival probability for young fish that depend on shallow habitat patches with slow velocity (Freeman et. al. 2001; Nehring and Anderson 1993). Loss of shallow slow water habitat features for fry and juveniles as a result of river regulation is well documented in the literature (Bowen et. al. 2003; Poff et al. 1997).

Habitat Quality: Project operations have also negatively impacted the redband trout fishery and habitat in the JC Boyle dewatered and peaking reaches by affecting food availability, fish production, and overall fish size (Addley et al 2005). Macroinvertebrate drift data show much lower drift density in the JC Boyle dewatered and peaking reaches compared to the Keno reach above JC Boyle Dam. In the Keno reach, drift density was 11 times higher in July and 2.4 times higher in September than drift density in the dewatered reach (Addley et. al. 2005, page 5). This difference in density does not include the much lower total productivity that results from less habitat area available due to lower base flow (approximately six times less flow in the JC Boyle dewatered reach than in the Keno reach in June, July, and August.) Similarly, the Keno reach macroinvertebrate density was 3.4 times higher in July and 5.6 times higher in September than the upper peaking reach and 11 times higher in July and 7.7 times higher in September than in the lower peaking reach below the JC Boyle powerhouse. The largely static flows in the dewatered reach and high ramp rates in the peaking reach contribute to low drift density and may help explain the lower fish growth and survival observed relative to the Keno reach. The studies show that fish growth, fish survival of older age classes and fish size-at-age in the JC Boyle dewatered reach is less than observed in the Keno reach (PacifiCorp 2004b). Similar patterns in fish population structure were observed by Beak Consulting Inc. (City of Klamath Falls 1986). Trout age distributions (few trout over three years of age and of smaller size at age) and macroinvertebrate drift data suggest that existing flow conditions limit both habitat availability and forage productivity, thus affecting redband trout growth and productivity. Gislason (1985) found that drift densities on the Skagit River were 2-60 times higher when the river was operated on stable flow regimes as opposed to high ramp rates. Insect abundance is generally greater near stream edges. However, the situation is reversed in peaking streams and the effect is disproportionate since more macroinvertebrate biomass is affected. Therefore, fry occupying the stream margins are disproportionately affected.

Habitat Quantity: The amount of wetted perimeter change occurring in the JC Boyle peaking reach between 350 to 700 cfs is approximately 3.8 ft per 100 cfs versus 1.9 ft per 100 cfs between 700 cfs and 1,500 cfs (PacifiCorp 2005 - Peaking Impacts Report). This data indicates that the smallest degree of impact to flow changes occurs at higher flows, and that flows that do not drop below 700 cfs will avoid the most extreme dewatering and associated impacts. The minimum flow condition requiring 720 cfs downstream of the JC Boyle Powerhouse will avoid extreme changes in the wetted perimeter in the varial zone. As a result, this license condition will prevent dewatering of many of the low gradient (<2-4%) bank slopes that are susceptible to conditions that cause fish stranding.

A higher minimum flow will also provide for riparian vegetation to recolonize the varial zone. This larger riparian area will become aquatic habitat available for fish, macroinvertebrates and other aquatic life. In comparison to current frequent flow fluctuations that favor the undesirable reed canary grass riparian community, the requirement for reduced ramp rates combined with a more constant and higher base flow will aid in re-establishment of desirable riparian communities.

Fish Population Structure, Growth and Abundance: Fish growth and population structure are also different between the Keno reach and the JC Boyle peaking reach, reflecting flow and food availability differences. In comparison to the Keno Reach, fish growth, fish survival of older age classes and fish size-at-age class is less in both the dewatered and peaking reaches (PacifiCorp 2004, Fish Resources FTR, Addley et. al. 2005). Similar patterns in population structure were observed by Beak Consulting Inc. (City of Klamath Falls 1986). Trout studies show that in the peaking reach there are few trout over three years of age and these trout are smaller than trout of the same age in the Keno Reach (Hemmingsen 1997; Addley et. al. 2005). This data, coupled with macroinvertebrate drift data, suggest that existing flow conditions reduce habitat and forage productivity, thus affecting redband trout growth and productivity. The evidence from redband trout studies (Addley et. al. 2005) indicates that the minimum base flows of 320 cfs in the peaking reach coupled with impacts of daily peaking does not provide for a healthy productive fish community. These effects are also documented in literature reviews of peaking effects (e.g., Cushman 1985) which describe reductions in productivity, species diversity, density, biomass, and mean and individual weight. The cumulative evidence suggest that widely fluctuating flows combined with low base flows (320 cfs) in the peaking reach are responsible for lower fish growth and survival.

Restoration of stream flows and reduced ramp rates have been documented to restore trout populations. McKinney et al (2001) documented that increased minimum, higher mean, and more stable flow releases below Glen Canyon Dam in Arizona increased the abundance of wild spawned rainbow trout fourfold. The increase in rainbow trout was attributed to increased food production (reduction in the varial zone), stability of shallow nearshore areas, and development of warmer nearshore areas for nursery habitat due to stable flows.

Fish Movement and Migration: Project-related flow reductions have affected fish movement and migration (PacifiCorp 2004, Fish Resources FTR, page 5-36 and 37). Habitat fragmentation and degradation have been identified as limiting factors for native migratory redband trout (ODFW 1997; Bowers et. al. 1999). Historically, migrations of redband trout were documented throughout the Klamath River basin. Redband trout in the JC Boyle and Keno areas of the river exhibit a spring time migration from the Frain Ranch area (RM 217) to Upper Klamath Lake (RM 251), with a smaller migration during the fall (Fortune et. al. 1966). Recent passage continues to be less than 10% of that reported one year after project construction of JC Boyle Dam (Buchanan et. al. 1991). In addition, average size of redband trout passing over the ladder showed a decline in fish size over the 30 years since the dam was constructed (Hemmingsen et. al. 1997).

The Licensee also documented in a pilot radio telemetry study than in ten instances, downstream migrating fish passed quickly by the JC Boyle Powerhouse (PacifiCorp 2004, Fish Resources FTR). However, information on five upstream-moving fish showed that the two longest delays observed (213 and 24 hours) occurred near the powerhouse. These fish moved into the vicinity of the powerhouse during an extended period of power generation and remained in this vicinity for up to 213 hours. This fish data represents 20 percent of the observations of upstream passage past the JC Boyle Powerhouse. These observations indicate that flow alterations, including low minimum flow in the JC Boyle dewatered reach affect fish movement.

Additionally, the Project continues to block upstream migrations of anadromous fish species which were present prior to the Project development. Buchanan et al. (1994) reported that the close similarity of redband trout from Spring Creek and Trout Creek (above Upper Klamath Lake) to Spencer Creek and the Klamath River (below Upper Klamath Lake) and to steelhead from Bogus Creek in California suggests that some of these lake populations were once associated with runs of anadromous rainbow trout Pacific lamprey, spring and fall Chinook salmon, coho salmon, and steelhead trout were present historically above the dam (Hamilton et al 2005). Flows and fish passage provisions do not currently provide for adequate migration and passage conditions for native fish species

<u>Fish Stranding:</u> Changes in vertical water surface elevation harm fish and aquatic resources, particularly from fish and macroinvertebrate stranding and dewatering of spawning areas during down ramping events (Cushman 1985, Hunter 1992). Ramping studies below dams document that stranding rates increase as a function of increasing magnitude of stage change, and increasing rates of change (Bradford et. al. 1995). Daytime stranding rates (2% bar slope) for coho juveniles in a controlled lab experiment ranged from 20% at a 2.4 inches per hour down ramp rate to 65% at an 11 inches per hour downramp rate. Standing rates for juvenile rainbow trout were proportionally lower

but exhibited similar patterns. Rapid flow increases in regulated reaches can wash out existing redds (Anglin et al 2005), displace fry (Hunter 1992), displace macroinvertebrates (Gislason 1985) and incur energetic costs to fish due to frequently changing locations of available fish habitat (Anglin et al 2005). This is particularly relevant for rearing life stages of suckers and trout in the Klamath River because most of the habitat for rearing fish is in near-shore areas (PacifiCorp 2004, Fish Resources FTR). The Klamath River in the peaking reach is relatively steep and confined and therefore, rearing fish are further limited to near shore areas due to velocity constraints.

Downstream dewatering and desiccation of spawning habitat were documented in the JC Boyle Peaking Reach (City of Klamath Falls 1986) and sucker larval stranding was documented in a previous study (City of Klamath Falls 1987). The Final EIS for the proposed Salt Caves Project (FERC #1990) noted low adult trout densities in the upper peaking reach. The EIS reported that trout in the upper peaking reach, where ramping effects would be least attenuated, had relatively low growth rates and that large trout were under- represented in the age structure. The EIS cited five years of investigation compiled by the City of Klamath Falls. The FERC EIS concluded that flow fluctuations below the JC Boyle Powerhouse caused chronic stress on trout and stranding of eggs, fry, and juveniles. Stress occurred from daily flow fluctuations and other related changes. These flow fluctuations caused trout to continue to seek new feeding and resting habitat.

The Licensee evaluated potential fish stranding and entrapment in the peaking reach (PacifiCorp 2005). The Licensee's findings were consistent with the findings of other stranding and entrapment studies that report difficulty in detecting stranded fish (Hunter 1992). Field surveys were unable to detect stranded trout fry and yielded small numbers of stranded sculpin, suckers, and dace and are consistent with the low numbers of trout fry rearing within the peaking reach and the poor success of visual detection methods for stranded fish. However, examination of isolated pools and side channels found trapped trout fry, larval suckers and dace. The Licensee generally concluded that peaking was not an impact since low numbers of fish were found stranded. However, low fish density of the target fish species (redband trout), particularly in the upper peaking reach, from years of flow fluctuations, prevented the study from coming to reasonable conclusions regarding potential stranding rates and mortality estimates since the Licensee concluded that.

Aquatics Monitoring Plan Recommendation: Monitoring of biological elements of the AMP is essential to evaluate the effectiveness of restoring the Klamath River to a more natural flow and sediment regime. Establishing appropriate minimum flows in Project-affected reaches, reducing Project ramp rates and addition of gravel is critical to restoring the physical and ecological processes that support fish and wildlife populations and influence aquatic and riparian habitat conditions in the Klamath River.

The original license favored power production to the great detriment and harm of fish and aquatic life. To correct this imbalance, the new license must provide for the physical and ecological processes to restore fish and aquatic productivity. The new license must also provide the means to monitor and document the biological effectiveness of new license conditions, the restoration of biological, physical and ecological systems in the Klamath River, and an adaptive management and feedback loop to make adjustments in the implementation measures and monitoring strategy.

12. Wildlife Mitigation Plan

12A. *Wildlife Mitigation Plan.* *Within two years of license issuance, the Licensee shall, in consultation with ODFW and affected agencies, develop a comprehensive Wildlife Mitigation Plan for the Project area and related company-owned lands. Plan strategies shall include routine monitoring and evaluation of wildlife and their habitats associated with the Project, and a long-term plan for implementation and monitoring consistent with federal, state, local and tribal wildlife management objectives. The Wildlife Mitigation Plan should compensate in-kind to the extent feasible for Project development and ongoing operational and facility impacts. The Wildlife Mitigation Plan shall include strategies for addressing Project impacts to wildlife species caused by ongoing Project facilities and operations, such as riverine and reservoir fluctuations; habitat loss; habitat degradation; and hazards from power canals, power poles, and transmission lines. Any new Project development or impacts authorized by Project relicensing should be consistent with ODFW's Fish and Wildlife Habitat Mitigation Policy* *and applicable wildlife management policies such as the Wildlife Diversity Plan and the Comprehensive Wildlife Conservation Strategy.*

12B. ***New Big Game Bridges and Escape Ramps.*** W*ithin two years following license issuance, the Licensee shall install additional large animal wildlife crossings at a minimum width of 36 feet and escape ramps at the JC Boyle power canal. The number of bridges shall be constructed, pending outcome of the survey results, at locations that will maximize opportunities for wildlife movement as determined through consultation with ODFW and USFWS.*

12C. ***Small Animal Crossings***. W*ithin two years following license issuance, the Licensee shall install additional structures to specifically provide crossing opportunities for small animals. The structures shall be a minimum of 2 ft. wide. Additional structures shall be installed at Project canals, pending outcome of small mammal trapping and survey results. The design and location of these structures will be determined in consultation with ODFW, USFWS, and BLM. The Licensee shall develop a written plan incorporating agency recommendations on design and location of the structures.*

12D. ***Wildlife Crossing Monitoring Plan.*** *Within one year of license issuance, the Licensee shall develop, in consultation with ODFW, USFWS and BLM, a Wildlife Crossing Monitoring Plan for Project canals and waterways to evaluate the efficacy of wildlife crossings. The Wildlife Crossing Monitoring Plan shall be completed and* *implemented immediately upon installing new crossings and when upgrading existing wildlife crossings. ODFW, USFWS and BLM may require the Licensee, based on monitoring results, to install additional wildlife crossings by the fifth anniversary of this license.*

12E. *Maintain Wildlife Crossings and Escape Ramps, and Annual Written Report.* *The Licensee shall continue to maintain wildlife crossings and escape ramps at power canals and waterways to prevent entrapment of wildlife. Within two years of license issuance, the Licensee shall consult with ODFW, USFWS, and BLM and include their recommendations into a written annual inspection and maintenance program for the wildlife crossings and escape ramps. The Licensee shall provide an annual written report of inspection and maintenance activities to the agencies by March 1 of each year.*

12F. *Minimize Interactions Between Powerlines and Birds*. *The Licensee shall implement measures to minimize adverse interactions between Project power lines and birds. Any power pole involved in a bird fatality shall be retrofitted or rebuilt to increase safety for large perching birds. In addition, all new or rebuilt power poles shall be constructed in accordance with guidelines in the publications, or the most current editions of these publications, entitled "Avian Protection Plan Guidelines" (APLIC 2005) which is intended to be used in conjunction with "Suggested Practices for Raptor Safety on Power Lines: The State of the Art in 1996" (APLIC 1996) and Mitigating Bird Collisions with Power Lines: The State of the Art in 1994. "Bird flight diverters" shall be* *installed on any new transmission lines and existing transmission lines shall be retrofitted that have been documented to cause mortality.*

12G. ***Implement Guidelines for Avian Protection*.** *The Licensee shall conduct operation and maintenance activities in the Project area in accordance with the most current spatial and temporal guidelines for avian protection (APLIC 1996 and 2005).*

12H*.* ***Implement ODFW/USFWS/PacifiCorp Agreement*.** *The Licensee shall follow the existing Agreement for Management of Birds on Powerlines, between the Licensee, ODFW, and the USFWS dated February 18, 1988. The agreement promotes cooperation between the Licensee and the signatory agencies and includes procedures for dealing with bird mortality and problem nests. Records of dead birds found near Project facilities will be kept in a database and annual reports that summarize avian protection program activities within the Project area shall be submitted to ODFW, USFWS, and BLM.*

Issue and Rationale

Compliance with Management Direction, Administrative Rules and Wildlife Species Plans: ODFW's goals and objectives for the Klamath River wildlife populations are to maintain and restore habitat including connectivity and productivity to support healthy wildlife populations of native amphibians, reptiles, birds and mammals. Habitat parameters must remain within the range that maintains the biological requirements (food, cover and water) to support productivity, growth, reproduction, and migration of native wildlife. Wildlife productivity, migration corridors, dispersal, and reproductive success are directly related to quantity and quality of habitat, so if the Project impacts these parameters, wildlife populations and their health are affected.

Wildlife Species: The Klamath Hydroelectric Project is located in ODFW's Keno Wildlife Management Unit (WMU). Mule deer *Odocoileus hemonius* are managed consistent with ODFW's Mule Deer Plan (2003) that details management objective levels for mule deer population and buck escapement. Deer populations in the Keno Unit have declined over the past few decades similar to declines throughout the west. The spring 2005 population estimate was 1200 which is 37% of the population management objective of 3200 wintering deer. Buck escapement is maintained through controlled (limited entry) hunting.

Elk *Cervus elaphus* are managed consistent with ODFW's Elk Management Plan (2003) that includes the objective to maximize recruitment into elk populations and maintain bull ratios at management objective levels. Currently elk populations are estimated at 400 animals which are 57% of the management objective of 700 elk. Elk numbers appear to be stable.

ODFW's Wildlife Diversity Plan includes the objective to protect and enhance populations of all native species at self-sustaining levels throughout their natural geographic ranges by supporting maintenance, improvement, and restoration of habitats and by conducting other conservation actions. This objective is also consistent with Oregon's recently adopted Comprehensive Wildlife Conservation Strategy (ODFW 2005).

A variety of wildlife species occur in the diverse habitats surrounding the Project. The Project is located near the confluence of several different eco-regions or physiographic provinces, resulting in a diverse mixture of flora and fauna. During relicensing studies, 210 species of wildlife were observed or documented via databases, literature reviews and surveys, including 4 amphibians, 9 reptiles, 172 birds and 21 mammals. More species than those that were actually observed probably use the Project area. Big game species in the area include deer, elk, black bear *Ursus americanus* and mountain lion *Felis concolor*. In addition, there are 16 other species of mammals including 5 species of furbearers and several medium size and small animals. Forty-seven species of water birds were observed, including 20 species of waterfowl. Nineteen species of birds of prey were observed including six species of hawks, two eagle species, three falcon species, seven owl species, and one vulture species. A total of 93 passerine species, 8 woodpeckers and five game bird species were documented in the study area of the Project.

Project Impacts: Project impacts from facilities (dam, reservoirs, and canals) and operations (riverine and reservoir fluctuations) have resulted in loss and degradation of habitat and interruption of animal migration and travel corridors, particularly in riparian and wetland habitats. Habitat loss and degradation continue to reduce the carrying capacity of the remaining winter range.

The Licensee conducted nine studies for terrestrial resources that included vegetation cover type and wildlife habitat inventory and mapping, wetland and riparian plan community characterization, Threatened, Endangered and Sensitive (TES) species inventory, amphibian and reptile inventory, wildlife movement/connectivity assessment, wildlife habitat association assessment and synthesis of existing wildlife information, noxious weed inventory, grazing analysis, and spring-associated mollusk inventory (PacifiCorp 2004, Terrestrial Resources FTR). These studies documented several important Project impacts to wildlife species or their habitats:

1) Under current conditions, between 19 and 30% of the JC Boyle, Copco and Iron Gate reservoirs are bordered by riparian/wetland habitat. Currently, wetland and riparian vegetation along reservoirs is limited mostly to small patches in protected locations near inlets/tributaries. This is a loss of important riparian/wetland habitat when historical riverine reaches for the same three reservoirs were 28%, 49% and 68%, respectively, for JC Boyle, Copco and Iron Gate reservoirs. The vertical range of riparian/wetland vegetation at JC Boyle reservoir occupies a narrow band, likely the result of greater daily water level fluctuations.

2) The riparian/wetland community in the JC Boyle peaking and dewatered reaches is dominated by reed canary *Phalaris arundinacea* grass, a highly invasive and

aggressive riparian species that out competes native riparian species such as willow *Salix* species. The pattern of reed canary grass abundance within the varial zone of the peaking reach is positively correlated with elevation and associated with inundation frequency and duration. In other words, the daily ramping in the peaking reach significantly favors reed canary grass which compounds the impact of germination and growth of native plant species. Reed canary grass and shading prohibit willow germination while daily peaking floods seed and seedlings before that can develop, reducing growth and reproduction of native riparian species.

3) Major changes to channel geomorphology were observed in the JC Boyle dewatered reach as a result of sidecast material generated by the Project's road construction and maintenance activities, and erosion from the emergency forebay spillway. The material has constricted the channel and has altered the riparian vegetation along the 0.8 km reach of the channel below the spillway.

4) The extreme low flow of 10 cfs in the Copco 2 dewatered reach has resulted in encroachment of mature riparian vegetation into the narrow river channel with numerous mature alder *Alnus rhombifolia* occupying former in-channel islands and bars.

5) The flow regime in the Klamath River below Iron Gate Dam currently mandated by the Biological Opinion for TES fish protection appears to be support and

maintain native riparian communities. The ramp rate below Iron Gate Dam is 125 cfs per hour and 300 cfs per 24 hours when flows are greater than 1,750 cfs and 50 cfs per 2 hours and 150 cfs per 24 hours when flows are 1,750 cfs or less.

6) The weed survey documented a total of 14 noxious weed species with 112 infestations covering more than 226 hectares (ha) in the study area. The acreage figure did not include three major weed species including yellow starthistle *Centaurea solstitialis*, cheatgrass *Bromus tectorum*, and medusahead *Taeniatherum caputmedusae*. Noxious weeds occurred in 74% of all the vegetation plots and 62% of the riparian/wetland plots. Several of the noxious weeds were documented near Project facilities where maintenance, vegetation removal, and ground disturbing activities create suitable habitat for invasive species.

7) The greatest effect of the Project on passerine bird species is the effect on the distribution and connectivity of riparian/wetland habitats. The dominance of reed canary grass in the JC Boyle dewatered and peaking reaches, related to the flow regime, limits habitat quality for birds by allowing non-native species to out compete native vegetation. In addition, Project reservoirs have large gaps in the shoreline wetland/riparian vegetation, and the habitat patches are mostly small with limited usefulness to riparian species. The average break between neighboring riparian habitat patches on Project reservoirs is significantly larger at

individual reservoirs than along natural riverine reaches. One of the focal species, the yellow warbler *Dendroica petechia*, had a lower habitat quality at JC Boyle Reservoir, possibly due to daily water level fluctuations that reduce shoreline riparian shrub habitat.

8) The impacts of the Project on amphibians and reptiles are 1) poor breeding habitat available along Project reservoirs as a result of water level fluctuations and large predator populations, and 2) large gaps in riparian habitat connectivity that are a result of the existence of the Project reservoirs and canals.

9) Water level fluctuations in the reservoirs and peaking in the JC Boyle reach likely adversely affects the northwestern turtle *Clemmys marmorata* population by making basking sites unavailable, increasing the risk of predation, and reducing forage resources.

10) The presence of reed canary grass and the native coyote willow *Salix exigua* were evaluated on the basis of Project hydrology, fluvial geomorphology and their life-history strategies. Reed canary grass is highly invasive and aggressive, apparently in response to the additive effects of increased nutrient supply (below JC Boyle and Keno reservoirs), agricultural runoff (from USBR return irrigation water) and increasing intensity of inundation. Coyote willow occurred normally in the riverine reach below Iron Gate Dam where peaking impacts do not occur.

11) While there was little evidence of deer mortality from attempted canal crossings or entrapment, the small mammal trapping along the JC Boyle canal documented that small mammals and snakes occupy habitat along the canal. The canal creates a barrier so that riparian habitat along the river is isolated from upland habitats on the opposite side of the canal. The canal impacts animals by barring movement and dispersal and contributes to small animal mortality. The degree to which wildlife are entrapped is dependent on incidences of terrestrial amphibians, reptiles and mammals either entering the canal at one of the two existing vehicle access points or along the 52% of the canal that has wall heights of less than 1.2 m (4 feet) along the northwestern side of the canal. The likely source of entrapment is lengths of the canal with both low wall height and non-steep slopes. There are only three points at which entrapped wildlife can escape the canal: two vehicle access ramps and at the forebay. Approximately 37% of the northwestern side of the canal has gentle or moderate terrain where virtually all wildlife species that occur in the area could easily pass if the canal were not there. The fish entrainment study at East Side and West side canals on Link River documented mortality of wildlife including mink *Mustela vison*, raccoon *Procyon lotor*, muskrat *Ondatra zibethicus*, garter snake *Thamnophis* species, bullfrog *Rana catesbeiana*, rough-skinned newt *Taricha granulosa*, and various waterfowl.

Big game populations have been adversely affected over the last half-century from cumulative effects from habitat loss and degradation, forest maturation, fire suppression, weather, poaching, disease, and highway impacts. The Klamath River Canyon (between JC Boyle Dam and Iron Gate Dam) provides critical winter range habitat, particularly along the south slopes, for big game in the Keno and Rogue WMUs. Despite the small numbers of deer mortalities (4) reported for the JC Boyle canal, Project reservoirs and canals likely affect big game movement by restricting animals along shorelines and by limiting the locations where animals can cross through the area. In addition reservoir inundation has reduced overall winter range habitat.

Through cooperative agreement, ODFW, PacifiCorp, BLM, and major landowners in the Project area seasonally restrict motor vehicles (Pokegama Closure) during the critical winter period with the following objectives: 1) to reduce harassment to wintering big game and other wildlife; 2) to improve law enforcement; and 3) reduce damage to roads and soils. This seasonal road closure program should be continued to protect critical big game winter range.

Project facilities, operations and maintenance activities affect wildlife species via daily and seasonal reservoir or riverine drawdowns, block animal movement and migrations, and impact native habitat via the invasion of invasive aquatic and upland noxious weed species. These combined impacts reduce habitat quantity and quality available to support wildlife, reduce connectivity, and fragment populations. Potential Project impacts occur to big game, small mammals, eagles, raptors and other avian species, waterfowl, bats, and amphibians and reptiles.

Researchers have reported that the closer the flow regime mimics the natural hydrograph with a seasonal peak in late winter or early spring and then a gradual decline, then the more likely conditions will occur to favor native plant seed dispersal, germination and growth along the riverine system. The instream flow regimes proposed as 10(j) recommended conditions in this document (license conditions 6 and 7) will restore currently degraded riparian habitat and shoreline conditions for terrestrial species as well as restoring instream flow conditions for aquatic species.

Wildlife Mitigation Plan: A Wildlife Mitigation Plan is necessary to address ongoing and continuous impacts to wildlife species and their habitats. The Plan should provide routine monitoring and evaluation of wildlife and their habitats associated with the Project, mitigation strategies, and regular and frequent consultation with ODFW and affected agencies for wildlife management objectives. Strategies in the Plan should develop and implement PM&Es to mitigate for ongoing impacts to riparian and wetland habitats, entrapment and mortality at power canals, and avian losses to power poles, and provide for monitoring of compliance and success of implementation measures.

Wildlife Crossings and Power Canals: The Project includes approximately 8 to 9 miles of canals, flumes, and penstocks, which are obstacles to wildlife moving through the area. Large and small animals can become entrapped in Project waterways, particularly small animals that have small home ranges and patchy distributions. ODFW believes that impacts are substantial in some reaches of the JC Boyle power canal. Seasonal movements of reptiles and amphibians are a well-documented aspect of their life history. The canals represent an important cause of mortality and block dispersion and genetic flow for some species.

ODFW recommends implementing and evaluating additional large and small wildlife crossing structures that maximize opportunities for successful wildlife movement. ODFW recommends that these new crossings be developed and implemented according to current standards. The Licensee should also document use of the crossings by wildlife with track counts or other evaluation methodology. It may be determined that for crossings to be most effective it may be necessary to install small animal fencing to funnel wildlife to crossing structures. This will reduce the potential for small mammals and reptiles to enter the canal and thus reduce mortality.

Terrestrial Resources, Wildlife Crossings: The Project has long water conveyance structures. Concerns about loss of wildlife and connectivity of wildlife populations were raised long ago for the Eastside and Westside diversions at Link River Dam and JC Boyle power canal.   There has been little opportunity to conduct evaluation of alternatives to determine the most suitable width for crossing structures to accommodate the wide range of species expected to use them.

Most of the current state of knowledge of wildlife crossing structures is based on passage over or under roads. The general conclusion based on evaluation and testing of wildlife crossing structures is to allow the widest width possible. Wildlife overpasses can vary in width from 3.4 m (11.15 ft) to 870 m (2,853.6 ft). Wider passages are more effective at allowing animals to cross and animal behavior on wider structures is more normal than on narrower ones (http://environment.transportation.org/compendium/manual/3_4.aspx#tooltip).

The ODFW recommendation is based on current developments in wildlife crossing technology. ODFW supports incorporating cover components along the edge of any crossings intended for big game to increase the utility of each crossing for the full range of animal communities. However, the cover components require additional width of the crossing in order to maintain a useful width of crossing for large animals. ODFW's recommendation is based on its expertise and knowledge of animal communities in the Project area, its knowledge of the success of the current crossings from the available information, and the current state of knowledge regarding animal crossings to provide connectivity for animal populations.

Recent evaluation of wildlife crossings has led to the conclusion that wider is more effective. There have been effectiveness and monitoring plans developed and implemented for recent wildlife crossing projects. Effectiveness and monitoring can include whether species passage frequency is related to their abundance and distribution, e.g. high density species have relatively high passage frequencies, low-density species have relatively low passage frequencies, and localized species use crossings located near them, and whether use is observed during critical seasons such as breeding and migration. Monitoring of crossing structures is the only means of obtaining solid, reliable information on species relationships, ecosystem processes, and, in this case, the functionality of these structures for wildlife in facilitating normal life history patterns.

Power Lines and Avian Injury and Mortality: Overhead lines on the landscape pose potential hazards for many avian species. Collision can be a major source of mortality for some avian species, especially where power lines and towers or poles are present in the path of migrating concentrations of birds such as passerines or raptors. Collision can be a mortality factor during the daytime and at night, and can also be related to weather conditions. The probability of collision is related to characteristics of particular bird species and to the environmental characteristics of the particular area. The Klamath River Canyon is an important flight corridor (daily and seasonal) for raptors and other avian species.

Raptors are the avian species of greatest concern for electrocution because of their larger size and their attraction to powerlines and associated poles and towers for roosting, perching, hunting and nesting. Species that prefer open locations, rather than forest interior habitats, are the most susceptible, and include golden *Aquila chrysaetos* and bald eagle *Haliaeetus leucocephalus*, osprey *Pandion haliaetus*, prairie falcon *Falco mexicanus*, peregrine falcon *Falco peregrinus* and red-tailed hawk *Buteo jamaicensis*, all of which have been documented in the Project area. ODFW recommends that PacifiCorp modify power poles for safe use by raptors and design new or retrofitted power poles to accommodate or even encourage safe use for nesting, perching and feeding. ODFW also recommends "bird flight diverters" be installed on any new transmission lines or during repair or replacement of existing lines.

Big Game Habitat: The Pokegama seasonal road closure should be continued to protect critical winter range habitat. Maintenance activities including gate repair and appropriate signage must continue to help achieve the closure objectives.   In addition, any primitive roads within the Project area identified as non-essential for public access or for Project operation and maintenance should be permanently closed and rehabilitated.

Mitigation for Project impacts to big game habitat should be accomplished by improving winter range habitat on existing PacifiCorp lands and BLM administered lands in the Klamath River Canyon and through acquisition of additional winter range habitat. Vegetation treatments in mixed conifer, oak woodland, and shrub communities would improve the mosaic of forage and cover components. Potential treatments include juniper removal, conifer and oak thinning, prescribed fire, mechanical shrub rejuvenation, improved livestock grazing management and noxious weed control. It is imperative that a plan be drafted that will actively manage habitat for optimum big game benefits. These treatments will also improve habitat for many other wildlife species.

12. Fish and Wildlife Enhancement Plan

13A. ***Fish and Wildlife Habitat Enhancement Plan.*** *Within one year of license issuance, the Licensee, in consultation with ODFW and other Fish Agencies, and BLM shall develop a Fish and Wildlife Habitat Enhancement Plan. The purpose of the Plan is to develop strategies to implement mitigation measures for ongoing impacts to fish and wildlife populations from Project facilities and operations. Implementation of the Plan will be to increase the success of anadromous fish reintroduction and potamodromous restoration and to support resource protection measures for project-related impacts not otherwise covered by specific license conditions, including projects that enhance and improve wetlands, riparian and riverine habitats, and riparian, aquatic and terrestrial species connectivity that may be affected by the continued operation of the Project. The Plan shall be developed and implemented in coordination with state and federal fish and wildlife agencies including ODFW, CDFG, USFWS, and NMFS, and with the major land management agency, BLM. The Plan shall identify strategies to be funded by the Licensee to implement habitat enhancement measures in mainstem reaches and tributaries containing native fish and wildlife species. The Licensee will restore fish habitat above and below the Project to mitigate the continued effects of the Project on fish and wildlife habitat. The Licensee shall provide funding for this mitigation throughout the term of the license, though priority for Projects will be given for the first 15 years. These measures shall focus on appropriate reaches within and above the Project. In cooperation with landowners, the Plan associated measures shall focus on restoration of riparian areas and wetlands, instream flow and water quality restoration, and land acquisition. The Plan shall include procedures based on common methods utilized in fisheries and wildlife science, including state-of-the-art techniques, for* *prioritizing and selecting habitat restoration, conservation, and/or acquisition projects. The Plan shall provide temporal and spatial management strategies that restore and maintain optimum habitat components for the diverse wildlife and vegetative species present within the Project. All fish habitat protection, mitigation, and enhancement proposals will be reviewed by the FPIC prior to approval.*

13B*. Funding.* *The Licensee shall establish a habitat fund to accomplish the purposes of the Habitat Enhancement Program. This fund amount shall be developed in consultation with ODFW, other Fish Agencies, and BLM. Commencing on the second year after license issuance, annually, on the anniversary of the date that the Annual Report is submitted pursuant to Condition 1, the Licensee shall deposit a designated amount, adjusted annually based on the Consumer Price Index, into the fund. The Licensee shall use these funds to conduct restoration, conservation, and/or acquisition projects as described in an Annual Work Plan developed to implement the Plan. Operation and maintenance costs associated with habitat enhancement will also be covered by this fund.*

13C. *Vegetation and Noxious Weed Plan.* *Within two years of license issuance, the Licensee shall develop a vegetation management plan in consultation with resource agencies including ODFW, CDFG, BLM, and USFWS. The Plan should include strategies for managing native vegetation to optimize habitat for wildlife species and control invasive weed species. The Plan should guide land management practices on company-owned lands such as management of forest, shrub and grassland* *communities to contain, control, and suppress exotic and invasive weeds so they do not act as a source for infestations downstream or on adjacent property or compromise the integrity of native fish and wildlife habitat.*

Issue and Rationale

Compliance with Management Direction, Administrative Rules and Wildlife Species Plans: ODFW's goals and objectives for the Klamath basin are to maintain and restore habitat including connectivity and productivity to support healthy fish and wildlife populations. Habitat parameters must be restored to the range that maintains the biological requirements to support productivity, growth, reproduction, and migration of native wildlife. Fish and wildlife productivity, migration corridors, dispersal, and reproductive success are directly related to quantity and quality of habitat, so if the Project impacts these parameters, fish and wildlife populations and their health, productivity and survival are affected.

OAR 635-415-000 to 0025 requires ODFW to seek to mitigate impacts to fish and wildlife habitat caused by land and water development actions. A Fish and Wildlife Habitat Enhancement Plan is necessary to mitigate for irrevocable impacts to fish and wildlife resources and their habitats caused by ongoing and continuous Project operations and facilities. This condition requires the Licensee to improve habitat quantity and quality for fish and wildlife above and below the Project commensurate with the loss of riparian, riverine, wetland, and upland habitat caused by ongoing operation of the Project. Mitigation for riverine salmonid habitat is proposed to compensate for the following ongoing Project impacts:

A. Compensatory mitigation for a total of five miles of dewatered channel (four miles below JC Boyle Dam and one mile below Copco 2 Dam).

B. Compensatory mitigation for a total of 41.7 miles of riverine channel that has been inundated by project reservoirs (9.1 miles for Iron Gate reservoir, 4.4 miles for Copco reservoirs; 3.7 miles for JC Boyle reservoir; and 23 miles for Keno reservoir).

C. Compensatory mitigation for fish passage facilities that are less than 100% effective for upstream and downstream migrating fish.

Habitat mitigation may include cooperatively funding with water users in the Klamath basin, adult and juvenile fish passage facilities at irrigation diversions or other constructed fish barriers in the upper basin. Habitat enhancement may also include purchase of instream water rights. The Licensee shall fund the planning and implementation of projects on federal lands to meet associated agency requirements under the National Environmental Policy Act and the Endangered Species Act. The Licensee shall fund the maintenance of these projects and monitoring to determine their effectiveness.

The Project continues to reduce fish habitat quantity and quality through the continued loss of nearly 41 miles of instream fish habitat, including the fish habitats of the mainstem Klamath River and its tributaries within the Project's reservoirs. These reaches of the river were important areas for chinook, coho, steelhead, and Pacific lamprey. Even with the Licensee implementing fish passage, production capacity for redband trout, ESA-listed suckers and reintroduced anadromous species will be reduced due to the continued occupation of the river habitat by Project reservoirs.

Cumulative and Continuous Impacts to Riparian, Wetland, Riverine and Botanical Resources: The Klamath Hydroelectric Project blocks access to historic anadromous fish habitat and fragments native salmonids and other native potamodromous fish species from populations below, within, and above the Project. The Project results in conversion of a free flowing mainstem river to a series of five reservoirs.

Construction of the Project’s reservoirs and alteration of the Klamath River’s hydrology and geomorphology has impacted fish and wildlife through the loss or conversion of over 80 acres of riparian habitat. The operation of the JC Boyle, Copco and Iron Gate reservoirs affect up to 131 ha (324 ac) of drawdown zone that have a limited amount of wetland or riparian vegetation. Current peaking operations in the JC Boyle peaking zone also affect up to 23 ha (58 ac) in the varial zone.

Flow alteration and Project operations have inundated riparian, wetland and riverine habitat, diminished remaining riverine and riparian habitats and caused ongoing entrapment and mortality of fish and wildlife species, and increased the establishment of non native species such as reed canary grass to the detriment of native riparian plant and wildlife species.

The JC Boyle spillway overflow and failure of the waterway power canals results in impacts to riparian and aquatic habitats by erosion and sediment deposition. Road cast along the JC Boyle access road has also deposited road materials in the Klamath River, causing turbidity and sedimentation problems, and reducing riparian and riverine habitat quality.

There are large gaps in riparian/wetland habitat, particularly along Iron Gate and Copco reservoirs, but also along JC Boyle, that limits habitat quality for amphibians, reptiles and other wildlife species and reduces connectivity. Also, most reservoirs provided very little habitat for breeding amphibians due to frequent water level fluctuations. Western pond turtles are found throughout the Project although use is more concentrated around shorelines with basking sites in lower gradient portions of the river. Western pond turtles are affected by fluctuating shoreline reservoirs that cause reduced basking habitat and juvenile habitat. Existing basking sites should be protected and opportunities to increase basking sites should be pursued in areas identified as lacking these components. The BLM has identified potential locations where basking structures (boulders and logs) could be placed in the vicinity of suitable nesting and over winter habitat. These type structures would also have high value for other wildlife species for foraging and roosting.

Aquatic furbearer species such as beaver *Castor canadensis*, river otter *Lutra canadensis*, mink, and muskrat are impacted by lack of riparian vegetation and denning sites due to peaking impacts causing shoreline erosion and degradation of riparian vegetation.

Project operations also result in the proliferation of non-native species, resulting in competition for available resources. The extirpation of anadromous species within and above the Project affected potamodromous species through the loss of marine derived nutrients and an available prey base.

Non-native invasive plant species either documented in the area include but are not limited to Canada thistle *Cirsium arvense*, cheatgrass *Bromus tectorum*, common toadflax *Linaria vulgaris*, dalmation toadflax *Linaria dalmatica*, leafy spurge *Euphorbia esula*, musk thistle *Carduus nutans*, scotch thistle *Onopordum acanthium*, puncture vine *Tribulus terrestris*, reed canary grass, spotted knapweed *Centaurea maculosa*, whitetop *Lepidium draba*, and yellow star thistle *Centaurea solstitialis*. These species have the greatest potential for impact to native wildlife and wildlife habitat.

14. Fish Disease Risk Monitoring and Evaluation

14A. Juvenile Disease Risk. *The Licensee shall develop and implement a Juvenile Fish Disease Risk Monitoring and Management Plan (JDRP) with ODFW and the other*

Fish Agencies and affected Tribes to reduce the disease risk for juvenile anadromous salmonids in the Klamath River to a level comparable to the disease risk in healthy river systems. This should first require studies to determine key factors controlling disease risk and pathogen abundance and to better understand pathogen ecology. If appropriate, the Plan shall include assessment of the benefits through restoration using geomorphic processes, management of flows, and water quality to minimize disease risk.

14B. Adult Disease Risk*. The Licensee shall develop and implement an Adult Fish Disease Risk Monitoring and Management Plan (ADRP) in consultation with ODFW, the Fish Agencies and affected Tribes to reduce disease risk for adult anadromous salmonids in the Klamath River below Iron Gate Dam to a level comparable to the disease risk in the Trinity River. The Plan shall include recommendations for the management of flows and water quality to minimize disease risk. This plan shall also include mitigation steps to be taken to minimize disease risk to reintroduced anadromous species above Iron Gate Dam and to resident species. In addition, the plan shall include studies to assess the role of seasonal flow reductions in increasing habitat and pulse flows in decreasing habitat for the intermediate host, Manayunkia speciosa, of the anadromous fish parasite, Ceratomyxa shasta. In order to assess this issue, the Licensee shall test flows of varying extent and magnitdue to determine sufficient mobilization of the bed that results in scour of the algae mats and then subsequent testing of both the polychaete and myxozoan abundance.*

14C. Emergency Response Pulse Flow Plan (ERP). *The Licensee shall develop a plan in consultation with ODFW, the Fish Agencies and affected Tribes to provide temporarily enhanced flows on an emergency basis utilizing the estimated active storage at Iron Gate and Copco reservoirs of 52,000 acre feet (AF). These flows would be provided when an Interagency Fish Health Assessment Team determines that enhanced flows would likely decrease the impacts of an impending juvenile or adult fish die-off. Adaptive Management reports would be provided by the Licensee summarizing the successes and failures of such attempts and recommendations for future enhanced flow management.*

14 D. Agency Consultation. *The schedule for completing the plans shall accommodate a 60-day review period for agencies to submit comments. If the Licensee does not adopt agency recommendations, a rationale for why these were not included should be included in the plans. Within two years of the development of disease risk Monitoring and Plans and agency approval, the Licensee shall fully implement the Plans.*

Issue and Rationale

Compliance with Management Direction, Administrative Rules and Wildlife Species Plans: ODFW's goals and objectives for the Klamath basin are to maintain and restore habitat including connectivity and productivity to support a healthy ecosystem and fish populations. Habitat parameters must be restored to the range that maintains the biological requirements to support productivity, growth, reproduction, and migration of native wildlife. Fish disease and the pathogens have been found to be often correlated with degraded habitats in recent years, particularly in habitats with reduced flow, higher nutrient loads, and alteration of natural river regimes with peak seasonal discharge during spring. Fish diseases cause both direct and indirect mortality in fish populations and in degraded habitat systems, may become a major impact on productivity. Therefore, if the Project impacts these parameters of nutrient loads and flow, fish populations and their health, productivity and survival are affected.

2002 Adult Salmon Fish Kill: Disease of fish and die-offs in the Lower Klamath River downstream from the Project are a serious management concern. During the September 2002 Fish Die-Off, increased flows provided from the Project helped trigger upstream migration and alleviated additional mortality due to disease. Fish in the Lower Klamath River were apparently not stimulated by ambient environmental conditions but did later migrate upstream in response to an increase in discharge after the die-off was underway (USDI Fish and Wildlife Service 2003a). On September 27, 2002, a pulse flow was released from Iron Gate Dam in a successful effort to increase the volume of river flow through the fish die–off reach to reduce crowding and stimulate fish to begin upstream movement (McCracken 2002). Flows were ramped up from 767 cfs to 1,350 cfs over a 2-day period. This discharge was maintained through October 9, 2002, after which discharges declined to 885 cfs by October 13, 2002. Approximately 36,000 acre-feet of additional water was provided over a 2-week period. While it is unclear if the Project alone has enough storage to provide these flows, at least 12,000 AF of storage is available in Project reservoirs and management of this water would have the potential to prevent or mitigate future fish kills.

The Licensee has not proposed any measures or studies to better understand fish die-offs in the Klamath River or to manage to minimize disease outbreaks. The development of juvenile, adults and emergency response plans for salmonids will help ensure that agencies, Tribes, and the Klamath River Basin Fisheries Task Force will explore all options for minimizing future fish die-offs and meet their management goals and objectives.

Project Impacts: Outmigrating juvenile Chinook and steelhead within the Lower Klamath River Basin experience significant mortality from infectious disease, with recent estimates of disease-related mortality in downstream migrants as high as 90 percent (Foott, personal communication). The primary pathogens implicated in this mortality are the myxozoan parasites *Ceratomyxa shasta* and *Parvicapsulum minibicornis* (Williamson and Foott 1998; Foott et al. 1999; Foott et al. 2002; Foott et al. 2003).

The life cycles of the parasites are complex and require development in both a vertebrate and invertebrate host. For *C. shasta*, the invertebrate host is the freshwater polychaete *Manayunkia speciosa* (Bartholomew et al. 1997). Fish become infected by contact with actinospores that are produced within *Manayunkia*. Following fish mortality, myxospores are released into the water where they are then taken up by the polychaete. The invertebrate host for *Parvicapsulum minibicornis* has not yet been identified, but new information suggests that its host may also be *Manayunkia* (Hendrickson, personal communication).

The buildup of algae on substrates in the Klamath River is believed to contribute to increasing habitat suitable for the polychaete worm that is the alternate host for *C. shasta* (Stocking and Bartholomew 2004). Increases in habitat can increase production of the polychaete and subsequently the number of myxozoan spores in the water column that infects fish. In addition to high nutrient levels from Project reservoirs, reductions in the magnitude and extent of peak flows resulting from hydroelectric operations has likely contributed to increasing the amount of stable habitat for the polychaetes downstream of the Project (McKinney et. al. 1999). PacifiCorp (2005 – AR-2) considered only temperature as an indicator and determinant of parasite load.

The Project contributes to higher water temperatures, which in turn leads to increased disease risk. Fish disease among anadromous fish has increased in recent years in both adults and outmigrating juveniles in the Lower Klamath River (Williamson and Foott 1998; Foott et al. 1999, 2002, 2003, Nichols and Foott 2005). The September 2002 fish die-off killed at least 33,000 adult fish, mostly Chinook salmon from infection by two pathogens (*Ichthyophthirius multifiliis* and *Flavobacterium columnare*) (USDI Fish and Wildlife Service 2003b). In 2004, juvenile outmigrating salmon were estimated to be 94 percent infected by myxozoan parasites (*Ceratomyxa shasta and Parvicapsula minibicornis)* on the Klamath River, which may have rivaled the loss of 33,000 adult fish two years earlier in impact to the population of Chinook salmon (Nichols and Foott

2005). Myxozoan parasitic infections in juvenile anadromous salmonids appear to be focused in the mainstem Klamath River as opposed to tributaries, and the duration of exposure to the mainstem river may be a major determinant in the disease (Nichols and Foott 2005). Higher spring flows would likely benefit survival probabilities of juvenile outmigrating salmonids by reducing their time spent in the mainstem river with associated disease infection risk along with reducing algal loads on substrates.

Project reservoir related degradation of water quality contributes to fish stress and conditions conducive to disease related die-offs. Project reservoirs result in higher water temperatures in the downstream receiving river in the fall (Bartholow et. al. 2005) that elevate the risk of disease to adult fish at least to the Seiad Valley. Both juvenile and adult die offs have been documented in the Klamath River since at least the 1990's. Juvenile die offs have been chronic in the mainstem Klamath River and undoubtedly are a contributor to the low (~0.18 percent) smolt to adult returns for production from Iron Gate Hatchery. In the September 2002 Chinook fish kill, the adult die-off in the lower river resulted in the loss of more than 30,000 fish (USDI Fish and Wildlife Service 2003b; CDFG 2004). The majority (98 percent) of fish killed in the September 2002 event were adult anadromous salmonids. Low river discharges apparently did not provide suitable attraction flows for migrating adult salmon, resulting in large numbers of fish congregating in the warm waters of the lower river (USDI Fish and Wildlife Service 2003a). The high density of fish, low discharges, warm water temperatures, and possible extended residence time of salmon created optimal conditions for disease (USDI Fish and Wildlife Service 2003a).

The estimate of active storage for these reservoirs is different from the amount reported in the Licensee's documents (PacifiCorp 2004, Water Resources FTR) because they report the active storage that is available during normal operations. The USGS estimated actual active storage in Copco and Iron Gate Reservoirs using a procedure outlined in the September 27, 2005, memo attachment to the U.S. Fish and Wildlife Service November 17, 2005, letter commenting on PacifiCorp's response to information request AR-1a, dated September 2005. Although both Copco and Iron Gate reservoirs are usually operated in near-full condition, each reservoir can be drawn down to the level of the outlet for the hydropower plant. In Copco, the outlet is located at 2,571 ft MSL, while the maximum storage elevation is at 2,607.5 ft MSL, with a total active storage estimated at 29,379 AF for Copco Reservoir. Iron Gate Dam outlet is located at 2,299 ft MSL, while the maximum storage elevation is 2,328 ft MSL, with a total active storage estimated as 2t,261 AF for Iron Gate Reservoir. Total active storage in both reservoirs is estimated at approximately 52,000 AF (52,640 AF). To translate that into discharge, 52,000 AF could provide approximately 875.4 cfs per day for a 30-day period (Sharon Campbell, USGS, pers. comm. Feb 1, 2006).

Fish Disease Monitoring Plan Recommendation: An interagency team of fisheries experts (Klamath Fish Health Assessment Team, KFHAT) has formed to provide an emergency plan and process to respond to potential fish kill events in their early stages (Klamath Fish Health Assessment Team 2005). Many of the individuals in this team were involved with fish kill responses on the Klamath River in the past few years and continue to monitor fish health conditions at critical time periods in the life cycles of anadromous salmonids. ODFW recommends that since many of the responsible factors that contribute to fish disease and have led to resultant fish kills in migrating anadromous salmonids in the Lower River (nutrient loads, discharge flow, retention of water and resultant solar heating and thermal lag and water quality degradation in the Lower Klamath River), that the Licensee is responsible for developing and implementing juvenile and adult disease monitoring plans and an emergency response plan.

15. Emergency or Special Conditions

15 A. *Emergency or Special Conditions – ESA listed species*. *If at any time, unanticipated circumstances or emergency situations arise in which federal or state ESA-listed fish or wildlife are being killed, harmed or endangered by any of the Project facilities or as a result of Project operation, the Licensee shall immediately take appropriate action to prevent further loss in a manner that does not pose a risk to human life, limb, or property. The Licensee shall, within six hours of an occurrence, notify the nearest office of ODFW, NMFS, USFWS, BLM, CDFG, CSWRCB, ODEQ, and OWRD, as appropriate, and comply with any restorative measures required by the resource agencies to the extent such measures do not conflict with the conditions of this license. The Licensee shall notify the Commission as soon as possible but no later than 10 days after each occurrence and inform the Commission as to the nature of the occurrence and restorative measures taken.*

15B. *Emergency or Special Conditions – non-ESA listed species*. *If at any time, unanticipated circumstances or emergency situations arise in which non-ESA listed fish or wildlife are being killed, harmed or endangered by any of the Project facilities or as a result of Project operation, the Licensee shall immediately take appropriate action to prevent further loss in a manner that does not pose a risk to human life, limb, or property. The Licensee shall, within 48 hours of an occurrence, notify the nearest office of ODFW, NMFS, USFWS, BLM, CDFG, CSWRCB, ODEQ, and OWRD, as appropriate, and comply with any restorative measures required by the resource agencies to the extent such measures do not conflict with the conditions of this license. The Licensee shall notify the Commission as soon as possible but no later than 10 days after each occurrence and inform the Commission as to the nature of the occurrence and restorative measures taken.*

13C. *Consultation for Modification of Project and Permit Compliance*. *It is the responsibility of the Licensee to consult with all appropriate local, state, or federal agencies before repairing or modifying Project operations or facilities, and to obtain and comply with all required permits.*

<u>Issue and Rationale</u>

ODFW believes that the new license should include conditions for managing emergencies at Project facilities that may cause harm or mortality to fish and wildlife species or their habitats. The license should also include conditions that enable ODFW to recommend new mitigation measures in the event that existing measures prove ineffective or if a fish or wildlife species is newly listed under the state or federal Endangered Species Acts.

16. Project Inspections and Access

16A*. Project Inspections and Access*. *The Licensee shall allow state and federal regulatory agencies, including ODFW, access to, through, and across Project lands and works for the purpose of inspecting fishway facilities and records, including monitoring data, to monitor compliance with this license. The Licensee shall allow such inspections upon the entity requesting the inspection providing the Licensee with reasonable notice of such inspections and agreeing to follow the Licensee's standard safety and security procedures when engaged in such inspections.*

Issue and Rationale

Inspections of Project fishway facilities and data records and summaries are needed to provide an opportunity for the regulatory agencies to determine compliance with environmental license conditions adopted in the license and to track development and implementation of resource plans. Under the existing license, there is little to no tracking of impacts of Project fishway facilities and operations to natural resources. FERC environmental inspections occur at best annually. When ODFW staff conducted research at the JC Boyle Dam facilities, flows in the ladder ranged from non-existent to raging white water, indicating non-compliance with existing license conditions. The relicensing process has strongly illuminated the need to provide regular and frequent inspections of facilities and operations and to make access available to regulatory personnel for environmental license conditions.

10A Recommendations

The following recommended license condition is submitted pursuant to Section 10(a) of the Federal Power Act.

1. Recreation

1A. ***Recreation Study and Instream Flow Recommendations.*** *ODFW's that flow recommendations for recreation for the Klamath River is the same as stated for fish and aquatic life (see 10J Condition 6. Streamflow in Dewatered, Peaking and Regulated Reaches).*

1B. ***Public Access****. For the purpose of full public utilization of such lands and waters for outdoor recreational purposes, including wildlife viewing, angling, and hunting, the Licensee shall allow the public free access to Project waters and adjacent Project lands owned by the Licensee, with the exception that access by motorized vehicles will* *continue to be restricted during the critical winter period per the Pokegama cooperative road closure.*

***1C. Flow Information**. Within one year of license issuance, the Licensee, in collaboration with the RSG and other interested parties, shall develop a plan to provide flow information for the JC Boyle Dewatered and Hell's Corner reaches. This plan will include the continuance of the Flow Phone and other outreach mediums to offer real-time flow projections and daily streamflow information. The information will include regularly scheduled project releases, geomorphic flows and natural spill events. The Licensee shall provide hourly flow information and projected 24 hour flow information to the public via a telephone hotline information service below each Project facility.*

***1D. Recreation Stakeholder Group**. Within 4 months of license issuance, the Licensee shall form a Recreation Stakeholder Group (RSG) to assist with the completion of the RRMP. The RSG shall be comprised of representatives from state and federal agencies, counties, Tribes, and other interested parties. Representatives from the state of Oregon shall include the Oregon Parks and Recreation Department and Oregon Department of Fish and Wildlife. Within one year of license issuance, the Licensee in collaboration with the RSG shall complete the RRMP.*

Issue and Rationale

Compliance with Management Direction, Administrative Rules and Wildlife Species Plans: ODFW's mission statement embodies goals for recreation objectives: protect and restore fish and wildlife and their habitats for present and future use by Oregonians. Therefore, ODFW statutes and policies are to further the mission to protect and restore fish and wildlife habitats so that the public may enjoy consumptive and non-consumptive uses of fish and wildlife populations. These include fishing, hunting, wildlife watching, photography, and more. Also, fish management basin and wildlife species plans have objectives to provide for use and enjoyment of fish and wildlife populations by providing public opportunity and access. Therefore, these recreation objectives for the Klamath basin fish and wildlife populations directly are mandated for our statutes to maintain and restore habitat.

The Klamath River between the JC Boyle Powerhouse and the Oregon-California state line (aka Hell's Corner or peaking reach) is designated an Oregon Scenic Waterway and federal Wild and Scenic River. The purposes of the Oregon Scenic Waterway Act and the Wild and Scenic Rivers Act are to protect and enhance those values that caused the waterway to be given such designations. The Klamath River special attributes (state values) are scenic, fish, wildlife, historic and recreation (specifically whitewater boating and fishing) resources. The outstandingly remarkable values (federal) are recreation (specifically whitewater boating and fishing), wildlife, fish, prehistoric, historic and scenic resources, and Native American traditional use.

Recreation Study Results: The angling recreation study conducted by the Licensee led to technically flawed results due to low sample sizes, misleading questions and false conclusions. The results disregard historical information that showed that the river, in the absence of the Project, was once a highly productive system with abundant trout populations and known for its large-sized trout, and produced the third largest salmon runs on the Pacific west coast. ODFW disagrees with conclusions of the recreation flow analysis, in which the existing condition of low flows in different segments of the Klamath River are considered the optimum flow range for recreational angling. The flow evaluation curves incorrectly conclude that lower flows tend to provide the best quality fishing conditions since it provides better wading access, lower velocities in different habitats, and less turbulence in the rapids. The analysis of flow duration curves is based on average daily flows which lead to misleading conclusions on impacts of flow fluctuations to angling use.

The FLA generally describes optimum fishing in different reaches of the Klamath River from Link River to Copco 2 as low flow conditions. The fundamental assumption is that the best condition for angling is when conditions are the most favorable for wading under existing peaking and flow fluctuation conditions. In addition, a very low number of anglers were interviewed for each reach with a total of 17 interviewees for fishing on all upper reaches of the river above Iron Gate Dam. These ranged from 4 to 8 total anglers for each flow per reach. The interviewees were not given the choice of angling under a river with restored flow but only the existing river with ongoing peaking and ramping impacts.

Abundance, size, and distribution of fish along with angler success are inextricably tied to quality, quantity and productivity of the habitat. Many of the anglers interviewed expressed valid concerns of separating out the biophysical characteristics of the river caused by Project operations from their ability to successfully fish the river. The historic character of the river was a highly productive river known for its large and abundant trout along with the third largest runs of anadromous fish on the Pacific coast. Therefore, a more natural river hydrograph along with better water quality conditions and fish passage would yield more abundant native fish populations and in turn lead to higher quality of fisheries.

The peaking and ramping operations along with other Project impacts such as reduced passage have reduced the productivity of the river, and in turn affected angler success and satisfaction over the long term. The Licensee's study relies on existing hydro Project conditions that have substantially reduced trout abundance, size and distribution. For example, anglers that were interviewed for their preference of fishing conditions in the Keno, dewatered and peaking reaches naturally preferred lower flows because fish are more concentrated and easier to catch in low flow conditions. However, lowered productivity has strongly affected anglers' ability to catch fish in what was once a highly productive system known for its large abundant trout populations (Fortune et al. 1966).

Since anglers were asked to characterize optimum angling conditions given existing Project conditions, without consideration for natural flow conditions, inappropriate flow evaluation curves were drawn for acceptable and optimum fishing conditions. These curves underestimate and recommend minimum flows for fishing well below the natural flows of the river. For example, the Link River flow evaluation curve for fishing with optimum flows is 100 to 1,500 cfs with best flows at the lower end. The Licensee's report states that minimum flows in the Link River dewatered have been higher than 90 cfs even in the driest period and are often in the 250 cfs to 600 cfs range from May through December, and therefore concludes that the power diversion effects are beneficial because the Project generally prevents higher flows that would be caused by the additional flow of 1,450 from the Eastside canal. The 1,450 cfs diversion is higher than the allocated take of water for the Eastside diversion and may be in violation of the certificated water right for the diversion. Additionally, ODFW biologists have frequently observed flows in the dewatered reach of less than 50 cfs.

Operation of the JC Boyle Powerhouse process limits the opportunity for a good angling experience on the Klamath River (Bill Tinniswood, ODFW fish biologist, pers. comm.). Under a normal peaking operation (one turbine) during the summer angling is good for about two hours in the very early morning (6 am to 8 am and occasionally in the late evening (8 pm). Angling is poor during the drastic increase in river flow during the day with a catch per unit effort of almost zero fish per hour (ODFW 2003). Use by anglers on the Klamath River below JC Boyle Powerhouse has been drastically reduced due to the fact that good angling is only experienced during a very short time period.

Public Access: Developed recreation in Oregon includes an access trail along the Westside of the Link River, a PacifiCorp park and camping facility located near Keno Dam, and BLM access sites along the JC Boyle Peaking reach. More recreational sites such as camping and boating are found at Copco and Iron Gate reservoirs.

The recreation use in the Link River reach is limited and is primarily angling, with some whitewater kayaking below the powerhouse tailraces. The recreation use in the Keno and JC Boyle Dewatered reaches are primarily angling with limited amounts of whitewater boating. Hunters also use the area. The recreation use in the JC Boyle Peaking Reach is dominated by commercial whitewater rafting that has effectively used the peaking flows to provide a whitewater journey down the Klamath River from the Spring Input to Copco Reservoir. Angling also occurs at some BLM access points such as the Frain Ranch and Stateline, and is more popular in the California segment where gradient is more moderate and peaking is attenuated with distance from JC Boyle Powerhouse. Impoundments created by the Project including JC Boyle, Copco and Iron Gate are accessible to the public and used primarily for flat water recreation such as boating, angling, waterfowl hunting, and swimming.

A telephone hotline service should be provided to the pubic to provide current and projected 24 flow information below each Project facility. Anglers and boaters should have readily available access to current flow information to determine optimal and safe conditions for recreational activities.

Literature Cited

Addley, R. C., B. Bradford and J. Ludlow. 2005. Klamath River Bioenergetics Report (Prepared for PacifiCorp). Logan, UT, Institute for Natural Systems Engineering, Utah Water Research Lab, Utah State University**:** 116 pp.

Anglin, D.R., S. L. Haeseker, J.J. Skalicky, H. Schaller, and 7 other authors. 2005. Effects of hydropower operations on spawning habitat, rearing habitat, and stranding/entrapment mortality of fall Chinook salmon in the Hanford reach of the Columbia River. 163 pp.

Annear, T., I. Chisholm, H. Beecher, A. Locke, and 12 other authors. 2004. Instream flows for riverine resource stewardship, revised edition. Instream Flow Council, Cheyenne, WY.

Avian Power Line Interaction Committee (APLIC). 1996. Suggested practices for raptor protection on power lines: the state of the art in 1996. Edison Electric Institute/Raptor Research Foundation, Washington, D.C.

APLIC. 2005. Avian Protection Plan (APP) Guidelines". Prepared by the Edison Electric Institute's Avian Power Line Interaction Committee (APLIC) and the U.S. Fish and Wildlife Service. April 2005.

Bain, M.B., J.T. Finn and H.E. Booke. 1988. Streamflow regulation and fish community structure. Ecology 69:382-392.

Behnke, R.J. 1992. Native Trout of Western North America. American Fisheries Society Monograph 6. 275 pp.

Belchik, M. 1997. Summer Locations and Salmonid Use of Cool Water Areas in the Klamath River - Iron Gate Dam to Seiad Creek, 1996. Klamath, CA, Yurok Tribal Fisheries Program. Funded by National Biological Service Cooperative Agreement**:** 1-13.

Belchik, M. 2003. Use of Thermal Refugial Areas on the Klamath River by juvenile salmonids: summer 1998, Yurok Tribal Fisheries Program**:** 36 pp.

Blackett, R.F. 1981. Establishment of Sockeye (*Oncorhynchus nerka*) and Chinook (*O. tshawytscha*) Salmon Runs at Frazer Lake, Kodiak Island, Alaska. Propagation, Enhancement, and Rehabilitation of Anadromous Salmonid Populations and Habitat Symposium, Arcata, CA.

Bowen, Z.H., K.D. Bovee, and T.J. Waddle. 2003. Effects of Flow Regulation on Shallow-Water Habitat Dynamics and Floodplain Connectivity. Transactions of the American Fisheries Society. Vol. 132, pages 809-823.

Bowen, Z.H., M.C. Freeman, and K.D. Bovee. 1998. Evaluation of generalized habitat criteria for assessing impacts of regulated flow regimes on warmwater fishes. Transactions of the American Fisheries Society 127:455-468.

Bryant, M. D., B. J. Frenette and S. J. McCurdy 1999. Colonization of a Watershed by Anadromous Salmonids Following the Installation of a Fish Ladder in Margaret Creek, Southeast Alaska. North American Journal of Fisheries Management 19: 1129-1136.

Buchanan, D. V., A.R. Hemmingsen, D.L. Bottom, P.J. Howell, R.A. French and K.P. Currens. 1990. Annual Progress Report Fish Research Project Oregon - Native trout project, Oregon Department of Fish and Wildlife.

Buchanan, D.V., A.R. Hemmingsen, D.L. Bottom, P.J. Howell, R.A. French and K.P. Currens. 1991. Annual Progress Report Fish Research Project Oregon - Native Trout Project - October 1990-September 1991. Portland, OR, Oregon Department of Fish and Wildlife.

Buchanan, D.V., A.R. Hemmingsen and K.P. Currens. 1994. Annual Progress Report - Fish Research Project Oregon - Native Trout Project - 1 October 1993 to 30 September 1994. Portland, OR, Oregon Department of fish and Wildlife**:** 36 pages.

Cada, G. F. 2001. The development of advanced hydroelectric turbines to improve fish passage survival. Fisheries 26(9):14-23.

California Energy Commission. 2003. Preliminary assessment of energy issues associated with the Klamath Hydroelectric Project. California Energy Commission Report. Prepared for the California Resources Agency and State Water Resources Control Board.

California Department of Fish and Game. 2004. September 2002 Klamath River Fish-Kill: Final Analysis of Contributing Factors and Impacts. Northern California-North Coast Region.

CH2MHill. 2003. Klamath Hydroelectric Project J.C. Boyle fish passage facilities. Draft Technical Memorandum No. 6. CH2MHill, prepared by Bob Gatton. 12 pp.

Chapman, D. W. 1981. Pristine Production of Anadromous Salmonids - Klamath River. Portland, OR, USDI Bureau of Indian Affairs**:** 1-57.

City of Klamath Falls (RMI). 1986. Application for license, Salt Caves Hydroelectric Project, FERC No. 10199. Submitted to the Federal Energy Regulatory Commission by the City of Klamath Falls.

City of Klamath Falls. 1987. Shortnose and Lost River Sucker Studies CopCo Reservoir and the Klamath River. Prepared by BEAK Consultants Incorporated. Portland, Oregon.

City of Klamath Falls. 1990. Application for License Salt Caves Hydroelectric Project No. 10199. Submitted to the Federal Energy Regulatory Commission. Response to License Additional Information Request Dated December 27, 1989.

Collier, M., R.H. Webb, and J.C. Schmidt. 1996. Dams and Rivers: A primer on the downstream effects of dam. USGS. Circular 1126. Tucson, AZ. 94 pp.

Cushman, R.M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5:330-339.

Deas, M. 2003. Klamath River Water Quality Studies. Watercourse Engineering, Inc. Powerpoint presentation to Water Quality Group stakeholders, September 9, 2003.

Deas, M. 2004. Klamath River Water Quality Analysis; Link Dam to the Pacific Ocean. Watercourse Engineering, Inc. Powerpoint presentation to Water Quality Group stakeholders, March 4, 2004.

Dynesius, M. and C. Nilsson. 1994. Fragmentation and Flow Regulation of River Systems in the Northern Third World. Science 266(5186): pp. 753-762.

Electric Power Research Institute (EPRI). 1987. Turbine-Related Fish Mortality: Review and Evaluation of Studies. Portland, OR, prepared by Eicher Associates Inc. 196 pp.

Environmental Protection Agency. 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards.

Estes, C. C. 1984. Evaluation of Methods for Recommending Instream Flows to Support Spawning Salmon, Washington State University., Pullman, WA.

Estes, C. C. 1998. Annual Summary of Instream Flow Reservations and Protection in Alaska. Anchorage, Alaska, Alaska Department of Fish and Game. 56 pp.

Federal Energy Regulatory Commission (FERC). 1990. Final Environmental Impact Statement - Main Text - Salt Caves Hydroelectric Project (FERC 10199-000). Washington, D. C., Federal Energy Regulatory Commission. 1:1-322.

Fishpro. 2000. Fish passage conditions on the Upper Klamath River. Submitted to the Karuk Tribe and PacifiCorp. Port Orchard, WA.

Foott, J.S., J.D. Williamson, and K.C. True. 1999. Health, physiology, and migration characteristics of Iron Gate Hatcher Chinook, 1995 releases. FY95 Investigational Report. U.S. Fish and Wildlife Service, California-Nevada Fish Health Center. Anderson, CA. 53pp.

Foott, J.S., T. Martinez, R. Harmon, K. True, B. McCasland, C. Glase and R. Engle. 2002. Juvenile Chinook health monitoring in the Trinity River, Klamath River and estuary, June – August 2001. FY2001 Investigational Report. U.S. Fish and Wildlife Service, California-Nevada Fish Health Center. Anderson, CA. 36pp.

Foott, J.S., R. Harmon, R. Stone. 2003. Ceratomyxosis resistance in juvenile Chinook salmon and steelhead trout from the Klamath River FY2002 Investigational Report. U.S. Fish and Wildlife Service, California-Nevada Fish Health Center. Anderson, CA. 25pp.

Fortune, J.D., A.R. Gerlach, and C.J. Hanel. 1966. A study to determine the feasibility of establishing salmon and steelhead in the upper Klamath basin. Oregon State Game Commission and Pacific Power and Light Company.

Fredd, L. 1991. Direct testimony of Louis Fredd. Oregon Department of Fish and Wildlife. Proposed Salt Caves Hydroelectric Project.

Freeman, M.C., Z.H. Bowen, K.D. Bovee, and E.R. Irwin. 2001. Flow and habitat effects on juvenile fish abundance in natural and altered flow regimes. Ecological Applications 11:179-190.

Gatton, B. 2003. Klamath Hydroelectric Project: Keno fish passage facilities. Technical Memorandum No. 5. CH2MHill. Prepared for PacifiCorp. 4 pp.

Gorman, O. T. and J. R. Karr. 1978. Habitat Structure and Stream Fish Communities. Ecology 59(3): 507-515 pp.

Gutermuth, B., C. Watson, and J. Kelly. 2000. Link River hydroelectric Project (Eastside and Westside powerhouses) final entrainment report, March 1997 – October 1999. Cell Tech Research and Development and PacifiCorp. Portland, OR. 127 pp.

Healey, M. C. 1991. Life History of Chinook Salmon (*Oncorhynchus tshawytscha*) in C. Groot and L. Margolis, Eds. Pacific Salmon Life Histories. Vancouver, University of British Columbia Press.

Hecht, B., and G. R. Kamman. 1996. Initial Assessment of Pre- and Post-Klamath Project Hydrology on the Klamath River and Impacts of the Project on Instream Flows and Fishery Habitat. Balance Hydrologics., Inc. March.

Hamilton, J.B., G.L. Curtis, S.M. Snedaker and D.W. White. 2005. Distribution of anadromous fishes in the upper Klamath River watershed prior to hydropower dams – a synthesis of the historical evidence. Fisheries 30(4):34 pp.

Hanel, J. and A. R. Gerlach. 1964. Klamath River flow study at JC Boyle project. Portland, OR, Pacific Power and Light Company**:** 1-68.

Hardy, T. 1999. Evaluation of Interim Instream Flow Needs in the Klamath River - Phase I. Logan, Utah, Institute for Natural Systems Engineering, Utah State University**:** 1-200.

Hardy, T.B., and R.C. Addley. 2001. Evaluation of interim instream flow needs in the Klamath River. Phase II. Final Report. Prepared for the U.S. Department of Interior. November 21, 2001.

Hemmingsen, A.R. 1997. Klamath River Hydro Issues, Oregon Department of Fish and Wildlife Memorandum. 23 pages.

Hemmingsen, A.R., D.V. Buchanan, D.L. Bottom, R.A. French, K.P. Currens, and F.C. Shrier. 1988. Native Trout Project. Oregon Department of Fish and Wildlife. Fish Research Project F-136-R, Annual Progress Report, Portland, Oregon.

Hemmingsen, A. R., R. A. French, D. V. Buchanan, D. L. Bottom and K. P. Currens. 1992. Annual Progress Report Fish Research Project Oregon - Native Trout Project. Portland, OR, Oregon Department of Fish and Wildlife. 14 pages.

Hesse, L.W. and W. Sheets. 1993. The Missouri River hydrosystem. Fisheries 18(5):5–14.

Hill, M.T., W.S. Platts, and R.L. Beschta. 1991. Ecological and geomorphological concepts for instream and out-of-channel flow requirements. Rivers 2(3):198-210.

Hokanson, K. E. F., C. F. Kleiner and T. W. Thorslund. 1977. Effects of constant Temperatures and Diel Temperature Fluctuations on Specific Growth and Mortality Rates and Yield of Juvenile Rainbow Trout. J. Fish. Res. Board. Can. 34: pp. 639-648.

Hunter, M.A. 1992. Hydropower flow fluctuations and salmonids: A review of the biological effects, mechanical causes, and options fro mitigation. State of Washington Department of Fisheries, Technical Report No. 119. Olympia, Washington. 46 pp.

Huntington, C.W. 2004. Klamath River flows within the JC Boyle bypass and below the JC Boyle powerhouse. Chiloquin, Oregon. Prepared for the Klamath Tribes. Technical Memorandum. Clearwater Biostudies Inc.22pp.

Huntington, C.W. 2004. Preliminary estimates of the recent and historic potential for anadromous fish production in the Klamath River above Iron Gate Dam. Chiloquin, Oregon. Prepared for the Klamath Tribes. Technical Memorandum. Clearwater Biostudies Inc. 11pp.

Huntington, C.W. 2006. Estimates of anadromous fish runs above the site of Iron Gate Dam. Chiloquin, Oregon. Prepared for the Klamath Tribes. 5pp.

Institute For Natural Systems Engineering (INSE). 1999. Evaluation of interim instream flow needs in the Klamath River: Phase I final report. Prepared for the Department of Interior. 53 p. plus appendixes.

Johnson, W. C. 1992. Dams and Riparian Forests: Case Study from the Upper Missouri River. Rivers 3(4): 229-242 pp.

Junk, W. J., P. B. Bayley and R. E. Sparks. 1989. The Flood Pulse Concept in River-Floodplain Systems. Canadian Special Publication in Fisheries and Aquatic Sciences 106: 110-127 pp.

Kaley, K. B. 2005. Comments on the Cyanobacterial/Microcystin toxin summer 2005 water sampling results for the Copco/Irongate reservoir. September 1, 2005 memorandum from Karen Black Kaley to Matt St. John, NCRWQCB.

Kann, J. 2005a. Copco/Irongate Reservoir Toxic Cyanobacteria Results: Follow-up, memorandum dated August 19, 2005 from Jacob Kann, Aquatic Ecosystem Sciences, LLC to the Karuk Tribe/SWRCB/NCRWQCB

Kann, J. 2005b. Klamath River Below Irongate Reservoir: Toxigenic Cyanobacteria Results, memorandum dated September 1, 2005 from Jacob Kann, Aquatic Ecosystem Sciences, LLC to the Karuk Tribe/SWRCB/NCRWQCB.

Kauffman, J. B., R.L. Beschta, N. Otting, and D. Lytjen. 1997. An ecological perspective of riparian and stream restoration in the western United States. Fisheries 22(5):12-24.

Klamath Fish Health Assessment Team. 2005. Klamath River Basin Fish Kill Response Plan**:** 17 pp.

Lane and Lane Associates. 1981. The Copco Dams and the fisheries of the Klamath Tribe. Portland, OR, USDI Bureau of Indian Affairs.

Lillehammer, A. E. and S. J. E. Saltveit. 1984. Regulated Rivers. Oslo, Norway, Universitetsforlaget AS.

McCracken, J. 2002. Secretary Norton announces water releases in Klamath River. Washington, DC, U.S. Department of the Interior**:** 2 pp.

McKinney, T., R. S. Rogers and W. R. Persons. 1999. Effects of Flow Reductions on Aquatic Biota of the Colorado River Below Glen Canyon Dam, Arizona. North American Journal of Fisheries Management 19: 984-991 pp.

Mitsch, W. J. and J. G. Gosselink. 1993. Wetlands. New York, NY, John Wiley & Sons, Inc.

Moyle, P.B. and J.J. Cech Jr. 2000. Fishes: an introduction to ichthyology. 4th ed., Prentice Hall.

Muir, W. D., S. G. Smith, J. G. Williams and B. P. Sanford. 2001. Survival of Juvenile Salmonids Passing Through Bypass Systems, Turbines, and Spillways with and without Flow Deflectors at Snake River Dams. North American Journal of Fisheries Management 21:135-146 pp.

National Marine Fisheries Service. 1997. Fish Screening Criteria for Anadromous Salmonids, National Marine Fisheries Service, Southwest Region**:** 10 pages.

National Marine Fisheries Service. 2002. Biological Opinion Klamath Project Operations. Silver Springs, Maryland.

National Marine Fisheries Service. 2003. Anadromous Salmonid Passage Facility Guidelines and Criteria. Portland, Oregon, National Marine Fisheries Service Northwest Region**:** 1-89.

National Research Council. 1992. Restoration of Aquatic Ecosystems - Science, Technology, and Public Policy. Washington, DC, National Academy Press.

National Research Council. 1996. Upstream: Salmon and Society in the Pacific Northwest. Washington, D.C., National Academy Press.

National Research Council. 2003. Endangered and Threatened Fishes in the Klamath Basin. Causes for Decline and Strategies for Recovery. The National Academy Press. Washington D.C.

Nehring, R.B. and R. M. Anderson. 1993. Determination of population-limiting critical salmonid habitats in Colorado streams using Physical Habitat Simulation System. Rivers 4:1-19.

Nichols, K. and J.S. Foott. 2005. Health monitoring of juvenile Klamath River Chinook salmon. FY 2004 Investigational Report. U.S. Fish and Wildlife Service, California-Nevada Fish Health Center, Anderson, CA. 16pp.

Oregon Department of Environmental Quality (ODEQ). November 2003. Figure 180A: Fish Use Designations, Klamath Basin, Oregon. http://www.deq.state.or.us/wq/standards/FishUseMapsFinal/FFigure180A_Klamath.pdf

Oregon Department of Fish & Wildlife. 1997. Klamath River Basin, Oregon fish management plan. Fish Division. Portland, OR. 186 pp.

Oregon Department of Fish and Wildlife. 2001. Letter to PacifiCorp RE: FERC 2082 - Klamath Hydro Project Comments on the First Stage Consultation Document. PacifiCorp. Portland, OR.

Oregon Department of Fish and Wildlife. 2003. Klamath River Redband Trout Investigations. Klamath Falls, OR, Oregon Department of Fish and Wildlife. 19 pp.

Oregon Department of Fish and Wildlife. 2004. Klamath River Redband Trout Investigations. Klamath Falls, Oregon Department of Fish and Wildlife. 10pp.

Oregon Department of Fish and Wildlife. 2006. Oregon Administrative Rules - Division 412, Fish Passage. 14 pp.

Oregon Department of Fish and Wildlife. 2006. Effects of impoundments and hydroelectric facilities on the life history of redband trout in the Upper Klamath River: a summary and synthesis of past and recent studies.

Oregon Department of Fish and Wildlife, Draft Report. Oregon Department of Fish and Wildlife Research. Corvallis, OR. 24pp.

PacifiCorp. 1997. Final Report of Fish Trapping Activities at the Klamath Hydroelectric Project in 1988-1991. Portland, OR, PacifiCorp. 26 pages.

PacifiCorp. 2003. Draft license application for new license for major project. FERC Project No. 2082. PacifiCorp. Portland, Oregon.

PacifiCorp. 2003. Draft water resources technical report. Draft license application for new license for major project. PacifiCorp. Portland, Oregon.

PacifiCorp. 2003. Klamath Hydroelectric Project Fish Salvage Information for JC Boyle. Klamath Relicensing Document and XLS Chart and Spreadsheet data Prepared for Aquatic Working Group Meeting – February 2003.

PacifiCorp. 2004. Final License Application for new license for major project. FERC Project No. 2082. PacifiCorp. Portland, Oregon.

PacifiCorp. 2004. Exhibit E. Final License Application for new license for major project. PacifiCorp. Portland, Oregon.

PacifiCorp. 2004. Fish resources final technical report. Final License Application for new license for major project. PacifiCorp. Portland, Oregon.

PacifiCorp. 2004. Water resources final technical report. Draft application for new license for major project. PacifiCorp. Portland, Oregon.

Petts, G. E. 1984. Page 196 in <u>Impounded Rivers</u>. Chinchester, UK, John Wiley and Sons.

Poff, N. L. and J. D. Allan. 1995. Functional Organization of Stream Fish Assemblages in Relation to Hydrological Variability. Ecology 76(2): 607-627 pp.

Poff, N. L., J. D. Allan, M. B. Bain, J. R. Karr, K. L. Prestegaard, B. D. Richter, R. E. Sparks and J. C. Stromberg (1997). The Natural Flow Regime - A Paradigm for River Conservation and Restoration. BioScience 47(1): 769-784.

Poff, N. L. and J. V. Ward. 1990. Physical Habitat Template of Lotic Systems: Recovery in the Context of Historical Pattern of Spatiotemporal Heterogeneity. Environmental Management 14(5): 629-645 pp.

Richter, B.D., J.V. Baumgartner, R. Wigington, and D.P. Braun. 1997. How much water does a river need? Freshwater Biology. 37: 231-249.

Rodnick, K. J., A. K. Gamperl, K. R. Lizars, M. T. Bennett, R. N. Rausch and E. R. Keeley 2004. Thermal tolerance and metabolic physiology among redband trout populations in south-eastern Oregon. Journal of Fish Biology 64: 310-335.

Roni, P., T. J. Beechie, R. E. Bilby, F. E. Leonetti, M. M. Pollock and G. R. Ress. 2002. "A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds." North American Journal of Fisheries Management 22:1-20.

Scott, M. L., M. A. Wondzell and G. T. Auble. 1993. Hydrograph characteristics relevant to the establishment and growth of western riparian vegetation. Proceedings of the American Geophysical Union 13th Annual Hydrology Days, Ft. Collins, CO.

Sletteland, T.B. 1995. Letter to Michael J. Ryan (Reclamation), and enclosure titled "Events Leading to the Construction of Iron Gate Dam and the Basis for Minimum Flow Releases to the Klamath River."

Sparks, R. E. 1992. Risks of Altering the Hydrologic Regime of Large Rivers. Advances in Modern Environmental Toxicology 20.

Stanford, J. A. 1994. Instream Flows to Assist the Recovery of Endangered Fishes of the Upper Colorado River Basin. Washington, DC, U.S. National Biological Survey**:** 47 pp.

Stanford, J. A. and J. V. Ward. 1979. Stream Regulation in North America. The Ecology of Regulated Streams. J. A. Stanford and J. V. Ward, Plenum Press**:** 215-236 pgs.

Stanford, J.A., J.V. Ward, W.J. Liss, C.A. Frissell, R.N. Williams, J.A. Lichatowich, and C.C. Coutant. 1996. A General Protocol for Restoration of Regulated Rivers. Regulated Rivers; Research & Management, Vol. 12. Pp. 391-413.

State of Oregon. 2003. Comments on PacifiCorp's Draft License Application for the Klamath Hydroelectric Complex, FERC 2082. Comments of Oregon Water Resources Department, Oregon Department of Environmental Quality, Oregon Department of Fish and Wildlife, and Oregon Public Utility Commission. Letter to Todd Olson and Toby Freeman, PacifiCorp dated September 17, 2003. Salem, Oregon.

Stocking, R. W. and J. L. Bartholomew. 2004. Assessing links between water quality, river health and Ceratomyxosis of salmonids in the Klamath River system, Dept. of Microbiology, Oregon State University**:** file memorandum, 4 pages.

Strange, J. S. 2005. Adult Chinook Migration in the Klamath River Basin: 2003 Radio Telemetry Study Final Progress Report, Yurok Tribal Fisheries Program; School of Aquatic and Fishery Sciences - University of Washington**:** 61 pages.

Tennant, D.L. 1976a. Instream flow regimens for fish, wildlife, recreation and related environmental resources. Fisheries 1(4):6-10.

Tennant, D.L. 1976b. Instream flow regimes for fish, wildlife, recreation and related environmental resources. Pages 359-373 in J.F. Osborn and C.H. Allman, editors. Instream Flow Needs. Bethesda, MD: Special publication of the American Fisheries Society.

Tessmann, S. A. 1980. Environmental Assessment, Technical Appendix E. In: Environmental use sector reconnaissance elements of the western Dakotas region of South Dakota study. Brookings, SD: South Dakota State University, Water Resources Research Institute.

Trihey and Associates. 1996. Instream Flow Requirements for Tribal Trust Species in the Klamath River. Prepared on behalf of the Yurok Tribe. March. 43p.

Torgersen, C. E., D. M. Price, H. W. Li and B. A. McIntosh. 1999. Multiscale Thermal Refugia and Stream Habitat Associations of Chinook Salmon in Northeastern Oregon. Ecological Applications 9(1): 301-319.

United States Department of the Interior (USDI) Bureau of Land Management. 1999. Snorkeling observations in Jenny Creek. Unpublished. Ashland Resource Area.

USDI Bureau of Land Management. 2002. Instream Flow Analysis for the Bureau of Land Management Federal Reserved Water Right, Claim Number 376, for the Klamath Wild and Scenic River in Oregon, Bureau of Land Management**:** 1-92 with appendices.

USDI Bureau of Land Management. 2004. Bureau of Land Management's comments on PacifiCorp's "Spring Creek Water Quality Investigations" report for the Klamath hydroelectric project. Medford, Oregon. November, 2004. 20pp.

USDI Bureau of Reclamation. 2005. Natural Flow of the Upper Klamath River. Klamath Falls, OR**:** 79 pgs + Attachments A-H.

USDI Fish and Wildlife Service. 1996. Formal Consultation on PacifiCorp and the New Earth Corporation Operations, as Permitted by Bureau of

Reclamation, for the Lost River Sucker and Shortnose Sucker. Klamath Falls, OR, USDI Fish and Wildlife Service**:** 56 pages.

USDI Fish and Wildlife Service. 2002. Biological/Conference Opinion Regarding the Effects of Operation of the U. S. Bureau of Reclamation's Proposed 10-Year Operation Plan for the Klamath Project and its Effect on the Endangered Lost River Sucker (*Delistes Luxatus*) Endangered Shortnose Sucker (*Chasmistes brevirostris*) Threatened Bald Eagle (*Haliaeetus leucocephalus*) and Proposed Critical Habitat for the Lost River and Shortnose Suckers. Klamath Falls, OR, U. S. Department of the Interior**:** 1-204.

USDI Fish and Wildlife Service. 2003a. Klamath River Fish Die-off - September 2002 - Causative Factors of Mortality. Arcata, CA, USDI Fish and Wildlife Service**:** 1-115.

USDI Fish and Wildlife Service. 2003b. Klamath River Fish Die-off September 2002 - Report on Estimate of Mortality, USDI Fish and Wildlife Service**:** 1-28.

Wales, J.H. 1944. The Klamath River at Different Stages of Flow. California Department of Fish and Game. Inland Fisheries Branch. Administrative Report 44-25, dated November 13, 1944. 13p.

Ward, J. V. and J. A. Stanford. 1983. The Intermediate Disturbance Hypothesis: An Explanation for Biotic Diversity Patterns in Lotic Ecosystems. Ann Arbor Science: pp.347-356.

Ward, J. V. and J. A. Stanford. 1989. Riverine Ecosystems: The Influence of Man on Catchment Dynamics and Fish Ecology. Canadian Special Publication in Fisheries and Aquatic Sciences 106: 56-64 pp.

Weaver, C. R. 1963. Influence of water velocity upon orientation and performance of adult migrating salmonids." U. S. Fish and Wildlife Service Fishery Bulletin 63(1): 97-121.

Weaver, C. R., C. S. Thompson and E. Slatick. 1976. Fish Passage Research at the Fisheries-Engineering Research Laboratory May 1965 to September 1970, North Pacific Division, U. S. Army Corps of Engineers**:** 90 pages.

Weisberg, S. B., A. J. Janicki, J. Gerritsen and H. T. Wilson. 1990. Enhancement of benthic macroinvertebrates by minimum flow from a hydroelectric dam. Regulated Rivers: Research & Management 5: 265-277 pp.

Wertheimer R.H and A. F. Evans. 2005. Downstream Passage of Steelhead Kelts through Hydroelectric Dams on the Lower Snake and Columbia Rivers. Transactions of the American Fisheries Society 134:853–865.

Williamson, J.D. and J. S. Foott. 1998. Diagnostic evaluation of moribund juvenile salmonids in the Trinity and Klamath rivers (June – September 1998). FY98 Investigational Report. U.S. Fish and Wildlife Service, California-Nevada Fish Health Center, Anderson, CA. 49pp.

Wright, B. E., M. D. Bryant, P. E. Porter and B. J. Frenette. 1997. Assessment of Introduction of coho salmon into the Slippery Lake Drainage, 1988 through 1991. USDA Forest Service, PNW Research Station Aquatic/Land Interactions Research Program. Juneau, Alaska

Zoellick, B. W. 1999. Stream temperatures and the elevation distribution of redband trout in Southwestern Idaho. Great Basin Naturalist 59(2): 136-143.