4.4 Continued Operations with Fish Passage Alternative

4.4.1 Introduction

4.4.1.1 Alternative Description

In the Continued Operations with Fish Passage Alternative, the J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dam complexes would be relicensed by FERC for continued operations with changes to allow for upstream and downstream fish passage and updated flow requirements. More specifically, the Continued Operations with Fish Passage Alternative assumes mandatory conditions issued by the USFWS, NMFS, and BLM, and FERC staff for the relicensing of PacifiCorp's Klamath Hydroelectric Project described in the 2012 KHSA EIS/EIR *Fish Passage at Four Dams Alternative*[191]. The primary conditions under the Continued Operations with Fish Passage Alternative are:

- *Fishways Prescriptions* – volitional year-round upstream and downstream fish passage at J.C. Boyle, Copco No.1, Copco No. 2, and Iron Gate dams consistent with the prescriptions from the DOI and U.S. Department of Commerce imposed during the FERC relicensing process (FERC 2007) and upheld in a trial-type administrative hearing, and specific fishway facility design and construction details included in the KHSA 2012 EIS/EIR *Fish Passage at Four Dams Alternative*[191], including fishway (i.e., fish ladder and screens) installation for both upstream and downstream migrations at all four Lower Klamath Project dam complexes and barriers to prevent juvenile salmonid entrainment into turbines;
- *Changes to J.C. Boyle Operations* – at least 40 percent of J.C. Boyle Reservoir inflow to be released downstream through the J.C. Boyle Bypass to increase minimum flows in the Bypass Reach. The generation of peaking power at J.C. Boyle Power Plant would be limited to one day per week, as water supplies allow, with the weekly peaking power flows also being used for recreation (whitewater boating) flows. Power generation would be suspended and all inflow to J.C. Boyle Reservoir would be released down the Bypass Reach under a seasonal high flow event that would occur for seven full days in later winter/spring when inflows to J.C. Boyle first exceed 3,300 cfs (DOI 2007, NMFS 2007, FERC 2007); and
- *Changes to Copco No. 2 Operations* – increase in minimum flows for the Copco No. 2 Bypass Reach, with a release of 70 cfs or inflow, whichever is less, to the bypass reach. Inflow would be computed as a 3-day running average of flows at the J.C. Boyle Powerhouse gage added to the flow from Shovel Creek, as measured by a new gage (FERC 2007).

The following conditions under the Continued Operations with Fish Passage Alternative are modifications to the 2012 KHSA EIS/EIR *Fish Passage at Four Dams Alternative*:

- Flows specified in the NMFS and USFWS 2013 BiOp for the USBR Klamath Irrigation Project, which are currently being considered under reinitiated consultation (see also 3.1.6.1 *Klamath River Flows under the Klamath Irrigation Project's 2013 BiOp*);

[191] The KHSA 2012 EIS/EIR's *Section 2.4.5 Fish Passage at Four Dams Alternative* (included in Appendix U of this EIR) include fishway facility design and construction details beyond what are specifically required in the FERC prescriptions and that are based on designs of similar fishway facilities used at other hydroelectric facilities. The 2012 alternative is essentially the *Staff Alternative with Mandatory Conditions* in the 2007 FERC EIS (see 2007 FERC EIS Section 2.3.3).

- Court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam, which became required after February 2017 (U.S. District Court 2017) (see also Section 4.2.1.3 *Summary of Available Hydrology Information for the No Project Alternative*); and
- Design and implementation of a Reservoir Management Plan, as described in the 2014 water quality certification application for Klamath Hydroelectric Project operations.

This alternative does not make any assumptions about potential Oregon or California water quality certification conditions.

Additionally, this section includes a short discussion of differences in the potential impact of using fishways described in the 2012 KHSA EIS/EIR *Fish Passage at Four Dams Alternative* compared to passage using trap and haul. For such additional analysis, this EIR generally assumes that trap and haul would be as described by FERC (2007) and would consist of trapping adult upstream migrants downstream of Iron Gate Dam and releasing them in J.C. Boyle Reservoir. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir and released downstream of Iron Gate Dam. This alternative assumes that trap and haul, like fishways prescriptions, would cover anadromous (fall- and spring-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey) and resident (rainbow and redband trout, shortnose and Lost River suckers) fish passage, and includes implementing operation and maintenance plans and prescribing attraction flows for upstream migrants (DOI 2007).

The aforementioned flow-related measures would reduce overall power generation at the Lower Klamath Project dam development. This alternative assumes that installation of fish passage facilities would follow the schedule prescribed in the FERC relicensing process, which would allow downstream facilities to be installed prior to upstream passage facilities. Although the duration of construction for any individual facility would range from approximately four months to one year (Table 4.4-1), the entire process of installing fish passage at each of the four Lower Klamath Project dams would take place over a four- to eight-year period (FERC 2007). The level of construction would be consistent with that estimated for development of the 2012 KHSA EIS/EIR *Fish Passage at Four Dams Alternative*. Fish ladder construction would include building upstream fish ladders, spillway modifications, tailrace barriers, screens, and bypass structures (see Appendix U of this EIR for more details) and would require work in wet conditions (i.e., in-water) in areas that cannot be dewatered or dried. Construction would include the use of heavy equipment, and blasting as necessary (e.g., removal of the existing J.C. Boyle fish ladder structure). Workforce estimates for the Continued Operations with Fish Passage Alternative are provided in Table 4.4-1 and are generally less than workforce estimates for the Proposed Project (Table 2.7-8).

Table 4.4-1. Workforce Projections for Continued Operations with Fish Passage Alternative.

Dam	Estimated Average Construction Workforce	Construction Duration
J.C. Boyle*	10 to 20 people	4 to 6 months
Copco No. 1	15 to 25 people	9 months
Copco No. 2	10 to 20 people	4 to 6 months
Iron Gate	15 to 30 people	12 months

* J.C. Boyle Dam is included in this analysis as some of the traffic flow may use roads in California (e.g., I-5 to OR 66)
Source: 2012 KHSA EIS/EIR (USBR and CDFW 2012)

If instead of fish ladders, trap and haul were used, there would be the potential for reduced construction compared to the aforementioned activities for fish ladders. While trap and haul facilities differ by site, common features include a trap holding pool, diffusers or gates to guide fish into the trap, a channel or port for discharge of attraction flows, a lift mechanism for truck-loading fish, a truck loading station, and a discharge platform. Much of the trap and haul facility would be located in-stream, with only the truck loading station and discharge platform potentially requiring upland grading or other earthwork. Although trap and haul construction activities would be limited to the same construction period described above for fish ladders, hauling operations (i.e., truck trips to move fish) would be ongoing.

Under Continued Operations with Fish Passage, no KHSA Interim Measures (IMs) would continue, although actions consistent with IMs designed for water quality improvements are analyzed in this alternative as part of the Reservoir Management Plan (Section 4.4.2 *Water Quality*). Additionally, the "California Klamath Restoration Fund/Coho Enhancement Fund" restoration actions, described under the No Project Alternative (see also Table 4.2-1), would continue.

Under this alternative, Iron Gate Hatchery would continue to target current annual production goals as described in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project – Fish Hatcheries*.

4.4.1.2 Alternative Analysis Approach

As for the Proposed Project, the potential impacts of the Continued Operations with Fish Passage Alternative are analyzed in comparison to existing conditions. Unless otherwise indicated, the significance criteria, area of analysis, environmental setting, and impact analysis approach, including consideration of existing local policies, for all environmental resource areas under the Continued Operations with Fish Passage Alternative are the same as those described for the Proposed Project (see Section 3.1 *Introduction* and individual resource area subsections in Section 3 *Environmental Setting, Potential Impacts, and Mitigation Measures*). The potential impacts for each environmental resource area are analyzed both in the short term and the long term, and unless otherwise indicated, use the same definitions of short term and long term as described for each resource area analyzed for the Proposed Project.

4.4.2 Water Quality

4.4.2.1 Water Temperature

In general, existing ongoing alterations to water temperatures caused by the reservoirs and by Lower Klamath Project operations (as described in Section 3.2.2.2 *Water Temperature*) would continue to occur under the Continued Operations with Fish Passage Alternative. Short-term and long-term potential impacts to water temperature due to implementation of the 2017 court-ordered flushing and emergency dilution flows under this alternative would be similar to the potential short-term impacts to water temperature described for the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-1). Flushing and emergency dilution releases could temporarily accentuate existing fall or spring shifts in water temperature that occur in the Middle Klamath River downstream of Iron Gate Dam, but this would be a less than significant impact on water temperatures since it would only promote the existing seasonal water temperature shift for the brief time period corresponding to the flow releases.

However, there are three actions under the Continued Operations with Fish Passage Alternative that would potentially modify water temperatures in the Klamath River and the Lower Klamath Project reservoirs relative to existing conditions in both the short term and long term: 1) increased minimum flows in the J.C. Boyle Bypass Reach and limited peaking operations at J.C. Boyle Powerhouse; 2) increased minimum flows for the Copco No. 2 Bypass Reach; 3) and implementation of a Reservoir Management Plan. These actions would alter water temperature relative to existing conditions in both the short term (0–5 years) and long term (5+ years). Changes to water temperature in the Klamath River and reservoirs from these three actions would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions and they are discussed below in Section 4.4.2 *Water Quality*, Potential Impact 4.2.2-1.

The 2007 FERC EIS found that PacifiCorp's proposal for relicensing of the Klamath Hydroelectric Project failed to address the project's water quality impairments within and downstream of the Hydroelectric Reach (FERC 2007). The Klamath River TMDLs later assigned water temperature and dissolved oxygen dual (i.e., co-occurring) load allocations to Copco No. 1 and Iron Gate reservoirs for the stratification period (May through October) to ensure compliance with the dissolved oxygen and water temperature targets (i.e., dissolved oxygen consistent with 85 percent saturation or better through September, and 90 percent or better in October [see also Table 3.2-5], and natural water temperatures, where natural baseline summer mean water temperature is approximately 18.7^{o}C) within the reservoirs and to ensure support of cold freshwater habitat (COLD), which is a designated beneficial use. The Klamath River TMDLs created a physical "compliance lens" where both dissolved oxygen and temperature conditions meet Basin Plan objectives in a layer of water stretching from the point of entry to the reservoirs throughout the reservoir (the depth of the compliance lens within the reservoir is not fixed) (North Coast Regional Board 2010). Since 2007, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including water temperature. Study results, including those under IM 11 (see Table 4.2-1), have indicated that while proposed reservoir management techniques can improve some of the project impacts to water quality (e.g., transport of nuisance and/or noxious blue-green algae downstream of Iron Gate Dam [Austin et al. 2016, PacifiCorp 2018]), the various techniques have not resulted in water quality improvements at Copco No. 1 or Iron Gate reservoirs that

create the TMDL compliance lens nor have they otherwise sufficiently improved Klamath Hydroelectric Project impacts to water temperature (PacifiCorp 2017, 2018). Results from testing of a powerhouse intake barrier/thermal curtain in Iron Gate Reservoir under IM 11 indicate that modest water temperature improvement is possible using this technique; Section 4.4.2 *Water Quality*, Potential Impact 4.2.2-1 below discusses these results.

As described under the Proposed Project (Potential Impact 3.2-1), in the long-term (5+ years), climate change models for the Klamath Basin suggest that as the western United States warms, air temperatures will increase, there will be a slight increase in overall precipitation, winter snowfall will likely shift to higher elevations, and snowpack will be diminished as more precipitation falls as rain (Oregon Climate Change Research Institute [OCCRI] 2010). Bartholow (2005) predicted that in the Klamath Basin as a whole, increasing air temperatures and decreasing flows in the summer months would be expected to cause general increases in summer and fall water temperatures on the order of 2–3°C (3.6–5.4°F). Long-term water temperature trends relevant to consideration of effects of the Continued Operations with Fish Passage Alternative are also discussed below.

For the Continued Operations with Fish Passage Alternative, there would be no sediment release due to removal of the Lower Klamath Project. Thus, there would be no sediment-related morphological changes in the Klamath River Estuary due to dam removal that would be likely to increase estuary water temperatures in a manner that would cause or substantially exacerbate an exceedance of water quality standards or would result in a failure to maintain existing beneficial uses currently supported (Potential Impact 3.2-2) and there would be no significant impact.

Potential Impact 4.2.2-1 Seasonal alterations in water temperature due to continued impoundment of water in the reservoirs.

Hydroelectric Reach

Under the Continued Operations with Fish Passage Alternative, J.C. Boyle Reservoir would remain in place but increased minimum flows in the J.C. Boyle Bypass Reach and limitation of peaking operations at J.C. Boyle Powerhouse would decrease the large daily water temperature range that occurs under existing conditions when warmer reservoir water is diverted around the Bypass Reach to produce power (Section 3.2.2.2 *Water Temperature*). Areas adjacent to the cold water springs in the Bypass Reach would continue to serve as thermal refugia for aquatic species because the springs themselves would not be affected by the Continued Operations with Fish Passage Alternative.

The primary decrease in daily and seasonal flow fluctuations relative to existing conditions would occur in the J.C. Boyle Bypass Reach in Oregon because flow fluctuations in the downstream J.C. Boyle Peaking Reach in California (i.e., from the Oregon-California state line to Copco No. 1 Reservoir) are attenuated with distance downstream due to tributary inputs and accretion flows. With the limitation of peaking operations under this alternative, the temperature effects downstream from J.C. Boyle are similar to those described by removal of the facility, as described in Proposed Project (Potential Impact 3.2-1 *Hydroelectric Reach*). Maximum water temperatures at the Oregon-California state line would be slightly lower and temperatures would be less artificially variable relative to existing conditions due to higher overall flows and lower

frequency of peaking operations at the J.C. Boyle Powerhouse (i.e., weekly peaking under this alternative as compared to daily peaking under existing conditions). The decrease in maximum daily water temperatures and temperature variability would be less than described under the Proposed Project, because there would still be peaking operations occurring one day per week in conjunction with recreational flows (see Section 4.4.1 *[Continued Operations with Fish Passage Alternative] Introduction*). Relative to existing conditions, the slight decreases in long-term maximum summer/fall water temperatures and less artificial diel temperature variation in the J.C. Boyle Peaking Reach would return the river to a more natural thermal regime, although the degree of benefit would be slightly lower than under the Proposed Project (Potential Impact 3.2-1). Elimination of the artificial temperature signal under existing conditions would better conform with the California Thermal Plan's prohibition on elevated temperature discharges (Table 3.2-4) and would be beneficial.

In the remainder of the Hydroelectric Reach (i.e., Copco No. 1 and Iron Gate reservoirs) water temperatures would be the same as those described under the existing condition (see Section 3.2.2.2 *Water Temperature*), where spring, summer, and fall water temperatures would continue to be influenced by the thermal mass of Copco No. 1 and Iron Gate reservoirs, and the seasonal stratification patterns of the two reservoirs. It is unclear what, if any, steps could reduce the impact of the reservoirs on the thermal regime within the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam and comply with the Thermal Plan's ban on elevated temperature discharges into COLD interstate waters (Table 3.2-4). Of the seven water quality improvement actions described in the Reservoir Management Plan[192], selective withdrawal and intake control is most focused on water temperature improvements. With respect to this approach, PacifiCorp has estimated that the maximum useable cool water volume in Copco No. 1 Reservoir in summer (approximately 3,100 acre-feet at less than 14°C and 4,800 acre-feet at less than 16°C) (PacifiCorp 2014b), which if selectively withdrawn from the reservoirs, would decrease water temperatures immediately downstream of Copco No. 1 Reservoir. It is currently unclear whether selective withdrawal from Copco No. 1 Reservoir alone would be sufficient to allow compliance with the Thermal Plan or to meet the Klamath TMDLs temperature requirement in the Hydroelectric Reach (see also below discussion in *Middle and Lower Klamath River and Klamath River Estuary*).

The increase in minimum flows in the Copco No. 2 Bypass Reach under this alternative would be expected to result in decreases in maximum summer/fall water temperatures and less artificial diel temperature variation than under existing conditions, returning the river to a more natural thermal regime, although the degree of benefit would be slightly lower than under the Proposed Project (Potential Impact 3.2-1). As for the J.C. Boyle Peaking Reach, elimination of any artificial temperature signal in the Copco No. 2 Bypass Reach under existing conditions would better conform with the California

[192] Water quality management techniques in the Reservoir Management Plan (PacifiCorp 2014b) for application in Copco No. 1 and Iron Gate reservoirs include the following techniques to control nutrients, algae, dissolved oxygen and pH: (1) constructed wetlands conceptual design and implementation planning; (2) further evaluation of tailrace aeration and oxygenation systems; (3) design and implementation planning of in-reservoir oxygenation systems; (4) evaluation of epilimnion (surface water) mixing and circulation; (5) further evaluation of selective withdrawal and intake control; (6) modeling and testing of deeper seasonal drawdown and fluctuation of the reservoirs; and (7) additional testing and controlled applications of SCP algaecide to treat localized areas (e.g., coves, embayments) in the reservoirs.

Thermal Plan's prohibition on elevated temperature discharges (Table 3.2-4) and would be beneficial.

As described under the Proposed Project (Potential Impact 3.2-1), for part of the Klamath Dam Removal Secretarial Determination studies, the effects of climate change were included in model projections for long-term water temperatures, including model runs assuming that the Lower Klamath Project dams remain in place. RBM10 model results using climate change predictions from five global circulation models (GCMs) (see also Section 3.2.4.1 *Water Temperature* and Appendix D) indicate that future water temperatures would be 1–2.3°C (1.8–4.1°F) warmer than historical temperatures in the Klamath Basin (Perry et al. 2011). While this temperature range is slightly lower than that estimated by Bartholow (2005), within the general uncertainty of climate change projections, the two modeling efforts correspond reasonably well and indicate that water temperatures in the Hydroelectric Reach are expected to increase within a 50-year period on the order of 1–3°C (1.8–5.4°F). RBM10 model results also show that with dams remaining in place, the thermal lag associated with the Lower Klamath Project reservoirs would continue to result in decreased river temperatures in the spring and increased river temperatures in the late summer/fall in the Hydroelectric Reach (Perry et al. 2011; USBR 2016), consistent with the general trend under existing conditions (3.2.2.2 *Water Temperature*).

The anticipated increases in water temperatures due to climate change would occur over a timescale of decades and would act in opposition to improvements expected from actions taken in furtherance of TMDL implementation throughout the Upper Klamath Basin, such as increased riparian shading and decreased diversion from cold springs (ODEQ 2010). While full implementation of the Klamath TMDLs is anticipated to result in late summer/fall reductions in water temperature in the range of 2–10°C immediately downstream from Iron Gate Dam (North Coast Regional Board 2010), there is currently no reasonable proposal to achieve the temperature allocations in the Klamath TMDLs with the Lower Klamath Project dams remaining in place, despite the modest improvements exhibited through implementation of the Reservoir Management Plan during the past several years (PacifiCorp 2017, 2018). Thus, this EIR assumes that reasonably foreseeable late summer/fall water temperature improvements under the Continued Operations with Fish Passage Alternative would be on the lower end of the 2–10°C range, such that any improvements in late summer/fall water temperatures due to partial TMDL implementation would be completely offset by climate change increases of 1–3°C, and overall, under the Continued Operations with Fish Passage Alternative, late summer/fall water temperature conditions would not move towards a condition that supports designated beneficial uses, including cold freshwater habitat (COLD), rare, threatened, or endangered species (RARE), and migration of aquatic organisms (MIGR) annually during late summer/early fall (North Coast Regional Board 2010).

In summary, continued impoundment of water in Copco No. 1 and Iron Gate reservoirs under the Continued Operations with Fish Passage Alternative would maintain existing adverse late summer/fall water temperatures in the Hydroelectric Reach downstream of Copco No. 1 Reservoir (Section 3.2.2.2 *Water Temperature*). There is currently no reasonable proposal to achieve the temperature allocations in the Klamath TMDLs with the Lower Klamath Project dams remaining in place, despite the modest improvements achieved to date through implementation of the Reservoir Management Plan. Further, long-term climate change-induced increases in water temperatures would partially offset any TMDL improvements. Overall, the Continued Operations with Fish Passage

Alternative would result in no change from existing adverse conditions in the Hydroelectric Reach and would continue to cause an exceedance of water quality standards as set forth in the Thermal Plan.

Middle and Lower Klamath River and Klamath River Estuary

The Continued Operations with Fish Passage Alternative would have similar effects on water temperature in the Middle and Lower Klamath River Estuary as those described under the existing condition (see Section 3.2.2.2 *Water Temperature*), where spring, summer, and fall water temperatures would continue to be influenced by the thermal mass of Copco No. 1 and Iron Gate reservoirs, and the seasonal stratification patterns of the two reservoirs. It is unclear what, if any, steps could reduce the impact of the reservoirs on the thermal regime within the Hydroelectric Reach between Copco No. 1 Reservoir and Iron Gate Dam and comply with the Thermal Plan's ban on elevated temperature discharges into COLD interstate waters (Table 3.2-4). As discussed above, short-term and long-term potential impacts on water temperature due to implementation of the 2017 court-ordered flushing and emergency dilution flows under this alternative would be similar to the potential short-term impacts on water temperature under the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-1). Flushing and emergency dilution releases could temporarily accentuate the existing fall or spring shifts in water temperature that occur in the Middle Klamath River downstream of Iron Gate Dam, but this would be a less than significant change to existing water temperatures since it would only promote the existing seasonal water temperature shift for the brief time period of the flow releases.

Of the seven water quality improvement actions described in the Reservoir Management Plan[192], selective withdrawal and intake control is most focused on water temperature improvements. PacifiCorp has estimated that the maximum useable cool water volume in Copco No. 1 Reservoir in summer (approximately 3,100 acre-feet at less than 14°C and 4,800 acre-feet at less than 16°C) and the maximum volume of cold water (8°C or less) in Iron Gate Reservoir in summer (8,000 to 10,000 acre-feet) could, if selectively withdrawn from the reservoirs, decrease water temperatures immediately downstream of Iron Gate Dam by 1 to 2°C for up to 1.5 months in late summer/early fall, with larger releases resulting in cooler water temperatures in the tailrace of the dam, but depleting the reservoir cool water pools more rapidly (PacifiCorp 2014). PacifiCorp has also noted that the water supply for Iron Gate Hatchery withdraws cold water from the deeper portion of Iron Gate reservoir, and depleting or exhausting this cold water pool during the summer would have effects on the hatchery that would need to be addressed (PacifiCorp 2014). In 2015, PacifiCorp installed a powerhouse intake barrier/thermal curtain in Iron Gate Reservoir under IM 11. One of the purposes of the curtain is to isolate warmer, less dense near-surface waters while withdrawing cooler, denser, and deeper waters from the reservoir for release to the Klamath River downstream (PacifiCorp 2018). The other purpose is to isolate surface waters that have high concentrations of blue-green algae (cyanobacteria) such that extensive summer and fall blooms are not readily released downstream to the Middle and Lower Klamath River (see further discussion in Potential Impact 4.2.2-4). Results from the intake barrier/thermal curtain indicate that modest 1–2°C (1.8–3.6°F) water temperature improvement is possible (PacifiCorp 2017), although data do not indicate that this measure could achieve compliance with the Thermal Plan or to meet the Klamath TMDLs temperature requirement in the Middle Klamath River (North Coast Regional Board (2010).

In the long term, the Klamath River TMDL model indicates that, absent climate change, as implementation of the TMDL progresses under a Continuing Operations with Fish Passage Alternative (the "TMDL dams-in" [T4BSRN] scenario), water temperatures from Iron Gate Dam (RM 193.1) to the Klamath River Estuary (RM 0−2) would improve towards modeled natural conditions (the "TMDL natural conditions" [T1BSR] scenario) (North Coast Regional Board 2010). However, some delayed warming of springtime water temperatures (February–March) and delayed cooling of late summer/fall (August–November) water temperatures would still occur under a dams-in scenario due to the large thermal mass of Copco No. 1 and Iron Gate reservoirs. With dams in-place, this temporal shift would continue to occur from downstream of Iron Gate Dam to approximately the confluence of the Salmon River (RM 66). This is because while full attainment of the Klamath River TMDLs would improve water temperature, the model is unable to demonstrate full temperature compliance in the spring and fall downstream from Iron Gate Dam to the Salmon River with the Lower Klamath Project complexes in place. The Klamath TMDL model also predicts that, with full implementation, reduced diel variation in water temperature downstream from Iron Gate Dam would continue to occur should the dams remain in place due to the thermal mass of the reservoirs. The magnitude of diel variation would increase with distance downstream from Iron Gate Dam as the river approaches equilibrium with ambient air temperatures (North Coast Regional Board 2010, Dunsmoor and Huntington 2006).

In the long term, climate change is expected to cause general increases in water temperatures. The historical data record indicates that mainstem water temperatures have increased, on average, approximately 0.05ºC (0.09ºF) per year between 1962 and 2001 (Bartholow 2005) such that climate change may already be affecting Klamath River water temperatures. Projecting the Bartholow (2005) estimate of an average annual temperature increase 50 years into the future, water temperatures would increase approximately 2–3°C (3.6–5.4°F). As part of the Klamath Dam Removal Secretarial Determination studies, the effects of climate change were included in model projections for future water temperatures under dams in and dams out scenarios. RBM10 model results using climate change predictions from five global circulation models (GCMs) indicate that future water temperatures in the Middle and Lower Klamath River under a scenario where the Lower Klamath Project dams remain in place (where simulated flows are subject to the 2010 Biological Opinion mandatory flow regime [NOAA Fisheries Service 2010]) would be 1–2.3°C (1.8–4.1 °F) warmer than historical temperatures at the end of the 50-year analysis period (Perry et al. 2011). While this temperature range is slightly lower than that suggested using the Bartholow (2005) historical estimates, within the general uncertainty of climate change projections, the two projections correspond reasonably well. Considering together the available sources for climate change predictions, annual average water temperatures in the Middle and Lower Klamath River are expected to increase within the period of analysis on the order of 1–3 °C (1.8–5.4 °F).

The anticipated increases in water temperatures due to climate change would also occur over a timescale of decades and would act in opposition to improvements expected from actions taken in furtherance of TMDL implementation in upstream reaches (see also discussion above in *Hydroelectric Reach*). While full implementation of the Klamath TMDLs is anticipated to result in late summer/fall reductions in water temperature in the range of 2–10ºC immediately downstream from Iron Gate Dam (North Coast Regional Board 2010), there is currently no reasonable proposal to achieve the temperature

allocations in the Klamath TMDLs with the Lower Klamath Project dams remaining in place.

In light of the ability of the thermal curtain/intake barrier to result in modest temperature improvements downstream of Iron Gate Dam during the past several years (PacifiCorp 2017, 2018), this analysis assumes that reasonably foreseeable late summer/fall water temperature improvements under the Continued Operations with Fish Passage Alternative would be on the lower end of the 2–10°C range. Any improvements in late summer/fall water temperatures due to partial TMDL implementation would be completely offset by climate change increases of 1–3°C, and overall, under the Continued Operations with Fish Passage Alternative, late summer/fall water temperature conditions would not move towards a condition that supports designated beneficial uses, including cold freshwater habitat (COLD), rare, threatened, or endangered species (RARE), and migration of aquatic organisms (MIGR) (North Coast Regional Board 2010) in the Middle Klamath River to approximately the confluence of the Salmon River.

In summary, continued impoundment of water in Copco No. 1 and Iron Gate reservoirs under the Continued Operations with Fish Passage Alternative would maintain existing adverse late summer/fall water temperatures in the Middle Klamath River from Iron Gate Dam to the Salmon River (Section 3.2.2.2 *Water Temperature*). There is currently no reasonable proposal to achieve the temperature allocations in the Klamath TMDLs with the Lower Klamath Project dams remaining in place, despite the modest improvements achieved to date through implementation of the Reservoir Management Plan (see discussion in Section 4.4.2 *Water Quality*, Potential Impact 4.2.2-1). Further, long-term climate change-induced increases in water temperatures would partially offset any TMDL improvements. Overall, the Continued Operations with Fish Passage Alternative would result in no significant change from existing adverse conditions in the Middle Klamath River from Iron Gate Dam to the Salmon River and would continue to cause an exceedance of water quality standards as set forth in the Thermal Plan.

Temperature effects of the dams do not extend downstream of the Salmon River confluence (see Section 3.2.2.2 *Water Temperature*). Therefore, there would be no change in the impact of the Continuing Operations with Fish Passage Alternative in the Middle and Lower Klamath River reaches downstream from the confluence with the Salmon River, including the Klamath River Estuary and the Pacific Ocean nearshore environment.

Significance

Beneficial in the short term and long term for the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir

No significant impact in the short term and long term for the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, the Middle Klamath River, the Lower Klamath River, the Klamath River Estuary, and the Pacific Ocean nearshore environment

4.4.2.2 Suspended Sediments

The Continued Operations with Fish Passage Alternative would not release sediments stored behind the Lower Klamath Project dams because this alternative would not remove the existing dams. Potential Impacts 3.2-3 and 3.2-4, as discussed under the Proposed Project, would not occur and there would be no significant impacts.

The Continued Operations with Fish Passage Alternative would result in no change from the existing condition with respect to interception and retention of mineral (inorganic) suspended material in the Lower Klamath Project reservoirs (Potential Impact 3.2-6), in either the short or the long term.

J.C. Boyle gravel placement and/or habitat enhancement (IM7) (Table 4.2-1) would not continue under the Continued Operations with Fish Passage Alternative. Thus, any incidental sediment release occurring under the existing condition as a result of this activity would cease. Because of construction management practices employed, this currently does not cause a meaningful degree of sedimentation in the river, and so ceasing this practice would be unlikely to cause a substantial benefit in reducing suspended sediments.

Nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions with respect to long-term seasonal increases in algal-derived (organic) suspended material due to algal blooms in the reservoirs. There are two exceptions to this general expectation. The first is that nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions. The second is that PacifiCorp intends to design and implement a Reservoir Management Plan. These differences are discussed under a new impact heading below (Potential Impact 4.2.2-2), along with consideration of flow changes under this alternative.

The Continued Operations with Fish Passage Alternative also includes 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam that would increase SSCs compared to existing conditions during these releases. Potential short-term and long-term impacts to suspended sediments under this alternative due to these flow releases would be the same as the potential short-term impacts discussed for the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-3) and there would be no significant impact.

Additionally, the Continued Operations with Fish Passage Alternative would include upstream and downstream fish passage construction at all four Lower Klamath Project dams over a four- to eight-year period, and potential impacts related to these construction activities are discussed under a new impact heading below (Potential Impact 4.4.2-1).

Potential Impact 4.2.2-2 Seasonal increases in algal-derived (organic) suspended material due to continued impoundment of water in the reservoirs.
The Continued Operations with Fish Passage Alternative would result in no change from existing conditions with respect to interception, decomposition, retention, and/or dilution[193] of algal-derived (organic) suspended material originating from Upper Klamath Lake (in Oregon) within J.C. Boyle Reservoir and the Hydroelectric Reach to Copco No. 1 Reservoir (Section 3.2.2.3 *Suspended Sediments* and Appendix C.2.1.1). With its shallow depth and short residence time, J.C. Boyle Reservoir does not provide suitable habitat for seasonal phytoplankton (including blue-green algae) blooms (Section 3.2.2.3 *Suspended Sediments* and Appendix C.2.1.1). Increased minimum flows in the J.C.

[193] Dilution from coldwater springs downstream of J.C. Boyle Dam.

Boyle Bypass Reach and limitation of peaking operations at J.C. Boyle Powerhouse under this alternative would not affect the ongoing mechanical breakdown of algal remains in the turbulent river reaches between J.C. Boyle and Copco No. 1 reservoirs or dilution by the coldwater springs located there. The breakdown and dilution of algal-derived (organic) suspended material in this portion of the Hydroelectric Reach is not an adverse existing condition and there would be no significant impact of the Continued Operations with Fish Passage Alternative on algal-derived (organic) suspended material in this reach.

However, the Continued Operations with Fish Passage Alternative would continue to result in the same adverse seasonal increases in algal-derived (organic) suspended material in Copco No. 1 and Iron Gate reservoirs as existing conditions, with subsequent release of suspended material to the Middle and Lower Klamath River, and eventually the Klamath River Estuary (Section 3.2.2.3 *Suspended Sediments*). Note that the increase in minimum flows for the Copco No. 2 Bypass Reach under this alternative could increase summertime algal-derived (organic) suspended material in the Bypass Reach relative to existing conditions if the water were to be withdrawn from the Copco No. 1 Reservoir surface waters during an intensive bloom period. However, there is no information indicating whether the water would be withdrawn from surface waters, and therefore this potential is too speculative to evaluate further.

The 2007 FERC EIS found that PacifiCorp's proposal for relicensing of the Klamath Hydroelectric Project failed to address the project's water quality impairments within and downstream of the Hydroelectric Reach (FERC 2007). Since 2007, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including large seasonal phytoplankton blooms. Of the seven water quality improvement actions described in the Reservoir Management Plan[192], surface water mixing and application of algaecides are focused on reduction of seasonal algae blooms in the reservoirs. Study results from physical mixing to reduce phytoplankton growth within Mirror Cove in Iron Gate Reservoir indicated that the combination of a barrier curtain, aeration, and pumping, reduced summertime phytoplankton growth in the localized area of the cove (Austin et al. 2016, PacifiCorp 2018). Treatment of blue-green algae blooms in Long Gulch Cove in Iron Gate Reservoir using a hydrogen-peroxide-based algaecide resulted in short-term reductions in phytoplankton and chlorophyll-*a* in the localized area of the cove; however, nutrient release following algaecide application may have supported a later season bloom (PacifiCorp 2013, 2014, 2015). In 2015, PacifiCorp installed a powerhouse intake barrier/thermal curtain in Iron Gate Reservoir under IM 11. One of the purposes of the curtain is to isolate surface waters that have high concentrations of blue-green algae (cyanobacteria) such that extensive summer and fall blooms are not readily released downstream to the Middle and Lower Klamath River (PacifiCorp 2018). The other purpose is to isolate warmer, less dense near-surface waters while withdrawing cooler, denser, and deeper waters from the reservoir for release to the Klamath River downstream (see further discussion in Section 4.4.2 *Water Quality*, Potential Impact 4.2.2-1). Results from the intake barrier/thermal curtain indicate that the curtain reduces entrainment of blue-green algae into the Iron Gate Powerhouse intake and subsequent release downstream into the Klamath River (PacifiCorp 2017), although data do not indicate that this measure could improve algal-derived (organic) suspended material in the reservoirs such that they would no longer cause an exceedance of water quality standards (Table 3.2-4) or achieve the Klamath TMDLs phytoplankton chlorophyll-*a*

target of 10 ug/L for Copco No.1 and Iron Gate reservoirs during the May to October growth season (North Coast Regional Board 2010).

Nutrient reduction measures in Oregon's Upper Klamath River and Lost River TMDLs could, over time, decrease algal-derived (organic) suspended material in Copco No.1 and Iron Gate reservoirs due to decreased nutrient availability. Similarly, nutrient reduction measures in California's Lower Lost River TMDLs and Klamath River TMDLs for organic enrichment/low dissolved oxygen, nutrients, and microcystin water quality impairments, could decrease algal-derived (organic) suspended material in Copco No.1 and Iron Gate reservoirs and could, in the long term, be beneficial to water quality. However, the measures necessary to achieve significant reductions are, at this point, unknown and reductions and subsequent effects on the Lower Klamath Project reservoirs are likely to require decades to achieve. Further, continuing seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs that subsequently die and settle to the bottom, would continue to build up nutrients and organic matter in the reservoir sediments. This layer of nutrients would continue to be recycled into the water column (through internal nutrient loading, see Figure 3.2-2) during periods of stratification and low dissolved oxygen and would continue to stimulate large seasonal phytoplankton blooms in the reservoirs that are then released to the Middle and Lower Klamath River. Warmer water temperatures under climate change (Perry et al. 2011, Bartholow 2005; see discussion in Section 4.4.2 *Water Quality*, Potential Impact 4.2.2-1) would further exacerbate increases in algal-derived suspended material under the Continued Operations with Fish Passage Alternative through earlier reservoir water column stratification in the spring, which provides more favorable conditions for the growth of blue-green algae.

Overall, despite the modest improvements achieved to date for localized reductions in seasonal phytoplankton blooms within Iron Gate Reservoir and reduced release of blue-green algae blooms downstream into the Klamath River, there is currently no reasonable proposal to achieve the Klamath TMDLs phytoplankton chlorophyll-*a* target of 10 ug/L for the Lower Klamath Project Reservoirs during the May to October growth season (North Coast Regional Board 2010). Overall, the Continued Operations with Fish Passage Alternative would result in no meaningful change from existing adverse conditions and would continue to cause an exceedance of water quality standards in the Hydroelectric Reach from Copco No. 1 Reservoir to Iron Gate Dam, the Middle and Lower Klamath River, and the Klamath River Estuary.

Significance

No significant impact in the short term and long term for the Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary

Potential Impact 4.4.2-1 Short-term increases in suspended material and contaminants from stormwater runoff due to construction activities associated with replacement and construction of new fish passage facilities.

Under the Continuing Operations with Fish Passage alternative, there is the potential for impacts to water quality from construction activities associated with building new fish passage facilities, including upstream fish ladders, spillway modifications, tailrace barriers, screens, and bypass structures (see Appendix U of this EIR for more details). This alternative also includes removal of the existing J.C. Boyle fish ladder structure, construction of a new fishway at or near the same location as the existing fish ladder (Figure 2.3-1), and construction of downstream fish passage. All these construction

activities could result in the disturbance of soil within the Limits of Work and result in loose sediment that could then be suspended during rainfall events in stormwater runoff. Additionally, use of heavy construction equipment and construction-related vehicles involves gasoline, other petroleum fuels, hydraulic and lubricating fluids and other materials that have the potential to contaminate waters should they be captured in stormwater runoff or due to accidents. Further, because some of the construction activities under this alternative would occur directly in the river channel (i.e., "in-water") or on the banks immediately surrounding the river, the potential for discharges to the Klamath River are greater than for work conducted in areas that can be dewatered or dried. Potential water quality impacts would occur over a four- to eight-year period (see also Section 4.4.1 *[Continued Operations with Fish Passage Alternative] Introduction*) and would be likely to cause an exceedance in water quality standards for suspended material, sediment, turbidity, and/or chemical constituents (Table 3.2-4), which would be a significant impact. Implementation of mitigation measures WQ-1, TER-1, and HZ-1 would reduce impacts to less than significant for fish passage construction-related activities in the Hydroelectric Reach throughout the four- to eight-year construction period under the Continued Operations with Fish Passage Alternative. If instead of fish ladders, trap and haul were used, there would be the potential for reduced construction compared to the aforementioned activities for fish ladders.

Significance
No significant impact with mitigation in the short term for the Hydroelectric Reach and the Middle Klamath River immediately downstream of Iron Gate Dam

4.4.2.3 Nutrients

The Continued Operations with Fish Passage Alternative would not release sediment-associated nutrients stored behind the Lower Klamath Project dams because this alternative would not remove the existing dams (Potential Impact 3.2-7) and there would be no significant impact.

The Continued Operations with Fish Passage Alternative would generally result in no change from the existing condition with respect to interception and retention of nutrients in the Lower Klamath Project reservoirs, in either the short term or the long term. There are two exceptions to this general statement. The first is that nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions. The second is that PacifiCorp intends to design and implement a Reservoir Management Plan. These differences are discussed under a new impact heading below (Potential Impact 4.2.2-4), along with consideration of flow changes under this alternative.

Potential Impact 4.2.2-4 Annual interception and retention of nutrients and seasonal release of nutrients due to continued impoundment of waters in the reservoirs.
The Continued Operations with Fish Passage Alternative would continue to result in the same small annual decreases in total phosphorus (TP) and total nitrogen (TN) across the Hydroelectric Reach as occur under existing conditions, due to settling of particulate matter and retention of associated nutrients originating from upstream reaches, including Upper Klamath Lake (in Oregon), in J.C. Boyle, Copco No. 1, and Iron Gate reservoirs, and dilution by the coldwater springs located downstream of J.C. Boyle Reservoir

(Section 3.2.2.4 *Nutrients*). Increased minimum flows in the J.C. Boyle Bypass Reach and limitation of peaking operations at J.C. Boyle Powerhouse under this alternative would not be expected to change the longitudinal decrease in total particulate nutrients on an annual basis from J.C. Boyle Reservoir to Iron Gate Reservoir (i.e., the Hydroelectric Reach).

However, this alternative would also continue to support the same seasonal increases in TP, and to a lesser degree TN, in the Hydroelectric Reach due to the release (export) of dissolved forms of phosphorus (ortho-phosphorus) and nitrogen (ammonium) from Copco No. 1 and Iron Gate reservoir sediments during summer and fall, when reservoir bottom waters are anoxic (through internal nutrient loading, see Figure 3.2-2). These nutrients can stimulate large seasonal blooms of phytoplankton, including blue-green algae, that are then released to the Middle and Lower Klamath River, and eventually the Klamath River Estuary (Section 3.4.2.1 *Phytoplankton*). Seasonal TP can also be transported downstream to the Middle Klamath River where it can stimulate excessive growth of periphyton (aquatic freshwater organisms attached to river bottom surfaces) (Section 3.4.2.2 *Periphyton*). Further downstream, the nutrient effects of the Lower Klamath Project diminish due to both tributary dilution and nutrient retention, such that effects are likely to be small in the Lower Klamath River and Klamath River Estuary (see Potential Impact 3.2-9). Thus, this impact focuses on seasonal nutrient trends in the Hydroelectric Reach and the Middle Klamath River under the Continued Operations with Fish Passage Alternative. Increasing minimum flows for the Copco No. 2 Bypass Reach would not change existing conditions with respect to annual or seasonal nutrient trends in this reach.

The 2007 FERC EIS found that PacifiCorp's proposal for relicensing of the Klamath Hydroelectric Project failed to address the project's water quality impairments within and downstream of the Hydroelectric Reach (FERC 2007). Since 2007, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams. Of the seven water quality improvement actions described in the Reservoir Management Plan[194], conceptual design and implementation of constructed wetlands and design and implementation of in-reservoir oxygenation systems have potential to reduce the seasonal release of nutrients from reservoir bottom sediments by intercepting incoming nutrients from upstream sources before they can enter the reservoirs, and by changing the chemistry of reservoir bottom waters (by physically adding oxygen) to inhibit (dissolved) nutrient release from the sediments.

PacifiCorp has conducted studies to determine the feasibility and effectiveness of constructing treatment wetlands upstream along the Upper Klamath River (e.g., along Lake Ewauna/Keno Impoundment) (Lyon et al. 2009, CH2M HILL 2012, PacifiCorp 2013), as well as along Copco No. 1 and Iron Gate reservoirs. PacifiCorp proposed a

[194] Water quality management techniques in the Reservoir Management Plan (PacifiCorp 2014b) for application in Copco No. 1 and Iron Gate reservoirs include the following techniques to control nutrients, algae, dissolved oxygen and pH: (1) constructed wetlands conceptual design and implementation planning; (2) further evaluation of tailrace aeration and oxygenation systems; (3) design and implementation planning of in-reservoir oxygenation systems; (4) evaluation of epilimnion (surface water) mixing and circulation; (5) further evaluation of selective withdrawal and intake control; (6) modeling and testing of deeper seasonal drawdown and fluctuation of the reservoirs; and (7) additional testing and controlled applications of SCP algaecide to treat localized areas (e.g., coves, embayments) in the reservoirs.

design for a demonstration wetlands facility adjacent to the Upper Klamath River, evaluated five potential sites, and developed construction costs and a monitoring plan (PacifiCorp 2018). To date PacifiCorp has not implemented the demonstration facility, although PacifiCorp has continued to fund pilot studies of diffuse source (i.e., small distributed) treatment wetlands for reducing nutrient transport into Upper Klamath Lake, which would eventually help to improve water quality conditions downstream in the Klamath River. PacifiCorp has also tested chemical coagulants at the laboratory scale to assess the potential for binding and removing phosphorus from waters entering the Lower Klamath Project reservoirs. While some of the coagulants were effective, potential toxicity to aquatic organisms was indicated in the laboratory tests due to elevated dissolved aluminum levels (PacifiCorp 2018). Other Reservoir Management Plan studies have included consideration of in-reservoir oxygenation systems for Keno, J.C. Boyle, and Iron Gate reservoirs (MEI 2007, PacifiCorp 2014, 2018); however, results of the aforementioned studies do not indicate that these approaches, either individually or in combination, would allow the reservoirs to meet Klamath TMDL targets for nutrients (TP and TN) for the tailraces of Copco No. 2 and Iron Gate dams, where these targets numerically interpret the narrative biostimulatory substances objective for the Klamath River (see Section 3.2.3.1 *Thresholds of Significance – Nutrients*).

Nutrient reduction measures in Oregon's Upper Klamath River and Lost River TMDLs would, over time, decrease nutrient input to the Lower Klamath Project reservoirs. Similarly, nutrient reduction measures in California's Lower Lost River TMDLs and Klamath River TMDLs for nutrients would decrease nutrient inputs and would, in the long term, be beneficial to water quality. However, the measures necessary to achieve significant reductions are, at this point, unknown and reductions, along with the corresponding reductions in nutrient inflows to the Lower Klamath Project are likely to require decades to achieve. Further, continuing seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs that subsequently die and settle to the bottom, would continue to build up nutrients and organic matter in the reservoir sediments. This layer of nutrients would continue to be recycled into the water column (through internal nutrient loading, see Figure 3.2-2) during periods of stratification and low dissolved oxygen and would continue to stimulate large seasonal phytoplankton blooms in the reservoirs that are then released to the Middle Klamath River. Warmer water temperatures under climate change (Perry et al. 2011, Bartholow 2005; see discussion in Section 4.4.2 *Water Quality*, Potential Impact 4.2.2-1) would further exacerbate seasonal nutrient internal loading by supporting earlier reservoir water column stratification in the spring and later water column mixing in the fall, for an overall longer period of anoxia in bottom waters and opportunity for seasonal nutrient release to the Hydroelectric Reach and the Middle Klamath River.

With respect to the potential impact of 2017 court-ordered flushing and emergency dilution flows on nutrients downstream of Iron Gate Dam under the Continued Operations with Fish Passage Alternative, since suspended sediments transported by these releases would be primarily mineral (inorganic) sediments there would be no change from existing conditions for nutrients due to implementation of these flows. Flushing and emergency dilution releases downstream of Iron Gate Dam would end by June 15, which is generally before large phytoplankton (e.g., blue-green algae) blooms occur in Iron Gate Reservoir under existing conditions (E&S Environmental Chemistry, Inc. 2013, 2014, 2015, 2016, 2018a, 2018b), so releases would result in a less than significant increase in the export phytoplankton cells and associated nutrients downstream of Iron Gate Dam for the reasons described for the No Project Alternative

(Section 4.2.2, Potential Impact 4.2.2-4 and Section 4.2.4.1 *Phytoplankton*). Increasing minimum flows for the Copco No. 2 Bypass Reach under this alternative also would not change existing conditions with respect to annual or seasonal nutrient trends in the Hydroelectric Reach or the Klamath River downstream of Iron Gate Dam.

There is currently no reasonable proposal to achieve the Klamath TMDLs targets for nutrients (TP and TN) for the tailraces of Copco No. 2 and Iron Gate dams, where these targets numerically interpret the narrative biostimulatory substances objective. Overall, the Continued Operations with Fish Passage Alternative would result in no significant change from existing adverse conditions with respect to seasonal release of nutrients and would continue to cause an exceedance of water quality standards in the Hydroelectric Reach and the Middle Klamath River in the short term and long term.

Significance

No significant impact in the short term and long term for annual interception and retention of nutrients in the Hydroelectric Reach

No significant impact in the short term and long term for seasonal release of nutrients to the Hydroelectric Reach and the Middle Klamath River

4.4.2.4 Dissolved Oxygen

The Continued Operations with Fish Passage Alternative would not release sediments stored behind the Lower Klamath Project dams because this alternative would not remove the existing dams. Thus, there would be no short-term depletion of oxygen from the river due to resuspension of unoxidized organic matter during drawdown (Potential Impact 3.2-10) and there would be no significant impact.

The Continued Operations with Fish Passage Alternative would result in no change from the existing adverse condition with respect to large summertime variations in dissolved oxygen in the Hydroelectric Reach and dissolved oxygen concentrations in the Middle Klamath River immediately downstream of Iron Gate Reservoir that fall below the Basin Plan minimum dissolved oxygen criteria (Section 3.2.2.5 *Dissolved Oxygen*), in either the short or the long term. There are two exceptions to this general expectation. The first is that nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions. The second is that PacifiCorp intends to design and implement a Reservoir Management Plan. The 2007 FERC EIS found that PacifiCorp's proposal for relicensing of the Klamath Hydroelectric Project failed to address the project's water quality impairments within and downstream of the Hydroelectric Reach (FERC 2007). The Klamath River TMDLs later assigned water temperature and dissolved oxygen dual (i.e., co-occurring) load allocations to Copco No. 1 and Iron Gate reservoirs for the stratification period (May through October) to ensure compliance with the dissolved oxygen and water temperature targets (i.e., dissolved oxygen consistent with 85 percent saturation or better through September, and 90 percent or better in October [see also Table 3.2-5]) within the reservoirs and to ensure support of COLD. The Klamath River TMDLs created a physical "compliance lens" where both dissolved oxygen and temperature conditions meet Basin Plan objectives in a layer of water stretching from the point of entry to the reservoirs throughout the reservoir (the depth of the compliance lens within the reservoir is not fixed) (North Coast Regional Board 2010). Since 2007, PacifiCorp has developed several iterations of a

Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including dissolved oxygen. Study results, including those under IM 11 (see Table 4.2-1), have indicated that while proposed reservoir management techniques can improve some of the project impacts to water quality (e.g., transport of nuisance and/or noxious blue-green algae downstream of Iron Gate Dam [Austin et al. 2016, PacifiCorp 2018]), the various techniques have not resulted in water quality improvements at Copco No. 1 or Iron Gate reservoirs that create the TMDL compliance lens nor have they otherwise sufficiently improved Lower Klamath Project impacts to dissolved oxygen (Section 3.2.2.5 *Dissolved Oxygen*). Results from operation of a turbine venting system at Iron Gate Dam indicate that dissolved oxygen improvement is possible using this technique; Potential Impact 4.2.2-5 below discusses these results, along with consideration of flow changes under this alternative.

Potential Impact 4.2.2-5 Seasonal low dissolved oxygen concentrations due to continued impoundment of water in the reservoirs.

Hydroelectric Reach

The Continued Operations with Fish Passage Alternative would continue to result in the same large summertime variations in dissolved oxygen in J.C. Boyle Reservoir, especially at depth, where summer/late fall concentrations can fall below 5 mg/L, releasing water with low dissolved oxygen concentrations to the Klamath River immediately downstream of J.C. Boyle Dam (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.1*). Increased minimum flows in the J.C. Boyle Bypass Reach and limitation of peaking operations at J.C. Boyle Powerhouse under this alternative would result in more natural flow conditions, which could have no effect or potentially a small effect on average dissolved oxygen concentrations in the Hydroelectric Reach downstream of J.C. Boyle Dam and at the Oregon-California state line, and somewhat reduced variability in daily dissolved oxygen for this same reach. These results are predicted by the Klamath River TMDL model, which is useful for informing impacts associated with the Proposed Project and alternatives, although it includes as a starting assumption that there will be full implementation of the TMDLs (see further discussion of TMDLs below). Overall, since daily variability in dissolved oxygen is not currently an issue in the J.C. Boyle Peaking Reach, slightly reducing this variability under future conditions where there is full implementation of the TMDLs would not be considered a beneficial effect under this alternative. Instead, there would be no change from existing adverse conditions for dissolved oxygen during summer months immediately downstream of J.C. Boyle Dam.

In Copco No. 1 and Iron Gate reservoirs, this alternative would continue to result in the same adverse seasonal anoxia (0 mg/L dissolved oxygen) in reservoir bottom waters, which often occurs by May and lasts through October to early November (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.1*). Of the seven water quality improvement actions described in the Reservoir Management Plan[192], in-reservoir oxygenation of J.C. Boyle Reservoir or the upstream Lake Ewauna/Keno Impoundment have potential to increase seasonal dissolved oxygen in J.C. Boyle Reservoir bottom waters indirectly, by reducing oxygen demand of waters entering J.C. Boyle Reservoir, or directly, by adding oxygen to J.C. Boyle Reservoir (PacifiCorp 2014, 2018). Further downstream in Iron Gate Reservoir, in-reservoir oxygenation could directly increase seasonal dissolved oxygen without depleting or exhausting the cold water pool in Iron Gate Reservoir that is used for the Iron Gate Hatchery water supply (see also discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*,

Potential Impact 4.2.2-1). PacifiCorp undertook a feasibility study for this reservoir, which indicated that placement of a hypolimnetic (bottom water) bubble-type oxygenation system near Iron Gate Dam could result in well-oxygenated conditions in the Iron Gate Powerhouse releases to the Middle Klamath River (PacifiCorp 2014, MEI 2007); however, this approach did not demonstrate creation of the TMDL compliance lens compliance within the remainder of the reservoir and the study raised questions regarding financial feasibility. To date implementation of in-reservoir oxygenation in the Lower Klamath Project reservoirs has not occurred. In 2015, PacifiCorp installed a powerhouse intake barrier/thermal curtain in Iron Gate Reservoir under IM 11. One of the purposes of the curtain is to isolate warmer, less dense near-surface waters while withdrawing cooler, denser, and deeper waters from the reservoir for release to the Klamath River downstream (PacifiCorp 2018). The other purpose is to isolate surface waters that have high concentrations of blue-green algae (cyanobacteria) such that extensive summer and fall blooms are not readily released downstream to the Middle and Lower Klamath River (see further discussion in Section 4.4.2 *[Continued Operations with Fish Passage] Suspended Sediments*, Potential Impact 4.2.2-2). Results from deployment of the intake barrier/thermal curtain in 2016 indicate that the presence of the curtain can reduce mixing of reservoir surface waters near the curtain such that moderate (5 to 6 mg/L) to low (approximately 2 to 5 mg/L) dissolved oxygen concentrations occur at depths from 2 to 12 meters due to respiration of dense phytoplankton blooms (PacifiCorp 2017). Overall, while results from the Reservoir Management Plan feasibility investigations of in-reservoir oxygenation and deployment of an intake barrier/thermal curtain suggest that improvement in dissolved oxygen is possible in the reservoirs (PacifiCorp 2017, 2018), these studies have not resulted in water quality improvements at Copco No. 1 or Iron Gate reservoirs that meet TMDL requirements for dissolved oxygen in the reservoirs, nor have they otherwise sufficiently improved Lower Klamath Project impacts to dissolved oxygen in the Middle Klamath River immediately downstream of Iron Gate Dam (see below discussion under *Middle and Lower Klamath River and Klamath River Estuary*). There would be no change from existing conditions with respect to dissolved oxygen due an increase in the minimum flows for the Copco No. 2 Bypass Reach.

Nutrient reduction measures in Oregon's Upper Klamath River and Lost River TMDLs would, over time, decrease nutrient input to the Lower Klamath Project reservoirs which would reduce the prevalence of anoxic conditions in reservoir bottom waters during periods of stratification under existing conditions (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.2*). Similarly, nutrient reduction measures in California's Lower Lost River TMDLs and Klamath River TMDLs for nutrients would decrease nutrient inputs and would, in the long term, be beneficial to water quality by improving seasonal dissolved oxygen in the reservoirs. However, it is anticipated that full attainment of the Oregon and California TMDLs would require decades to achieve. Further, continuing seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs, which subsequently die and settle to the bottom, would continue to result in zero to low dissolved oxygen in bottom waters during periods of stratification (see Figure 3.2-2), which is then released to the Middle Klamath River (see below discussion under *Middle and Lower Klamath River and Klamath River Estuary*). Warmer water temperatures under climate change (Perry et al. 2011, Bartholow 2005; see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1) would further exacerbate low dissolved oxygen concentrations in reservoir bottom waters by supporting earlier reservoir water column stratification in the spring and later water column mixing in the fall, for an overall longer period of anoxia

in bottom waters and releases of water with low dissolved oxygen concentrations to the Middle Klamath River.

There is currently no reasonable proposal to achieve the Klamath TMDLs compliance lens for dissolved oxygen in Copco No. 1 and Iron Gate reservoirs or Basin Plan minimum dissolved oxygen criteria (minimum dissolved oxygen criteria of 85 percent saturation for the period April 1 through September 30, and below the minimum criterion of 90 percent saturation for the period October 1 to March 31, for the Klamath River from Oregon-California state line [RM 214.1] to the Scott River [RM 145.1]; Table 3.2-4) with the dams remaining in place, despite the modest improvements achieved to date through implementation of the Reservoir Management Plan. Overall, the Continued Operations with Fish Passage Alternative would not resolve the existing adverse conditions and would continue to cause an exceedance of water quality standards in the Hydroelectric Reach.

Middle and Lower Klamath River and Klamath River Estuary

As discussed above, the Continued Operations with Fish Passage Alternative would continue to result in the same seasonal anoxia (0 mg/L dissolved oxygen) in reservoir bottom waters during periods of stratification (July through October/November) in Copco No. 1 and Iron Gate reservoirs as existing conditions (see also Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.1*). Immediately downstream of Iron Gate Dam, this alternative would continue to result in low dissolved oxygen in waters released from Iron Gate Reservoir during summer/late fall months, where concentrations regularly fall below 8.0 mg/L and the current Basin Plan minimum dissolved oxygen criteria based on percent saturation[195] (see also Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.2*). Alterations in dissolved oxygen concentrations due to implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would result in no significant impacts for the reasons described under the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-5). Further downstream, the effects of the Lower Klamath Project on dissolved oxygen diminish due to natural stream re-aeration, such that effects are not generally discernable by Seiad Valley (RM 132.7) (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.2*). Thus, this impact focuses on dissolved oxygen trends in the Hydroelectric Reach and the Middle Klamath River from Iron Gate Dam to Seiad Valley (RM 132.7) under the Continued Operations with Fish Passage Alternative. For the Middle Klamath River downstream of Seiad Valley (RM 132.7), the Lower Klamath River, and the Klamath River Estuary, there would be no significant impact of the Continued Operations with Fish Passage Alternative.

Of the seven water quality improvement actions described in the Reservoir Management Plan[194], tailrace aeration and oxygenation, in-reservoir oxygenation, and selective withdrawal and intake control have potential to increase seasonal dissolved oxygen in the Middle Klamath River immediately downstream of Iron Gate Dam by physically adding oxygen to reservoir waters or pulling higher oxygen water from selected depths in the water column for downstream release, while avoiding low oxygen water. In-reservoir oxygenation is described above for the *Hydroelectric Reach*. With respect to tailrace

[195] Minimum dissolved oxygen criteria of 85 percent saturation for the period April 1 through September 30, and below the minimum criterion of 90 percent saturation for the period October 1 to March 31, for the Klamath River from Oregon-California state line (RM 214.1) to the Scott River (RM 145.1); see also Table 3.2-4.

aeration/oxygenation, PacifiCorp currently (since 2009), and on a year-round basis, automatically operates a turbine venting system with a blower that mechanically adds oxygen as water is passed through the powerhouse turbines, with the goal of improving dissolved oxygen concentrations immediately downstream from the dam during periods of reservoir stratification. The system is automatically turned on when dissolved oxygen levels drop below 87 percent saturation and is automatically turned off when dissolved oxygen levels exceed 87 percent saturation. Despite improvements reported during 2008 and 2011, dissolved oxygen immediately downstream of Iron Gate Dam has continued to exhibit percent saturation values below the Basin Plan minimum dissolved oxygen criteria of 85 percent saturation for the period April 1 through September 30, and below the minimum criterion of 90 percent saturation for the period October 1 to March 31 for the Klamath River from Oregon-California state line (RM 214.1) to the Scott River (RM 145.1) (see also Table 3.2-4), with the majority of measured low dissolved oxygen saturation values occurring from August through November (see Appendix C – *Section C.4*). Dissolved oxygen concentrations improve with natural aeration as water moves downstream such that within approximately 6 miles downstream of the dam, the effect of turbine venting is no longer discernable (PacifiCorp 2011).

In 2015, PacifiCorp installed a powerhouse intake barrier/thermal curtain in Iron Gate Reservoir under IM 11. One of the purposes of the curtain is to isolate warmer, less dense near-surface waters while withdrawing cooler, denser, and deeper waters from the reservoir for release to the Klamath River downstream (PacifiCorp 2018). The other purpose is to isolate surface waters that have high concentrations of blue-green algae (cyanobacteria) such that extensive summer and fall blooms are not readily released downstream to the Middle and Lower Klamath River (see further discussion in Section 4.4.2.2 *[Continued Operations with Fish Passage] Suspended Sediments,* Potential Impact 4.2.2-2). Results from deployment of the intake barrier/thermal curtain in 2016 indicate that the presence of the curtain can reduce mixing of reservoir surface waters near the curtain such that low dissolved oxygen concentrations are entrained in the powerhouse intake, and to date turbine venting does not sufficiently improve dissolved oxygen concentrations in the Middle Klamath River immediately downstream of Iron Gate Dam (PacifiCorp 2018).

Overall, while results from the Reservoir Management Plan techniques employed indicate thus far that improvement is possible (PacifiCorp 2017, 2018), they have not resulted in water quality improvements at Copco No. 1 or Iron Gate reservoirs that create the TMDL compliance lens nor have they otherwise sufficiently improved Lower Klamath Project impacts to dissolved oxygen in the Middle Klamath River immediately downstream of Iron Gate Dam (North Coast Regional Board (2010).

Nutrient reduction measures in Oregon's Upper Klamath River and Lost River TMDLs would, over time, decrease nutrient input to the Lower Klamath Project reservoirs which would reduce the prevalence of anoxic conditions in reservoir bottom waters during periods of stratification under existing conditions and improve dissolved oxygen in waters discharged to the Middle Klamath River (Section 3.2.2.5 *Dissolved Oxygen* and Appendix C – *Section C.4.2*). Similarly, nutrient reduction measures in California's Lower Lost River TMDLs and Klamath River TMDLs for nutrients would decrease nutrient inputs and would, in the long term, be beneficial to water quality by improving seasonal dissolved oxygen in the reservoirs and the downstream river. However, it is anticipated that full attainment of the Oregon and California TMDLs would require decades to achieve. Further, continuing seasonal phytoplankton blooms in Copco No. 1

and Iron Gate reservoirs, which subsequently die and settle to the bottom, would continue to result in low to zero dissolved oxygen in bottom waters during periods of stratification (see Figure 3.2-2) that is then released to the Middle Klamath River. Warmer water temperatures under climate change (Perry et al. 2011, Bartholow 2005; see discussion in 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature,* Potential Impact 4.2.2-1) would further exacerbate low dissolved oxygen concentrations in reservoir bottom waters by supporting earlier reservoir water column stratification in the spring and later water column mixing in the fall, for an overall longer period of anoxia in bottom waters and potential release to the Middle Klamath River.

There is currently no reasonable proposal to achieve the Klamath TMDLs compliance lens for dissolved oxygen in Copco No. 1 and Iron Gate reservoirs or Basin Plan minimum dissolved oxygen criteria (minimum dissolved oxygen criteria of 85 percent saturation for the period April 1 through September 30, and below the minimum criterion of 90 percent saturation for the period October 1 to March 31, for the Klamath River from Oregon-California state line [RM 214.1] to the Scott River [RM 145.1]; Table 3.2-4) with the dams remaining in place, despite the modest improvements achieved to date through implementation of the Reservoir Management Plan. Overall, the Continued Operations with Fish Passage Alternative would not resolve existing adverse conditions and would continue to cause an exceedance of water quality standards in the Middle Klamath River immediately downstream of Iron Gate Dam to Seiad Valley (RM 132.7).

Significance

No significant impact in the long term for the Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary

4.4.2.5 pH

The Continued Operations with Fish Passage Alternative would result in no change from the existing adverse condition with respect to pH values that exceed the Basin Plan instantaneous maximum pH objective of 8.5 s.u and large daily fluctuations in the Hydroelectric Reach in Copco No. 1 and Iron Gate reservoirs during summertime periods of intense algal blooms (see Section 3.2.2.6 *pH*). In the Middle and Lower Klamath River and Klamath River Estuary, pH exhibits large (0.5–1.5 pH units) daily fluctuations during periods of high photosynthesis and pH values also regularly exceed Basin Plan instantaneous maximum pH objective of 8.5 s.u. during late-summer and early-fall months (August–September), with the most extreme pH exceedances typically occurring from Iron Gate Dam to approximately Seiad Valley (see Section 3.2.2.6 *pH*). There are two exceptions to the general expectation that these adverse existing conditions would continue under this alternative. The first is that nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions. The second is that PacifiCorp intends to design and implement a Reservoir Management Plan. These differences are discussed under Potential Impact 4.2.2-6 below. Note that while the Hydroelectric Reach is not currently identified as being impaired for pH specifically and the California Klamath River TMDLs do not include specific allocations or targets for pH itself, pH is identified as a secondary indicator of biostimulation, and pH impacts (i.e., exceedances of Basin Plan numeric pH objectives, see Table 3.2-4) are closely related to excessive nutrient inputs to the Klamath River (North Coast Regional Board 2010).

Potential Impact 4.2.2-6 Seasonal high pH and daily pH fluctuations due to continued impoundment of water in the reservoirs.

Hydroelectric Reach

The Continued Operations with Fish Passage Alternative would continue to result in the same pH values that exceed the Basin Plan instantaneous maximum pH objective of 8.5 s.u and large daily fluctuations in the Hydroelectric Reach in Copco No. 1 and Iron Gate reservoirs during summertime periods of intense algal blooms (see Section 3.2.2.6 *pH*).

As discussed in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality*, Potential Impacts 4.2.2-2, 4.2.2-4, and 4.2.2-5, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including large seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs that would affect pH. The improvement actions described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, and 4.2.2-5 do not indicate that this measure could improve phytoplankton blooms in the reservoirs such that they would no longer cause an exceedance of pH standards (Table 3.2-4). Also as described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, and 4.2.2-5, nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial to pH. However, the measures necessary to achieve significant reductions are, at this point, unknown and reductions are likely to require decades to achieve. Warmer water temperatures under climate change would further exacerbate seasonal phytoplankton blooms in the Hydroelectric Reach and overall there is currently no reasonable proposal to achieve TMDL targets and meet applicable water quality standards for water temperature, nutrients and dissolved oxygen, which would also continue to result in elevated pH in the surface waters of Copco No. 1 and Iron Gate reservoirs during summer and fall months. Overall, the Continued Operations with Fish Passage Alternative would result in no change from existing adverse conditions and would continue to cause an exceedance of water quality standards in the Hydroelectric Reach. There would be no change from existing conditions with respect to pH due an increase in the minimum flows for the Copco No. 2 Bypass Reach.

Middle and Lower Klamath River and Klamath River Estuary

As discussed above, the Continued Operations with Fish Passage Alternative would continue to result in continuation of pH values that exceed the Basin Plan instantaneous maximum pH objective of 8.5 s.u and large daily fluctuations in the Hydroelectric Reach in Copco No. 1 and Iron Gate reservoirs during summertime periods of intense algal blooms (see Section 3.2.2.6 *pH*). Downstream of Iron Gate Dam, this alternative would continue to result in similar pH trends for periods of high photosynthesis, particularly when large phytoplankton blooms are transported from Iron Gate Reservoir into the Middle and Lower Klamath River, with the most extreme pH exceedances typically occurring from Iron Gate Dam to approximately Seiad Valley (see Section 3.2.2.6 *pH*). Alterations in pH due to implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would result in no significant impacts for the reasons described under the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-6).

As discussed in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, and 4.2.2-5, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water

quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including large seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs that would affect pH. The improvement actions described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, and 4.2.2-5 do not indicate that this measure could improve phytoplankton blooms in the reservoirs such that they would no longer cause an exceedance of pH standards in the Middle Klamath River (Table 3.2-4). Also as described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, and 4.2.2-5, nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial to pH. However, the measures necessary to achieve significant reductions are, at this point, unknown and reductions are likely to require decades to achieve. Warmer water temperatures under climate change would further exacerbate seasonal phytoplankton blooms in the Hydroelectric Reach and overall there is currently no reasonable proposal to achieve TMDL targets and meet applicable water quality standards for water temperature, nutrients and dissolved oxygen, which would also continue to result in elevated pH in the Middle Klamath River, potentially extending downstream of Seiad Valley into the Lower Klamath River and Klamath River Estuary during summer and fall months. Overall, the Continued Operations with Fish Passage Alternative would result in no meaningful change from existing adverse conditions and would continue to cause an exceedance of water quality standards in the Middle and Lower Klamath River and Klamath River Estuary.

Significance

No significant impact in the long term for the Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary

4.4.2.6 Chlorophyll-*a* and Algal Toxins

The Continued Operations with Fish Passage Alternative would continue to result in the same adverse, large, seasonal phytoplankton blooms, including blue-green algae, in Copco No. 1 and Iron Gate reservoirs, chlorophyll-*a* concentrations exceeding the TMDL target of 10 ug/L during the May to October growth season, and periodically high levels of algal toxins (concentrations greater than 0.8 and/or 4 ug/L microcystin[196]) (see also Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*) as existing conditions. This alternative would also continue to result in release of chlorophyll-a and microcystin to the Middle and Lower Klamath River, and eventually the Klamath River Estuary, where longitudinal and temporal variations in microcystin concentrations from upstream of Copco No. 1 Reservoir to Turwar indicate that Iron Gate Reservoir is the principal source of *Microcystis aeruginosa* cells to the Middle and Lower Klamath River (Otten et al. 2015) (see also Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*). There are two exceptions to the general expectation that these adverse existing conditions would continue under this alternative. The first is that nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations

[196] Since the less than 4 ug/L criterion for microcystin in recreational waters is common to the California Klamath River TMDL, WHO, and Yurok Tribe criteria, and it is less than the Hoopa Valley Tribe recreational criterion, 4 ug/L microcystin is used as the threshold of significance for the Lower Klamath Project EIR water quality analysis. The current lowest CCHAB and Yurok Tribe posting limit for microcystin (0.8 ug/L) is also considered in the analysis although application of the lower threshold would in no case change the significance determinations in this EIR (see Section 3.2.3.1 *Thresholds of Significance – Chlorophyll-a and Algal Toxins*).

with Fish Passage Alternative and existing conditions. The second is that PacifiCorp intends to design and implement a Reservoir Management Plan. These differences are discussed under Potential Impact 4.2.2-7 below, along with consideration of flow changes under this alternative.

Potential Impact 4.2.2-7 Seasonal increases in chlorophyll-a and algal toxins due to continued impoundment of water in the reservoirs.

Hydroelectric Reach

While seasonal phytoplankton (including blue-green algae) blooms originating from Upper Klamath Lake (in Oregon) can enter J.C. Boyle Reservoir, the short residence time of this reservoir does not support substantial additional growth of algae (Section 3.2.2.3 *Suspended Sediments* and Appendix C.2.1.1). Increased minimum flows in the J.C. Boyle Bypass Reach and limitation of peaking operations at J.C. Boyle Powerhouse under this alternative would not be expected to significantly affect this condition and there would be no significant impact of the Continued Operations with Fish Passage Alternative on chlorophyll-*a* and algal toxin concentrations in the Hydroelectric Reach from J.C. Boyle Reservoir to the upstream end of Copco No. 1 Reservoir. However, the Continued Operations with Fish Passage Alternative would continue to result in chlorophyll-*a* concentrations exceeding the TMDL target of 10 ug/L during the May to October growth season, and periodically high levels of algal toxins (concentrations greater than 0.8 and/or 4 ug/L microcystin), in Copco No. 1 and Iron Gate reservoirs and would result in no change from existing adverse conditions (see also Section 3.2.2.7 *Chlorophyll-a and Algal Toxins*).

As discussed in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including large seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs that result in elevated chlorophyll-*a* concentrations and periodically high algal toxin concentrations. The improvement actions described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6 do not indicate that this measure could reduce the extent of phytoplankton blooms in the reservoirs such that they would no longer cause exceedances of chlorophyll-*a* and algal toxin standards. Also as described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6, nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial with respect to decreasing these water quality constituents, although the measures to achieve such reductions remain unclear, and the improvements could require decades. Warmer water temperatures under climate change would further exacerbate seasonal phytoplankton blooms in the Hydroelectric Reach and overall there is currently no reasonable proposal to achieve TMDL targets and meet applicable water quality standards for water temperature, nutrients and dissolved oxygen, which would also continue to result in elevated chlorophyll-*a* concentrations and periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs during summer and fall months. Overall, the Continued Operations with Fish Passage Alternative would result in no change from existing adverse conditions and would continue to cause an exceedance of water quality standards in the Hydroelectric Reach. There would be no change from existing conditions with respect to chlorophyll-*a* and algal toxins due an increase in the minimum flows for the Copco No. 2 Bypass Reach.

Middle and Lower Klamath River and Klamath River Estuary
As discussed above, the Continued Operations with Fish Passage Alternative would continue to result in the same elevated chlorophyll-*a* concentrations (i.e., exceeding the TMDL target of 10 ug/L during the May to October growth season), and periodically high levels of algal toxins (concentrations greater than 0.8 and/or 4 ug/L microcystin) in the Hydroelectric Reach in Copco No. 1 and Iron Gate reservoirs during summertime periods of intense algal blooms (see Section 3.2.2.6 *pH*). Downstream of Iron Gate Dam, this alternative would continue to result in similar chlorophyll-*a* and algal toxin trends when large phytoplankton blooms are transported from Iron Gate Reservoir into the Middle and Lower Klamath River and Klamath River Estuary.

As discussed in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including large seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs that increase chlorophyll-*a* and algal toxin concentrations when they are transported from Iron Gate Reservoir into the Middle and Lower Klamath River. The improvement actions described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6 do not indicate that this measure could reduce the extent of phytoplankton blooms in the upstream Lower Klamath Project reservoirs such that they would no longer cause exceedances of chlorophyll-*a* or algal toxin standards in the Middle and Lower Klamath River. Alterations in chlorophyll-a and algal toxins due to implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would result in no significant impacts for the reasons described under the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-7).

Also as described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6, nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial with respect to decreasing these water quality constituents, although the measures to achieve such reductions remain unclear, and the improvements could require decades. Warmer water temperatures under climate change would further exacerbate seasonal phytoplankton blooms in the Hydroelectric Reach, which would then be transported downstream, and overall there is currently no reasonable proposal to achieve TMDL targets and meet applicable water quality standards for water temperature, nutrients and dissolved oxygen, which would also continue to result in elevated chlorophyll-*a* concentrations and periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs during summer and fall months. Overall, the Continued Operations with Fish Passage Alternative would result in no change from existing adverse conditions and would continue to cause an exceedance of water quality standards in the Middle and Lower Klamath River and Klamath River Estuary.

Significance
No significant impact in the long term for the Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary

4.4.2.7 Inorganic and Organic Contaminants

The Continued Operations with Fish Passage Alternative would continue the existing condition with respect to short-term and long-term freshwater aquatic species' or human exposure to inorganic and organic contaminants (Section 3.2.2.8 *Inorganic and Organic Contaminants*).

The short-term increases in freshwater aquatic species' or human exposure to inorganic and organic contaminants associated with sediment release under the Proposed Project (Potential Impacts 3.2-13 through 3.2-15) would not occur because the dams and sediment deposits would remain in place and there would be no significant impact. There would be no significant impact to aquatic biota in the short term from herbicide application during restoration of the former reservoir areas, as the reservoirs would remain in place (Potential Impact 3.2-16). There would be no change from existing conditions in the short term or long-term with respect to changes in Iron Gate Hatchery operations on Klamath River water quality since Iron Gate Hatchery would continue existing operations (Potential Impact 3.2-17). Fall Creek Hatchery would not be reopened under this alternative and thus there would be no effects of hatchery discharges on water quality and thus no significant impact (Potential Impact 3.2-17). There would be no significant impacts on water quality from short-term construction activities on Parcel B lands since land transfer would not occur (Potential Impact 3.2-18). The potential for increases in inorganic and organic contaminants from hazardous materials associated with construction of fishways is discussed in Potential Impact 4.4.2-1.

Alterations in human and freshwater aquatic species' exposure to inorganic and organic contaminants due to implementation of the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would result in no significant impacts for the reasons described under the No Project Alternative (Section 4.2.2, Potential Impact 4.2.2-8). Increased minimum flows in the J.C. Boyle Bypass Reach, limitation of peaking operations at J.C. Boyle Powerhouse, and increased minimum flows in the Copco No. 2 Bypass Reach would have no effect on exposure pathways for inorganic and organic contaminants because the flow changes would not alter the Lower Klamath Project reservoir sediment deposits nor would they alter physical, chemical, or biological conditions within the river or reservoir reaches that would change the potential for exposure to inorganic or organic contaminants compared with existing conditions.

4.4.3 Aquatic Resources

4.4.3.1 Suspended Sediment

Under the Continued Operations with Fish Passage Alternative, the Lower Klamath Project dams would not be removed, and sediment would continue to be trapped and stored behind the dams. This evaluation assumes that the Continued Operations with Fish Passage Alternative would result in similar SSCs to the model runs for existing conditions. This model scenario provides the closest evaluation of the long-term suspended sediments effects of Continued Operations with Fish Passage Alternative. It results in no change to algal-derived (organic) suspended material as compared to existing condition over the long term, as the dams would continue to exert the same influence on algal-derived (organic) suspended material as under existing conditions (see also Potential Impact 4.2.2-2).

However, the modeling for the No Project Alternative somewhat underestimates the short-term SSC impacts of the Continuing Operations with Fish Passage Alternative, as it does not have SSC impacts related to the construction of fish passage facilities. As discussed in Section 4.4.2 *Water Quality – Suspended Sediments*, and specifically in Potential Impact 4.4.2-1, implementation of mitigation measures WQ-1, TER-1, and HZ-1 would reduce the potential significance of the short-term construction-related impacts to less than significant. Thus, there would be no significant impact in the short term of suspended sediment on any aquatic species under the Continued Operations with Fish Passage Alternative with mitigation. This alternative would have no long-term effects associated with suspended sediment transport for any aquatic species, relative to existing conditions.

4.4.3.2 Bed Elevation and Grain Size Distribution

Under the Continued Operations with Fish Passage Alternative, the Lower Klamath Project dams would not be removed and sediment would continue to be stored behind Lower Klamath Project dams, as described for existing conditions in Section 3.11.2.5 Reservoir Sediment Storage and Composition. As described for existing conditions (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project– Suspended Sediment*), the Lower Klamath Project dams would continue to trap fine and coarse sediment which, when transported as bedload sediments and deposited downstream, are necessary for the long-term maintenance of aquatic habitats. As of the interception of sand, gravel and coarser sediment supply from sources upstream of Iron Gate Dam the channel downstream from Iron Gate Dam would continue to coarsen and decrease in mobility (USBR 2012), providing fewer components of habitat, in particular spawning habitat, and decreased habitat quality over time. This effect would continue to gradually decrease in the downstream direction as coarse sediment is resupplied by tributary inputs (Hetrick et al. 2009) and would be substantially reduced at the Cottonwood Creek confluence (PacifiCorp 2004a). As occurs under existing conditions, the coarser bed material is mobilized at higher flows that occur less frequently, resulting in channel features that are unnaturally static and provide lower value aquatic habitat (Buer 1981), and provide stable substrate favorable for polychaetes and for C. shasta and P. minibicornis (Hetrick et al. 2009). Additionally, as described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, in 2017, the United States District Court ordered USBR to change operations to meet court-ordered flushing flows below Iron Gate Dam. These are not modeled as part of existing conditions hydrology. These flows increase bedload mobilization during the years in which they are ordered by the court.

4.4.3.3 Water Quality

Under the Continued Operations with Fish Passage Alternative, water quality would be the same as described for existing conditions (Section 3.2.2 *Water Quality*) with the modifications described in Section 4.4.2 *Water Quality*. However, unlike under existing conditions, anadromous fish would be able to move through the Hydroelectric Reach and would be seasonally exposed to poor water quality during upstream and downstream migration, and for long durations if rearing were to occur in the mainstem river. Diminished dissolved oxygen concentrations within reservoirs can be seasonally stressful for anadromous fish from June to September (FERC 2007), high levels of the cyanotoxin microcystin also occur during summer months (see Section 3.2.2.7 *Chlorophyll-a and Algal Toxins* and discussion below for more detail) and continued high

rates of algal photosynthesis in the reservoirs would result in pH values that would not consistently meet applicable ODEQ and California Basin Plan water quality objectives (see Section 3.2.2.6 *pH*).

Under the Continued Operations with Fish Passage Alternative, the effects on water temperature are predicted to be similar to those described for existing conditions (Section 3.2.2.2 *Water Temperature*), with the modifications described in Section 4.4.2 *Water Quality – Water Temperature*. Under the Continued Operations with Fish Passage Alternative, the 40 percent bypass requirement at J.C. Boyle Dam would result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler water temperatures in late fall and winter. These effects would be similar to those under the Proposed Project and would move this short reach away from consistently cooler water temperatures during summer and early fall months; however, as with the Proposed Project, areas adjacent to the cold-water springs in the Bypass Reach would continue to serve as thermal refugia for aquatic species because the springs themselves would not be affected by the Continued Operations with Fish Passage Alternative. If volitional fishways were implemented (rather than trap and haul; as described below in Section 4.4.3.7 *Fish Passage*) anadromous fish would be able to move through the Hydroelectric Reach and might be seasonally exposed to high temperatures during upstream and downstream migration. Water temperature in Copco No. 1 and Iron Gate reservoirs can be high from June to September (Section 3.2.2.2 *Water Temperature*) and surface layers may seasonally exceed thermal tolerances for salmonids or resident fish. During late spring through summer, early fall-run Chinook salmon adult migrants could be exposed to high water temperatures, as well as spring-run Chinook salmon adults not already holding in tributary habitat; for spring-run Chinook salmon, peak migration would occur outside of the period of high water temperatures, and most juvenile outmigration occurs earlier in the spring or later in the fall. However, fall-run Chinook salmon migrating upstream through Iron Gate Reservoir and Copco No. 1 Reservoir during the primary period of their migration (August and September) would be limited to waters exhibiting suitable dissolved oxygen concentrations; under existing conditions, these concentrations are located within the top approximately 10 meters of depth in these two reservoirs where water temperatures are greater than approximately 23ºC in most years (see Appendix C – *Section C.1* and *C.4*.) The combination of warm water temperatures in surface waters and low dissolved oxygen below approximately 10 meters would potentially limit upstream migration of a proportion of fall-run Chinook salmon through the Hydroelectric Reach, unless migrating fish are able to remain within a water depth shallow enough to provide suitable dissolved oxygen and deep enough to avoid unsuitable water temperatures. If the trap and haul fish passage option was implemented consistent with FERC (2007), these water quality migration impediments would be avoided (as described in Section 4.4.3.7 *Fish Passage*).

Since J.C. Boyle Reservoir, with its large thermal mass, would remain in place under the Continued Operations with Fish Passage Alternative, effects on diel temperature variation in the Bypass Reach would be similar to those described for existing conditions (i.e., reduced diel temperature variation). Maximum water temperatures in the Peaking Reach would be slightly cooler and temperatures would be less artificially variable compared to existing conditions due to higher overall flows and the lower frequency of peaking operations at the J.C. Boyle Powerhouse.

Under existing conditions, there is a delay in the normal progression of water temperatures downstream from Iron Gate Dam (or Phase Shift from historical timing) (Bartholow et al. 2005). Under this alternative, the current phase shift and lack of temporal temperature diversity would persist, including current warm temperatures in late summer and fall (Hamilton et al. 2011). Juveniles and adults migrating later in the year would continue to experience warm temperatures in late summer and fall that could be deleterious to health and survival, including increased risk of disease, and high rates of delayed spawning and pre-spawn mortality (Hetrick et al. 2009). As there is currently no reasonable proposal to achieve the temperature allocations in the Klamath River TMDLs with the Lower Klamath Project dams remaining in place, and long-term climate change-induced increases in water temperatures would partially offset any TMDL improvements (see Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1), overall the Continued Operations with Fish Passage Alternative would maintain existing adverse late summer/fall water temperatures in the reach downstream from Iron Gate Dam.

4.4.3.4 Fish Disease and Parasites

As discussed in detail in Section 3.3.2.3, *Habitat Attributes Expected to be Affected by the Proposed Project [Fish Disease and Parasites],* under the existing condition, fish diseases, specifically the myxozoan parasites *Ceratomyxa shasta* (*C. shasta*) and *Parvicapsula minibicornis (P. minibicornis),* regularly result in substantial mortality of Klamath River salmon (Fujiwara et al. 2011, True et al. 2013). Additional diseases that may affect fish in the Klamath Basin include *Ichthyophthirius multifis* (Ich) and *Flavobacterium columnare* (columnaris). These parasites and diseases occur throughout the watershed but appear to cause the most severe mortality in the Lower Klamath Basin where *C. shasta* has been observed to result in high rates of mortality in salmon (True et al. 2013). Ich and columnaris occasionally result in substantial mortality (e.g., the 2002 fish kill of primarily adult Chinook salmon)

As discussed in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Fish Disease and Parasites],* there is currently an infection nidus (reach with the highest disease infection) for *C. shasta* and *P. minibicornis* in the Klamath River in the reach from the Shasta River downstream to Seiad Valley. With fish passage, there would be the potential that in addition to the current infection nidus downstream of Iron Gate Dam, an additional nidus could be created in upstream areas where salmon spawning congregations occur (Foott et al. 2012). Any creation of a new infection zone upstream, or the continuation of the existing infection zone (or zones) would be the result of the synergistic effect of numerous factors, such as those that occur within the current disease zone (FERC 2007, Bartholomew and Foott 2010).

Under the Continued Operations Alternative with Fish Passage Alternative, some of these conditions would persist relatively unchanged, while others would be reduced. The conditions promoting infection zones which would continue to occur under this alternative include an altered hydrograph and altered sediment transport rates below Iron Gate Dam (Hetrick et al. 2009). Additionally, altered water temperatures driven by Lower Klamath Project reservoirs would continue.

However, this alternative also has the potential to reduce crowding downstream of Iron Gate Dam, through the provision of upstream fish passage. FERC's (2007) analysis concluded that restoring access to reaches above Iron Gate Dam for anadromous fish

would allow adult fall-run Chinook salmon to distribute over a greater length of the river, reducing crowding and the concentration of disease pathogens that currently occur in the reach between Iron Gate Dam and the Shasta River. This would be a reduction in conditions that promote infection zones. However, provision of fish passage alone will not eliminate crowding at Iron Gate Dam or some of the conditions to contribute to high infection rates. Concentrations of myxospore-infected salmon carcasses downstream from Iron Gate Dam are likely to still be elevated in association with two factors. First, the continued operation of Iron Gate Hatchery will continue to promote congregations of adult salmonids near the base of Iron Gate Dam. Second, congregations of adults at the entrance to fish passage facilities are likely to occur. Thus, crowding would be ameliorated, but not eliminated as a contributing factor to high disease rates.

Additionally, as described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, in 2017, the United States District Court ordered USBR to change operations to meet court-ordered flushing and dilution flows below Iron Gate Dam. These are not modeled as part of existing conditions hydrology. These flows are aimed at reducing fish disease downstream of Iron Gate Dam. This alternative assumes that these flows would continue to be required, because the addition of habitat alone is unlikely to eliminatethe current nidus downstream of Iron Gate Dam under the Continued Operations with Fish Passage Alternative.

Therefore, under this alternative, fish disease would potentially be reduced by the addition of habitat and associated reduction in crowding below Iron Gate Dam, and the continued operation of 2017 flow requirements. The flow and dilution requirements alone have not been successful in eliminating the disease nidus. Although the conditions leading to nidus downstream of Iron Gate Dam will be ameliorated by reduced crowding, and by flushing and dilution flows as required by the 2017 court order, the nidus is anticipated to continue to occur to some degree.

As discussed in detail for the Proposed Project in Section 3.3.5.5 *Fish Disease and Parasites*, available information indicates that fish passage under the Continued Operations with Fish Passage Alternative would not increase the risk of disease for resident species that occur upstream of Iron Gate Dam (NMFS 2006a).

4.4.3.5 Algal Toxins

Upper Klamath River—Hydroelectric Reach

Continued impoundment of water in the Lower Klamath Project reservoirs under the Continued Operations with Fish Passage Alternative would continue to support growth conditions for toxin-producing nuisance algal species such as *Microcystis aeruginosa* in Copco No. 1 and Iron Gate reservoirs, resulting in high seasonal concentrations of algal toxins in the Hydroelectric Reach and downstream for decades into the future. As described for existing conditions in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Algal Toxins]*, this would result in continued bioaccumulation of microcystin in fish tissue for species in the Hydroelectric Reach and could be deleterious to fish health. As there is currently no reasonable proposal to achieve TMDL targets and meet applicable water quality standards for water temperature, nutrients and dissolved oxygen, which would also continue to result in elevated chlorophyll-*a* concentrations and periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs during summer and fall months with the Lower Klamath Project dams remaining in place (see Potential Impact

4.2.2-7), overall the Continued Operations with Fish Passage Alternative would maintain existing adverse high seasonal concentrations of algal toxins in the Hydroelectric Reach. For salmonids, impacts would be similar to those currently observed downstream from Iron Gate Dam.

Middle and Lower Klamath River

Continued impoundment of water in the Lower Klamath Project reservoirs under the Continued Operations with Fish Passage Alternative would continue to support the seasonal transport of toxin-producing nuisance algae and microcystin to the Klamath River downstream from Iron Gate Dam. This would result in continued bioaccumulation of microcystin in muscle tissue for aquatic species in the river and could be deleterious to fish health. As there is currently no reasonable proposal to achieve TMDL targets and meet applicable water quality standards for water temperature, nutrients and dissolved oxygen, which would also continue to result in elevated chlorophyll-*a* concentrations and periodically high algal toxin concentrations transported to the Klamath River downstream from Iron Gate Dam during summer and fall months (see Potential Impact 4.2.2-7), overall the Continued Operations with Fish Passage Alternative would maintain existing adverse high seasonal concentrations of algal toxins in the Klamath River downstream of Iron Gate Dam. For aquatic species, impacts would be similar to those currently observed downstream from Iron Gate Dam (described in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Algal Toxins]*).

4.4.3.6 Aquatic Habitat and Instream Flows

Under the Continued Operations with Fish Passage Alternative, access to historical anadromous fish habitat would be restored to some degree. Volitional fishways would provide anadromous fish access to 58 miles of habitat upstream of Iron Gate Dam not inundated by Lower Klamath Project reservoirs (and downstream of Keno Dam) (DOI 2007). This is considered historical habitat for coho salmon, Pacific lamprey, fall-run Chinook salmon, spring-run Chinook salmon, and steelhead (Hamilton et al. 2005, 2016). Volitional fishways would also provide 360 miles of habitat upstream of Upper Klamath Lake and Keno Impoundment/Lake Ewauna (Huntington 2006, DOI 2007, NMFS 2007). This is considered historical habitat for fall-run Chinook salmon, spring-run Chinook salmon, and steelhead (Hamilton et al. 2005, 2016). The number of miles of fish habitat made potentially available under this alternative may also be impaired by high water temperatures in during some seasons in association with Lower Klamath Project reservoirs, as described above in *Water Quality*.

If fish passage were provided by trap and haul (as described below), the amount of habitat upstream of Upper Klamath Lake and Keno Impoundment/Lake Ewauna would be the same, but of the 58 miles of habitat between Iron Gate Dam and Keno Dam, only approximately 25 miles of habitat would be available on the mainstem Klamath River between J.C. Boyle and Keno, and within Spencer Creek (Huntington 2006, FERC 2007).

Hydrology of the Klamath River from Iron Gate Dam to the Klamath River Estuary would generally remain the same as under existing conditions. Additional winter-spring surface flushing flows and deep flushing flow requirements outlined in *Measures to Reduce Ceratanova Shasta Infection of Klamath River Salmonids: A Guidance Document* and U.S. District Court Filing 111 (U.S. District Court 2017a–c; see also Section 4.4.1

[Continued Operations with Fish Passage Alternative] Introduction – Alternative Description) is predicted to help reduce juvenile salmon disease below Iron Gate Dam, as discussed in Section 4.4.3.4 *Fish Disease and Parasites*. However, as described in Section 3.1.6 *Summary of Available Hydrology Information for the Proposed Project*, 2017 court-ordered flushing and dilution flows required to be released from Iron Gate Dam are not modeled as part of existing conditions hydrology.

Activities currently underway to recover salmonid and sucker populations within the Klamath Basin would likely continue at their current levels. See Section 5, *Cumulative Impacts* for information on salmonid and sucker recovery activities.

Under this alternative, there would be substantial changes to hydroelectric operations. J.C. Boyle Powerhouse would no longer generate in peaking mode, and higher flow releases would be made through the J.C. Boyle Bypass Reach than under existing conditions. Higher base flows would also be provided in the Copco No. 2 Bypass Reach. Peaking operations would only occur one day a week to coincide with recreation flows, at least 40 percent of flow would go into the Bypass Reach (and not enter the powerhouse), and ramping rates would be slower than they are currently. Seasonal high flows would contribute to improving the quality of riparian habitat in the J.C. Boyle Bypass Reach by increasing the sediment deposited within the channel and decreasing reed canary grass (NMFS 2006a). The more normative flow regime associated with this alternative would provide these seasonal high flows. These modifications would benefit fish in this reach, including redband trout and anadromous fish.

As discussed in Section 4.2.3.2, Potential Impact 4.2.3-21, continued implementation of the Coho Enhancement Fund under the Continued Operations with Fish Passage Alternative would continue to provide benefits to fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, freshwater mussels, and benthic macroinvertebrates. These actions are also beneficial for coho salmon (particularly from the Upper Klamath River Population Unit). Implementation of the Coho Enhancement Fund under the No Project Alternative would have no significant impact (no change from existing conditions) on redband trout, shortnose and Lost River suckers, green sturgeon, eulachon, and Southern Resident Killer Whales, since these species are not found in or near the river reaches associated with IM2 projects or actions.

4.4.3.7 Fish Passage

Under the Continued Operations with Fish Passage Alternative, fish migrating upstream and downstream past Lower Klamath Project dams and reservoirs would have fishways for the provision of safe and timely passage, consistent with FERC (2007). Under the Continued Operations with Fish Passage Alternative upstream and downstream fish passage at all four Lower Klamath Project dams would be provided consistent with the prescriptions from the U.S. Department of Interior (DOI) and U.S. Department of Commerce imposed during the FERC relicensing process (FERC 2007), and in the KHSA 2012 EIS/EIR *Fish Passage at Four Dams Alternative*, including barriers to prevent juvenile salmonid entrainment into turbines. This alternative assumes fish passage is consistent with the general prescriptions (DOI 2007) that cover anadromous (fall- and spring-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey) and resident (rainbow and redband trout, shortnose and Lost River suckers) fish passage, and includes implementing operation and maintenance plans and prescribing attraction flows for upstream migrants (DOI 2007). As noted, this alternative also provides

information on where trap and haul would result in different impacts, although that process would not comply with the mandatory conditions.

Fish migrating through fishways may experience delay, injury, and mortality, beyond what would occur from natural migration in the absence of dams and reservoirs (FERC 2007). In the relicensing proceeding for the Klamath Hydroelectric Project, NMFS (2006) recommended dam removal as the preferred alternative to provide the least mortality and injury to migrating fish. NMFS' mandatory fishway prescription (DOI 2007) was submitted in the event that FERC chose to reject NMFS' recommendation to removal all Lower Klamath Project mainstem dams. In the FERC (2007) analysis, potential mortality occurring during fish passage was considered for fall-run Chinook salmon adults and juveniles, for both volitional fishways (e.g., fish ladders and screened turbines), as well as for trap and haul. In analyzing volitional fishways FERC (2007) considered potential sources of mortality for upstream and downstream migrating fish, such as poor water quality conditions, predatory fish in Lower Klamath Project reservoirs, and injuries while passing through multiple fish ladder and screening facilities. As described in Section 4.4.3.3 *Water Quality*, poor water quality conditions in Iron Gate and Copco No. 1 reservoirs would likely limit migration of a proportion of the adult fall-run Chinook salmon migration through the Hydroelectric Reach during most years if fish passage were provided from volitional fishways at each of the Lower Klamath Project facilities, unless migrating fish are able to remain within a water depth shallow enough to provide suitable dissolved oxygen and deep enough to avoid unsuitable water temperatures.

Based on the reservoir dynamics and the predator population that currently occurs, predation of outmigrating salmonids above Iron Gate Dam is anticipated to be low (NMFS 2006a). In restoration efforts elsewhere in the Pacific Northwest, anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (NMFS 2006a). These potential sources of mortality were estimated based on Oosterhout (2005, cited from PacifiCorp 2006). FERC (2007) predicted that average cumulative (migration in reservoirs and through fishways) mortality for adult Chinook salmon migrating upstream from Iron Gate Dam to upstream of J.C. Boyle Dam would be 28 percent with volitional fish ladders. The prediction for juveniles migrating downstream from Upper Klamath Lake to downstream of Iron Gate was 58 percent mortality for passage through the reservoirs and volitional fishways. For this analysis, it is assumed that effects of passage through volitional fishways would be equivalent for other migratory species, which appears to be a reasonable assumption based on available data (DWR 2013) for fishways designed and constructed to modern agency criteria as required by DOI (2007).

Trap and haul fish passage facilities are described by FERC (2007) and are addressed under the Continued Operations with Fish Passage Alternative to the extent the impacts of trap and haul would be different from those considered under mandatory fishway conditions. However, trap and haul facilities do not provide volitional fish passage, and thus are not considered by NMFS or USFWS to be equivalent to volitional fishways, such as fish ladders and downstream bypass facilities. The trap and haul alternative described by FERC (2007), would consist of trapping upstream adult migrants downstream of Iron Gate Dam and releasing them in J.C. Boyle Reservoir. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir, and released downstream of Iron Gate Dam (potentially far enough downstream to avoid disease issues). In addition, the trap and haul option avoids water quality impediments to

upstream migration for adult fall-run Chinook salmon described in Section 4.4.3.3 *Water Quality*. Therefore, trap and haul was predicted to have lower cumulative mortality than volitional ladders, since this option would avoid mortality associated with passage through the Lower Klamath Project reservoirs and riverine habitat that would be bypassed. FERC (2007) predicted that average cumulative mortality for adult Chinook salmon migrating upstream from Iron Gate Dam to upstream of J.C. Boyle Dam would be 21 percent for trap and haul. The prediction for juveniles migrating downstream from Upper Klamath Lake to downstream of Iron Gate was 46 percent for trap and haul. However, the FERC analysis did not consider the impacts of the trap and haul operation itself, such as handling and trucking stress and mortality. The recent review of Lusardi and Moyle (2017) note that adults trapped and hauled upstream experience high (> 20 percent) pre-spawn mortality rates, and juvenile salmonids transported downstream are observed to experience delayed mortality, reduced growth rates, and increased predation. Therefore, for purposes of comparing the impacts of the Continued Operations with Fish Passage alternative with the impacts of trap and haul, this analysis does not assume that mortality would be different from that estimated for volitional fishways reported by FERC (2007). In addition, for this analysis, it is assumed that effects of passage through trap and haul facilities would be equivalent for other migratory species, which is a reasonable assumption for modern fishways designed to accommodate all species (including Pacific lamprey).

Potential Impact 4.2.3-1 Effects on coho salmon critical habitat quality and quantity due to continued operations of the Lower Klamath Project.

Under the Continued Operations with Fish Passage Alternative, coho salmon would be able to access habitat in the Hydroelectric Reach by ascending the fishways associated with each of the dams. Available habitat for coho salmon would be approximately 54 miles with volitional fishways. If trap and haul were implemented to actively transport coho salmon migrants around the Lower Klamath Project reservoirs, there would be approximately 25 miles of newly accessible habitat. The estimate of 54 miles of additional habitat along the mainstem and within accessible tributaries is based on access to a maximum of 58 miles of anadromous fish (steelhead) habitat (NMFS 2006a)[197], reduced in some part for the propensity of coho salmon to remain in lower gradient habitat than steelhead (DOI 2007), habitat in the bypass reaches, and the continued inundation of approximately 22 miles of spawning and rearing habitat by the Lower Klamath Project reservoirs (Cunanan 2009). The upstream boundary of critical habitat for coho salmon in the Klamath Basin is Iron Gate Dam; any newly accessible areas would be outside of their currently designated critical habitat. NMFS may want to consider including the newly accessible reaches as critical habitat as part of their 5-year status review or in a separate decision (J. Simondet, NOAA Fisheries Service, pers. comm., 2011). The areas inundated by the reservoirs would not provide suitable spawning or rearing habitat for coho salmon, but coho salmon would regain access to the riverine reaches on the mainstem and to the tributaries, although the downstream ends of most of the tributaries would remain inundated by the reservoirs. It is anticipated that adults will migrate upstream through inundated reservoir habitat, and that juveniles will migrate downstream with mortality from predation and poor water quality considered in the estimates of passage survival discussed in Section 4.4.3.7 *Fish Passage*.

[197] This also takes into consideration slight differences in the Administrative Law Judge (2006) definition of the Project Reach from what is used in this report.

Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through elimination of peaking operation flows and increased base flows.

Water temperatures would continue to be seasonally affected by the reservoirs. Similar to existing conditions, temperatures would be warmer in the summer and fall when adults are migrating upstream and may pose a degree of seasonal risk to adult that are located downstream from Iron Gate Dam, migrating within reservoirs or in bypass reaches. As under existing conditions, this thermal stress may continue to contribute to coho salmon being more susceptible to disease downstream of Iron Gate Dam. Relative to existing conditions, the slight decreases in long-term maximum summer/fall water temperatures and less artificial diel temperature variation in the J.C. Boyle Peaking Reach would return the river to a more natural thermal regime (see also Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1).

As described above in Section 4.4.3.4 *Fish Disease and Parasites*, overall incidence of fish disease in salmon under the Continued Operations with Fish Passage Alternative may be reduced but is unlikely to be eliminated.

In terms of Primary Constituent Elements (PCEs) of coho salmon critical habitat, this alternative would provide access to additional spawning habitat upstream of currently designated critical habitat, including in Fall, Jenny, Shovel, and Spencer creeks, although the downstream ends of these streams would continue to be inundated by the reservoirs and would not provide suitable spawning or rearing habitat. Delay, injury, and mortality could occur for upstream migrating adults, and downstream migrating juveniles. As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within fishways is predicted to be approximately 28 percent, and 58 percent for downstream migrating juveniles (FERC 2007). Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007). Since mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, any upstream migrating adults that migrated past fewer facilities and reservoirs and spawned in Fall or Jenny creeks for example, would have much lower morality (e.g., 10 percent for adults, FERC 2007). The same is true for downstream migrating juveniles; the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality.

The food resources in these tributaries would also become available to fry and juvenile coho salmon rearing in those streams. Despite the modest water quality improvements achieved to date through implementation of actions contained within PacifiCorp's Reservoir Management Plan (see also Section 4.4.2 *Water Quality*), there is currently no reasonable proposal to achieve water quality standards important to coho salmon within or downstream of the Hydroelectric Reach. Based on the current designation of critical habitat, the effect of the Continued Operations with Fish Passage Alternative would be no impact (no change from existing conditions) for coho salmon critical habitat in the short term and long term.

Significance

No significant impact to coho salmon critical habitat in the short term and long term

Potential Impact 4.2.3-2 Effects on Southern Resident Killer Whale critical habitat quality due to alterations to salmon populations due to continued operations of the Lower Klamath Project.

Klamath River contributes to critical habitat for Southern Resident Killer Whales through its contribution of salmon to their food supply (included as a PCE). The Continued Operations with Fish Passage Alternative would not affect the geographic extent of critical habitat for this species, as it is located in the state of Washington. Implementation of this alternative is expected to increase production of salmon (as described in Potential Impacts 4.2.3-7, 4.2.3-8, and 4.2.3-9), which could increase food supply for Southern Resident Killer Whales. However, data on the Southern Resident Killer Whale diet indicate that based on the migratory range and behavior of the population, the Klamath River salmon are anticipated to provide less than one percent of the diet of Southern Resident Killer Whales in most months under current and future conditions. While Southern Resident Killer Whales have been shown to consume Klamath River Chinook salmon, the Klamath River is considered by NMFS and Washington Department of Fish and Wildlife (WDFW) tenth out of the top ten priority Chinook salmon populations for Southern Resident Killer Whales (NMFS 2018b, NMFS and WDFW 2018). Under this alternative, Iron Gate Hatchery would continue to operate and target existing production levels of hatchery Chinook salmon and contribution to ocean stocks. Due to the low proportion of the Sothern Resident Killer Whale diet being composed of Klamath River salmon, the Continued Operations with Fish Passage Alternative would result in no significant impact in the short term and long term.

Significance

No significant impact to Southern Resident Killer Whale critical habitat in the short term and long term

Potential Impact 4.2.3-3 Effects on eulachon critical habitat quality due to continued operations of the Lower Klamath Project.

Implementation of the Continued Operations with Fish Passage Alternative would not affect eulachon critical habitat. The Continued Operations with Fish Passage Alternative would not cause an alteration to habitat conditions in the Klamath River Estuary and Pacific Ocean nearshore environment compared to the existing conditions.

Significance

No significant impact to eulachon critical habitat in the short term and long term

Potential Impact 4.2.3-4 Effects on Chinook and coho salmon Essential Fish Habitat (EFH) quality due to continued operations of the Lower Klamath Project.

Implementation of the Continued Operations with Fish Passage Alternative would increase habitat for Chinook and coho salmon (upstream of currently designated EFH) by providing access to habitat upstream of Iron Gate Dam. As described above for Potential Impact 4.2.3-1, water quality, sediment dynamics, and fish disease affecting EFH would not change substantially from the existing conditions detailed in Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project*. Under this alternative, designated EFH for Chinook and coho salmon would be expected to remain similar to its current condition, as described for existing conditions (Section 3.3.2.1 *Aquatic Species*). The effect of the Continued Operations with Fish Passage Alternative would be no impact (no change from existing conditions) for Chinook and coho salmon designated EFH in the short term and long term.

Significance
No significant impact for Chinook and coho salmon EFH in the short term and long term

Potential Impact 4.2.3-5 Effects on groundfish Essential Fish Habitat (EFH) quality due to continued operations of the Lower Klamath Project.
Implementation of the Continued Operations with Fish Passage Alternative would not affect groundfish EFH. Habitat conditions within the estuary and nearshore environment would not be altered as result of this alternative. The effect of the Continued Operations with Fish Passage Alternative would be no impact (no change from existing conditions) for groundfish EFH in the short term and long term.

Significance
No significant impact to groundfish EFH in the short term and long term

Potential Impact 4.2.3-6 Effects on pelagic fish Essential Fish Habitat (EFH) quality due to continued operations of the Lower Klamath Project.
Implementation of the Continued Operations with Fish Passage Alternative would not affect pelagic fish EFH. Habitat conditions within the estuary and nearshore environment would not be altered as result of this alternative. The effect of the Continued Operations with Fish Passage Alternative would be no impact (no change from existing conditions) for pelagic fish EFH in the short term and long term.

Significance
No significant impact to pelagic fish EFH in the short term and long term

Potential Impact 4.2.3-7 Effects on the fall-run Chinook salmon population due to continued operations of the Lower Klamath Project.
Upper Klamath River and Connected Waterbodies
Under the Continued Operations with Fish Passage Alternative, fish passage facilities installed at the Lower Klamath Project dams within the Hydroelectric Reach would allow fall-run Chinook salmon to regain access to 360 miles of habitat upstream of J.C. Boyle Reservoir. The access would expand the Chinook salmon's current habitat to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood rivers (Hamilton et al. 2005, Hamilton et al. 2016). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds of miles of additional potentially productive habitat (DOI 2007), including access to groundwater discharge areas relatively resistant to effects of climate change (Hamilton et al. 2011).

Water quality problems (e.g., excessive water temperatures and low dissolved oxygen) that currently occur in the Keno Impoundment/Lake Ewauna during late spring, summer, and early autumn, may challenge fall-run Chinook salmon accessing these areas under the Continued Operations with Fish Passage Alternative. As discussed under Section 3.3.5.3 *Water Quality*, the Keno Impoundment/Lake Ewuana has the potential to be a habitat barrier during most years for fall-run Chinook due to poor water quality during the late summer, and therefore NMFS and USFWS have prescribed fish passage measures for the Keno Impoundment/Lake Ewuana to be used during periods of poor water quality (DOI 2007). If fish passage were not provided, fall-run Chinook salmon would be limited to the additional habitat access in the Hydroelectric Reach, as described in detail below. While seasonal dissolved oxygen in the Keno Impoundment/Lake Ewauna would be expected to improve in furtherance of TMDL implementation throughout the Upper

Klamath Basin, it would be speculative at this point to identify either the mechanisms necessary to fully implement the TMDLs or the timing required to achieve full compliance, thus this EIR assumes that trap and haul around the Keno Impoundment/Lake Ewauna would be needed in years of poor water quality for fish to be able to access habitat upstream of Keno Dam.

Implementation of the Continued Operations with Fish Passage Alternative would result in no change from existing conditions for suspended sediments or bedload sediment, flow-related habitat, or algal toxins and disease in this reach.

Upper Klamath River — Hydroelectric Reach

Implementation of the Continued Operations with Fish Passage Alternative would restore fall-run Chinook salmon access to the Hydroelectric Reach by providing fishways associated with each of the Lower Klamath Project dams. Available habitat for fall-run Chinook salmon would be approximately 54 miles with volitional fishways. However, low DO and high-water temperatures in Iron Gate and Copco No. 1 reservoirs would likely limit upstream migration of fall-run Chinook salmon during the peak of their migration (as described in Section 4.4.3.3 *Water Quality*), potentially limiting their access to habitat upstream of Iron Gate Dam, unless migrating fish are able to remain within a water depth shallow enough to provide suitable dissolved oxygen and deep enough to avoid unsuitable water temperatures. If trap and haul were implemented to actively transport fall-run Chinook salmon migrants around the Lower Klamath Project reservoirs, there would be approximately 25 miles of newly accessible habitat. The estimate of 54 miles of additional habitat along the mainstem and within accessible tributaries is based on access to a maximum of 58 miles of anadromous fish (steelhead) habitat (NMFS 2006a)[198], reduced in some part for the propensity of fall-run Chinook salmon to remain in lower gradient habitat than steelhead (DOI 2007), habitat in the bypass reaches, and the continued inundation of approximately 22 miles of spawning and rearing habitat by Lower Klamath Project reservoirs (Cunanan 2009). It is anticipated juveniles would migrate downstream with mortality from predation and poor water quality considered in the estimates of passage survival discussed in Section 4.4.3.7 *Fish Passage*. As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within fishways is predicted to be approximately 28 percent, and 58 percent for downstream migrating juveniles (FERC 2007). Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007). Since mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality in the reach.

Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through elimination of peaking operation flows and increased base flows. Under this alternative, the expected overall higher flow releases would result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler temperatures in late fall and winter. These effects would be similar to those under the Proposed Project and would move this short reach away from consistently cooler water temperatures during summer and early fall months; however, fishways would provide access to thermal refugia created by 200 to 250 cfs of spring flow accretion in the J.C.

[198] This also takes into consideration slight differences in the Administrative Law Judge (2006) definition of the Project Reach from what is used in this report.

Boyle Bypass Reach (DOI 2007, FERC 2007). Under this alternative, suspended and bedload sediment, water quality, and algal toxins would be the same as under existing conditions.

Under this alternative fish migrating through reservoirs would be seasonally exposed to some degree to stressful water quality conditions including high temperatures in reservoir surface layers with low dissolved oxygen in reservoir surface layers in the summer and fall, changes in dissolved oxygen, pH, and ammonia associated with algal blooms, and exposure to microcystin from *Microcystis aeruginosa* blooms (Dunsmoor and Huntington 2006, FERC 2007). These conditions can become stressful in June through September, contributing to lower resistance to disease seasonally. Based on the reservoir dynamics and the predator population that currently occurs therein, predation of outmigrating salmonids above Iron Gate Dam is anticipated to be low (NMFS 2006a). In restoration efforts elsewhere in the Pacific Northwest, anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (NMFS 2006a).

The amount of time required for the fall-run Chinook salmon population to reach capacity under this alternative would be a function of adult returns that recolonize new habitat. Recolonization success and rate is a function of fish straying into newly available habitats (Pess 2009). For Chinook salmon, stray rates are approximately six percent (Hendry et al. 2004), and 95 percent of strays migrate less than 20 miles from their natal area (Quinn and Fresh 1984, Quinn et al. 1991). However, following major changes in environmental conditions (e.g., dam removal, high SSC), salmonid stray rates have been observed to increase above these average levels. The time period of colonization (historical or new habitat) has been reported to occur within five to thirty years, with most falling between one to two decades (Withler 1982, Bryant 1999, Burger et al 2000, Glen 2002, Pess et al. 2003, Milner et al. 2008, Kiffney et al. 2009). Rapid (less than one year) recolonization was observed for fall-run Chinook salmon following fish ladder installation at Landsburg Dam on the Cedar River, Washington (Kiffney et al. 2009). A ladder was placed on the Landsburg Dam in 2003, and Chinook salmon immediately (i.e., the first fall following ladder installation) accessed areas upstream of the dam, with juveniles being observed during snorkel surveys the following year. By 2011, Chinook salmon occurred throughout nearly all accessible habitat upstream of the dam. It is likely that under this alternative fall-run Chinook salmon would recolonize newly accessible habitat.

Middle and Lower Klamath River

Under the Continued Operations with Fish Passage Alternative, suspended sediment downstream of Iron Gate dam would be the same as described under existing conditions (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Suspended Sediment]*). Lower Klamath Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment (leading to coarsening of the bed), but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009, Stillwater Sciences 2010a). Coarsening of the bed could reduce spawning habitat for fall-run Chinook salmon downstream from the dam over time, but this impact would be limited to the area upstream of Cottonwood Creek. Rearing habitat would be expected to remain similar to existing conditions.

Under the Continued Operations with Fish Passage Alternative, the Lower Klamath River downstream from Iron Gate Dam reach would continue to have seasonally poor water quality because of the continued presence of the reservoirs with their increased hydraulic residence time and thermal mass (Section 3.2.2.2 *Water Temperature*). The continuation of warm water releases from Iron Gate Dam would contribute to delay adult upstream migration of fall-run Chinook salmon (Dunsmoor and Huntington 2006) and increase the risk of mortality prior to spawning (Hamilton et al. 2011). PacifiCorp's Reservoir Management Plan actions, such as further development and use of an intake barrier/thermal curtain, may slightly reduce water temperatures downstream of Iron Gate Dam, but recent data indicate that only modest 1–2°C (1.8–3.6°F) water temperature improvement is possible using this approach (PacifiCorp 2017). Further, the maximum useable cool water volume in Copco No. 1 Reservoir in summer and the maximum volume of cold water (8°C or less) in Iron Gate Reservoir in summer are limited, such that selective withdrawal from the reservoirs would be anticipated to decrease water temperatures immediately downstream of Iron Gate Dam by only 1 to 2°C in late summer/early fall. PacifiCorp has also noted that the water supply for Iron Gate Hatchery withdraws cold water from the deeper portion of Iron Gate Reservoir, and depleting or exhausting this cold water pool during the summer would have effects on the hatchery that would need to be addressed (PacifiCorp 2014) (see also discussion under Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1).

As described above in Section 4.4.3.4 *Fish Disease and Parasites*, overall incidence of fish disease in salmon under the Continued Operations with Fish Passage Alternative may be reduced but is unlikely to be eliminated.

Despite modest improvements in dissolved oxygen concentrations from implementation of actions contained within the Reservoir Management Plan (i.e., turbine venting system at Iron Gate Dam; see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1 and Appendix C – *Section C.4.2*), dissolved oxygen concentrations during August through October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August through September and 90 percent saturation from October and November (see Section 3.2.2.5 *Dissolved Oxygen*). In addition, the presence of microcystin, associated with the dense blooms of *Microcystis aeruginosa* in Iron Gate and Copco reservoirs, would continue to occur downstream from Iron Gate Dam, as there is currently no reasonable proposal that would decrease periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs to concentrations that would not exceed water quality standards (see also Potential Impact 4.2.2-7).

Klamath River Estuary and Pacific Ocean Nearshore Environment

Habitat conditions within the estuary and nearshore environment would not be altered as result of this alternative. The Continued Operations with Fish Passage Alternative is not expected to substantially alter fall-run Chinook salmon estuarine habitat.

Summary

In the short term, there would be no impact (no change relative to existing conditions) for fall-run Chinook salmon populations from the habitat attributes that would be anticipated to affect the population within a short (i.e., less than five years) time frame.

In the long term (i.e., more than five years*)*, under this alternative, fish passage would result in alterations in habitat availability for fall-run Chinook salmon. However, low DO and high-water temperatures in Iron Gate and Copco No. 1 reservoirs would likely limit upstream migration of fall-run Chinook salmon during the peak of their migration (as described in Section 4.4.3.3 *Water Quality*), potentially limiting their access to habitat upstream of Iron Gate Dam if fish passage was provided by volitional fishways rather than trap and haul, unless migrating fish are able to remain within a water depth shallow enough to provide suitable dissolved oxygen and deep enough to avoid unsuitable water temperatures. In addition, if fish passage is not provided a Keno Impoundment/Lake Ewuana, restored habitat access to the Hydroelectric Reach would be beneficial for fall-run Chinook salmon in the long term. If fish passage were provided at Keno (per DOI [2007] fish passage prescriptions), an even greater magnitude of restored habitat access to the Upper Klamath River Basin. Mortality could occur for migrants from passage through fishways, and from migration through Lower Klamath Project reservoirs.

This alternative would result in continuation of some of the stresses that currently affect Chinook salmon populations. The presence of dams and reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist. Due to implementation of actions contained within PacifiCorp's Reservoir Management Plan, these conditions are likely to improve somewhat over the long term, although there is currently no reasonable proposal to improve water temperatures towards full support of cold freshwater habitat (COLD) (Section 4.4.2 *Water Quality*). These reservoir-related conditions would continue to have negative effects on fall-run Chinook salmon populations, as compared to a without-dams scenario under the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-7). The overall effect of the Continued Operations with Fish Passage Alternative on fish disease may be slightly improved but is unlikely to be substantially altered from existing conditions.

It is anticipated that increased habitat availability as a result of the Continued Operations with Fish Passage Alternative the fall-run Chinook salmon population within the Klamath River watershed would have an increase in abundance, population spatial structure, and genetic diversity if fish passage were to be provided by trap and haul rather than volitional fishways. Out-migrating smolts would continue to be subject to deleterious effects downstream from Iron Gate Dam. While the degree of harm may be reduced, the types of effects would be continued as under the existing condition. If fish passage were provided that avoided water quality barriers to adult upstream migration (i.e., trap and haul), increases in abundance, population spatial structure, and genetic diversity would confer greater population-level benefits than the expected mortality within the fishways, resulting in overall increases in the viability for fall-run Chinook salmon in the long term.

Significance

No significant impact for fall-run Chinook salmon in the short term

Beneficial for fall-run Chinook salmon in the long term

Potential Impact 4.2.3-8 Effects on the spring-run Chinook salmon population due to continued operations of the Lower Klamath Project.

Upper Klamath River and Connected Waterbodies

Under the Continued Operations with Fish Passage Alternative, fish passage facilities installed at the Lower Klamath Project dams within the Hydroelectric Reach would allow spring-run Chinook salmon to regain access to 360 miles of habitat in the upper Klamath River upstream of J.C. Boyle Reservoir. The access would expand the Chinook salmon's current habitat to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood rivers (Hamilton et al. 2005, Butler et al. 2010, Hamilton et al. 2016). Huntington (2006) reasoned that spring-run Chinook salmon likely accounted for the majority of the Upper Klamath Basin's actual salmon production under historical conditions. Overall, the Continued Operations with Fish Passage Alternative would provide spring-run Chinook access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds of miles of additional potentially productive anadromous fish habitat upstream of Iron Gate Dam (DOI 2007), including access to important thermal refugia within areas influenced by groundwater exchange that are more resistant to climate change (Hamilton et al. 2011). Some of these areas, such as the lower Williamson River, have habitat that would provide substantial holding areas for spring-run Chinook salmon (Hamilton et al. 2011). Other holding areas with suitable temperatures upstream of J.C. Boyle Reservoir include groundwater influenced areas on the west side of Upper Klamath Lake, and the Wood River (Gannett et al. 2007).

Poor water quality (e.g., severe hypoxia, temperatures exceeding 77°F, high pH) in the reach from Keno Dam to Link Dam might impede volitional fish passage at any time from late June through mid-November (Sullivan et al. 2009, USGS 2010; both as cited in Hamilton et al. 2011). However, available information indicates that Upper Klamath Lake habitat is presently suitable to support Chinook salmon for at least the period from October through May (Maule et al. 2009). Currently, adult spring-run Chinook migration takes place in approximately April through June. Historically, adult spring-run Chinook salmon migrated upstream of the current location of Iron Gate Dam perhaps as early as February and March (Fortune et al. 1966) and likely held over in large holding pools in the mainstem in tributaries fed by cool water, and in thermal refuge habitat upstream of Upper Klamath Lake (Snyder 1931, CDFG 1990c, Moyle 2002). One benefit of such early migration (similar to the spring-run Chinook salmon migration timing currently observed in the Klamath Basin) would be the avoidance of periods of poor water quality in the vicinity of Keno Impoundment/Lake Ewuana. Under the current migration timing, most or all of the spring-run Chinook salmon migrants would be able to pass upstream through the Keno Impoundment/Lake Ewuana area before seasonal water quality reductions would make passage restricted.

Upper Klamath River — Hydroelectric Reach

Implementation of the Continued Operations with Fish Passage Alternative would restore spring-run Chinook salmon access to the Hydroelectric Reach by providing fishways associated with each of the Lower Klamath Project dams. Available habitat for spring-run Chinook salmon would be approximately 54 miles with volitional fishways. (If trap and haul were implemented to actively transport spring-run Chinook salmon migrants around the Lower Klamath Project reservoirs, there would be approximately 25 miles of newly accessible habitat.) The estimate of 54 miles of additional habitat along the mainstem and within accessible tributaries is based on access to a maximum of 58

miles of anadromous fish (steelhead) habitat (NMFS 2006a)[199], reduced in some part for the propensity of spring-run Chinook salmon to remain in lower gradient habitat than steelhead (DOI 2007), habitat in the bypass reaches, and the continuation of approximately 22 miles of spawning and rearing habitat inundated by Lower Klamath Project reservoirs (Cunanan 2009). It is anticipated that adults will migrate upstream through inundated reservoir habitat, and that juveniles will migrate downstream with mortality from predation and poor water quality considered in the estimates of passage survival discussed in Section 4.4.3.7 *Fish Passage*. As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within fishways is predicted to be approximately 28 percent, and 58 percent for downstream migrating juveniles (FERC 2007). Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007). As mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, any upstream migrating adults that migrated past fewer facilities and reservoirs and spawned in Fall or Jenny creeks for example, would have much lower morality (e.g., 10 percent for adults, FERC 2007). The same is true for downstream migrating juveniles; the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality.

Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increasing base flows. Under this alternative, the expected overall higher flow releases than under current conditions would result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler temperatures in late fall and winter. These effects would be similar to those under the Proposed Project and would move this short reach away from the existing condition of consistently cooler water temperatures during summer and early fall months; however, passage structures would provide fish with some refuge from high temperatures due to access to cooler water from tributaries, in addition to that provided by 200 to 250 cfs of accretion from springs in the J.C. Boyle Bypass Reach (DOI 2007, FERC 2007, Hamilton et al. 2011). With the construction of fish passage facilities, flows and access would also be restored to the 1.4-mile Copco No. 2 Bypass Reach. Under this alternative, suspended and bedload sediment, water quality, and the occurrence of fish disease and algal toxins would be the same as under existing conditions.

This alternative would result in continuation of some of the stresses that currently affect Chinook salmon populations. The presence of J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist within reservoirs. Adult spring-run Chinook salmon in the Klamath River migrate upstream from April through June (and possibly earlier, Fortune et al. 1966), and most juveniles migrate from April through May or in the fall, as flows increase. Therefore, poor water quality in reservoirs is expected to have minor effects on this species, and only at the early and late ends of migration periods, outside peak migration times.

199 This also takes into consideration slight differences in the NMFS (2006a) definition of the Project Reach from what is used in this report.

There are a few basic mechanisms by which spring-run Chinook salmon could recolonize newly accessible habitat, including: (1) straying of adults, (2) adaptation of fall-run Chinook salmon to an early spring-run Chinook salmon life history, or (3) active reintroduction of spring-run Chinook salmon from another population. There are many examples of spring-run Chinook salmon rapidly recolonizing newly accessible habitat discussed in Potential Impact 4.2.3-7 above, and spring-run Chinook salmon were observed recolonizing habitat in the White Salmon River, Washington, following removal of Condit Dam (Allen et al. 2016). Following the removal of Condit Dam most of the observed spring-run Chinook salmon spawning was upstream of the location of the former Condit Dam. The current spring-run Chinook salmon abundance in the Salmon River is low (Table 3.3-10), and the rate of recolonization could be slow as a result.

The potential for adaptation of fall-run Chinook salmon to a spring-run Chinook salmon life history was assessed by Thompson et al. (2018), and they concluded that based on the genetics of the fall-run Chinook salmon currently downstream of Iron Gate Dam, it was unlikely that this would occur. Active reintroduction of Chinook salmon with genetics suited to adapt to an early spring-run Chinook salmon life history may be successful strategy for recolonization (Thompson et al. 2018). The Continued Operations with Fish Passage Alternative does not include an active reintroduction plan, although ODFW has been considering implementing active reintroduction of spring-run Chinook salmon following dam removal (T. Wise, ODFW, pers. comm., 2018). Such a strategy could be considered under this alternative as well.

Middle and Lower Klamath River

Under the Continued Operations with Fish Passage Alternative, suspended sediment downstream of Iron Gate Dam would be the same as described under existing conditions (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Suspended Sediment]*). Lower Klamath Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment (leading to coarsening of the bed), but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009, Stillwater Sciences 2010a).

Under the Continued Operations with Fish Passage Alternative, the Klamath River downstream from Iron Gate Dam would continue to have seasonally poor water quality related to temperature because of the continued presence of the reservoirs, with their increased hydraulic residence time and thermal mass (Section 3.2.2.2 *Water Temperature*). There is currently no reasonable proposal to achieve the temperature allocations in the Klamath TMDLs with the Lower Klamath Project dams remaining in place, despite the modest improvements achieved to date through implementation of actions contained within PacifiCorp's Reservoir Management Plan (see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1). Under this alternative, the current phase shift and lack of temporal temperature diversity will persist, including current warm temperatures in late summer and fall (Hamilton et al. 2011). Juveniles and adult migrants would continue to experience warm temperatures in late summer and fall that could be deleterious to health and survival, including increased risk of disease, and high rates of delayed spawning and pre-spawn mortality (Hetrick et al. 2009). These effects would be most pronounced for fish migrating through areas upstream of the Scott River, because tributary contributions dampen the temperature effect of the dams further downstream, as discussed in Section 3.2.2.2 *Water Temperature*.

As described above in Section 4.4.3.4 *Fish Disease and Parasites*, overall incidence of fish disease for spring-run Chinook salmon migrating from newly accessible habitat upstream of Iron Gate Dam under the Continued Operations with Fish Passage Alternative may be reduced but is unlikely to be eliminated.

Despite modest improvements in dissolved oxygen concentrations from implementation of actions contained within the Reservoir Management Plan (i.e., turbine venting system at Iron Gate Dam; see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1 and Appendix C – *Section C.4.2*), dissolved oxygen concentrations during August through October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August through September and 90 percent saturation from October and November (see Section 3.2.2.5 *Dissolved Oxygen*). In addition, the presence of microcystin, associated with the dense blooms of *Microcystis aeruginosa* in Iron Gate and Copco reservoirs, would continue to occur downstream from Iron Gate Dam, as there is currently no reasonable proposal that would decrease periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs to concentrations that would not exceed water quality standards (see also Potential Impact 4.2.2-7).

Klamath River Estuary and Pacific Ocean Nearshore Environment

The Continued Operations with Fish Passage Alternative is not expected to substantially alter spring-run Chinook salmon estuarine habitat.

Summary

In the short term, there would be no impact (no change relative to existing conditions) for spring-run Chinook salmon from the habitat attributes that would be anticipated to affect the population within a short (less than five years) time frame.

In the long term (more than five years), under this alternative, fishways could result in alterations in habitat availability for spring-run Chinook salmon. Under the Continued Operations with Fish Passage Alternative, spring-run Chinook salmon could regain access to approximately 414 miles of mainstem and tributary habitat in the upper Klamath River and Hydroelectric Reach, and thermal refugia within the Hydroelectric Reach, which would benefit the population. Mortality could occur for migrants from passage through fishways, and from migration through Lower Klamath Project reservoirs. The expansion of habitat opportunities will allow increased expression of life-history variation and the restoration of an additional population of spring-run Chinook salmon population to strengthen resiliency in the Klamath Basin, particularly because passage upstream of Iron Gate Dam would provide access to thermal refugia at groundwater areas (Hamilton et al. 2011).

Cool water temperatures (similar to existing conditions) during the spring would continue to benefit upstream migrating adult and downstream migrant juvenile spring-run Chinook salmon. Warm water temperatures in the fall would continue to be detrimental to juveniles and adults migrating at that time. These effects would be most pronounced for fish migrating through areas upstream of the Scott River.

This alternative would result in continuation of some of the stresses that currently affect Chinook salmon populations. The presence of dams and reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist. Due to implementation of actions contained within PacifiCorp's Reservoir Management Plan, these conditions are likely to improve somewhat over the long term, although there is currently no reasonable proposal to improve water temperatures towards full support of cold freshwater habitat (COLD) (Section 4.4.2 *Water Quality*). These reservoir-related conditions would continue to have negative effects on spring-run Chinook salmon populations, as compared to a without-dams scenario under the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-8). The overall effect of the Continued Operations with Fish Passage Alternative on fish disease may be slightly improved but is unlikely to be substantially altered from existing conditions.

It is anticipated that increased habitat availability as a result of the Continued Operations with Fish Passage Alternative the spring-run Chinook salmon population within the Klamath River watershed would have an increase in abundance, population spatial structure, and genetic diversity. These increases would confer greater population-level benefits than the expected mortality within the fishways and upstream reservoirs, resulting in overall increases in the viability for spring-run Chinook salmon in the long term.

Significance

No significant impact for spring-run Chinook salmon in the short term

Beneficial for spring-run Chinook salmon in the long term

Potential Impact 4.2.3-9 Effects on coho salmon populations due to continued operations of the Lower Klamath Project.

Upper Klamath River and Connected Waterbodies

Available data suggest that coho salmon were in both mainstem and tributary reaches of the Klamath River upstream to and including Spencer Creek at RM 232.6 (Figure 3.3-1, NRC 2004, as cited in NMFS 2007a, Hamilton et al. 2005). It is not anticipated that under the Continued Operations with Fish Passage Alternative coho salmon would begin to occupy habitat within the Upper Klamath River and connected waterbodies, and therefore there would be no change from the existing condition.

Upper Klamath River — Hydroelectric Reach

Under the Continued Operations with Fish Passage Alternative, coho salmon would be able to access habitat in the Hydroelectric Reach by ascending the fishways associated with each of the dams. Available habitat for coho salmon would be approximately 54 miles with volitional fishways. If trap and haul were implemented to actively transport coho salmon migrants around the Lower Klamath Project reservoirs, there would be approximately 25 miles of newly accessible habitat. The estimate of 54 miles of additional habitat along the mainstem and within accessible tributaries is based on access to a maximum of 58 miles of anadromous fish (steelhead) habitat (NMFS 2006a)[200], reduced in some part for the propensity of coho salmon to remain in lower

[200] This also takes into consideration slight differences in the NMFS (2006a) definition of the Project Reach from what is used in this report.

gradient habitat than steelhead (DOI 2007), habitat in the bypass reaches, and the continuation of around 22 miles of spawning and rearing habitat inundated by Lower Klamath Project reservoirs (Cunanan 2009). It is anticipated that adults will migrate upstream through inundated reservoir habitat, and that juveniles will migrate downstream with mortality from predation and poor water quality considered in the estimates of passage survival discussed in Section 4.4.3.7 *Fish Passage*. As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within fishways is predicted to be around 28 percent, and 58 percent for downstream migrating juveniles (FERC 2007). Since mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, any upstream migrating adults that migrated past fewer facilities and reservoirs and spawned in Fall or Jenny creeks for example, would have much lower morality (e.g., 10 percent for adults, FERC 2007). The same is true for downstream migrating juveniles; the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality. Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007).

Coho salmon downstream from Iron Gate Dam belonging to the Upper Klamath River Population Unit would likely migrate above the dam if access was provided by fishways (NMFS 2006a). Over time, access to habitat above Iron Gate Dam would benefit the Upper Klamath River Population Unit by: (a) extending the range and distribution of the species thereby increasing the coho salmon's reproductive potential; (b) increasing genetic diversity in the coho stocks; (c) reducing the species' vulnerability to the impacts of degradation; and (d) increasing the abundance of the coho salmon population (NMFS 2006a).

Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increasing base flows. Under this alternative, the expected overall higher flow releases would result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler temperatures in late fall and winter. These effects would be similar to those under the Proposed Project and would move this short reach away from consistently cooler water temperatures during summer and early fall months; however, upstream passage would provide fish with some refuge from high temperatures because of access to cooler water from tributaries, in addition to the 200 to 250 cfs provided by coldwater springs in the J.C. Boyle Bypass Reach (DOI 2007, FERC 2007, Hamilton et al. 2011).

This alternative would result in continuation of some of the stresses that currently affect coho salmon populations. The presence of the Lower Klamath Project reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist within reservoirs. Although water temperature in the summer upstream of Iron Gate Dam is an issue, the available information shows that water temperature would not preclude coho salmon from successfully using the habitat within the Project Area while the Lower Klamath Project dams are in place (NMFS 2006a). Adult coho salmon enter the Klamath River between late September and mid-December, with peak upstream migration occurring between late October and mid-November, and juvenile coho outmigrate to the ocean beginning in late February, with most outmigration occurring in

April and May. As such, poor water quality (e.g., high water temperatures) in reservoirs would have minor effect on this species.

Under this alternative, suspended and bedload sediment, water quality, and the occurrence of algal toxins would be the same as under existing conditions.

Middle and Lower Klamath River

Under the Continued Operations with Fish Passage Alternative, suspended sediment downstream of Iron Gate Dam would be the same as described under existing conditions (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Suspended Sediment]*). Lower Klamath Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment (leading to coarsening of the bed), but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009, Stillwater Sciences 2010a). Most coho salmon spawning and rearing takes place within tributaries. Coarsening of the bed could reduce spawning habitat between Iron Gate Dam and Cottonwood Creek over time, which would have little effect on coho salmon except for the few coho salmon from the Upper Klamath River Population Unit that spawn in the mainstem downstream of Iron Gate Dam. Rearing habitat would be expected to remain similar to existing conditions.

Under the Continued Operations with Fish Passage Alternative, the Lower Klamath River downstream from Iron Gate Dam would continue to have seasonally poor water quality related to temperature because of the continued presence of the reservoirs, with their increased hydraulic residence time and thermal mass (Section 3.2.2.2 *Water Temperature*). PacifiCorp's Reservoir Management Plan actions, such as further development and use of an intake barrier/thermal curtain, may slightly reduce water temperatures downstream of Iron Gate Dam, but recent data indicate that only modest 1–2°C (1.8–3.6°F) water temperature improvement is possible using this approach (PacifiCorp 2017). Further, the maximum useable cool water volume in Copco No. 1 Reservoir in summer and the maximum volume of cold water (8°C or less) in Iron Gate Reservoir in summer are limited, such that selective withdrawal from the reservoirs would be anticipated to decrease water temperatures immediately downstream of Iron Gate Dam by only 1 to 2°C in late summer/early fall. PacifiCorp has also noted that the water supply for Iron Gate Hatchery withdraws cold water from the deeper portion of Iron Gate Reservoir, and depleting or exhausting this cold water pool during the summer would have effects on the hatchery that would need to be addressed (PacifiCorp 2014) (see also discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1).

As described above in Section 4.4.3.4 *Fish Disease and Parasites*, overall incidence of fish disease for coho salmon under the Continued Operations with Fish Passage Alternative may be reduced but is unlikely to be eliminated.

Despite modest improvements in dissolved oxygen concentrations from implementation of actions contained within the Reservoir Management Plan (i.e., turbine venting system at Iron Gate Dam; see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1 and Appendix C – *Section C.4.2*), dissolved oxygen concentrations during August through October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August through September and 90 percent saturation from October

and November (see Section 3.2.2.5 *Dissolved Oxygen*). In addition, the presence of microcystin, associated with the dense blooms of *Microcystis aeruginosa* in Iron Gate and Copco reservoirs, would continue to occur downstream from Iron Gate Dam, as there is currently no reasonable proposal that would decrease periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs to concentrations that would not exceed water quality standards (see also Potential Impact 4.2.2-7).

Klamath River Estuary and Pacific Ocean Nearshore Environment
The Continued Operations with Fish Passage Alternative is not expected to substantially alter habitat in the estuary, and thus there would be no impact on coho salmon rearing in the estuary.

Summary
In the short term, there would be no impact (no change relative to existing conditions) for coho salmon from the habitat attributes that would be anticipated to affect the population within a short less than five years) time frame.

In the long term (more than five years), the Continued Operations with Fish Passage Alternative could result in alterations in habitat availability which could affect coho salmon. Under the Continued Operations with Fish Passage Alternative, coho salmon would regain access to approximately 54 miles (or 25 miles if trap and haul were used) of mainstem and tributary habitat in the upper Klamath River and Hydroelectric Reach, and thermal refugia within the Hydroelectric Reach, which would benefit the population. Mortality would occur for migrants from passage through fishways, and from migration through Lower Klamath Project reservoirs.

This alternative would result in continuation of some of the stresses that currently affect coho salmon populations. The presence of dams and reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, sediment and would continue to contribute to crowding (though to a lesser degree than under the current condition), allowing some conditions favorable for the transmission of fish disease to persist. Due to implementation of actions contained within PacifiCorp's Reservoir Management Plan, these conditions are likely to improve somewhat over the long term, although there is currently no reasonable proposal to improve water temperatures towards full support of cold freshwater habitat (COLD) (Section 4.4.2 *Water Quality*). These reservoir-related conditions would continue to have negative effects on coho salmon populations, as compared to a without-dams scenario under the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-9). The overall effect on fish disease of the Continued Operations with Fish Passage Alternative is likely to improve somewhat but is unlikely to be substantially altered from existing conditions.

Despite the continuation of poor conditions for coho salmon downstream of Iron Gate Dam, the Continued Operations with Fish Passage Alternative would benefit the Upper Klamath River Coho Salmon Population Unit (described in Section 3.3.2.1 *Aquatic Species [coho salmon]*) by increasing habitat access. This population would experience a long-term increase in abundance, population spatial structure, and genetic diversity. These increases would confer greater population-level benefits than the expected mortality within the fishways, resulting in overall increases in the viability of coho salmon from the Upper Klamath River population unit in the long term. The Mid-Klamath River,

Shasta River, Scott River, Salmon River population units would experience a continuation of existing effects, and the three Trinity River population units, and the Lower Klamath River population units would not be affected. Based on the continuation of existing conditions for populations downstream from Iron Gate Dam, this alternative would be no impact (no change from existing conditions) for the coho salmon from the Mid-Klamath River, Shasta River, Scott River, and Salmon River, three Trinity River population units, and the Lower Klamath River population units in the long term. Due to the benefit to the Upper Klamath River Population Unit, the Continued Operations with Fish Passage Alternative would provide an overall benefit to the Klamath River Basin coho salmon population in the long term.

Significance

No significant impact for coho salmon populations in the short term

Beneficial for coho salmon populations in the long term

Potential Impact 4.2.3-10 Effects on the steelhead population due to continued operations of the Lower Klamath Project.

Upper Klamath River and Connected Waterbodies

Under the Continued Operations with Fish Passage Alternative, steelhead would regain access to the Upper Klamath Basin upstream of J.C. Boyle Reservoir. This would expand the population's distribution to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood rivers (Hamilton et al. 2005). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising 360 miles of additional potentially productive habitat (Huntington 2006, DOI 2007, NMFS 2007a).

Water quality problems (e.g., excessive water temperatures and low dissolved oxygen) that currently occur in the Keno Impoundment/Lake Ewauna during late spring, summer, and early autumn, may challenge steelhead accessing these areas under the Continued Operations with Fish Passage Alternative. As discussed under Section 3.3.5.3 *Water Quality*, in some years poor water quality in the Keno Impoundment/Lake Ewuana reach may prevent the latest migrants of the summer steelhead run and the earlier migrants from the fall run from accessing upstream spawning habitat in these upper reaches. If no upstream trap and haul is provided at Keno, these fish would be likely to spawn in habitat downstream of Keno Dam in the Hydroelectric Reach (described below), or, in the case of fall-run steelhead, hold below the dam until conditions become passable. However, the majority of the summer steelhead adult migration, much of the fall-run adult steelhead migration, and all of the winter adult steelhead migration is anticipated to occur outside the mid-June to mid-November timeframe in which water quality in the Keno Impoundment/Lake Ewuana reach is typically so poor as to present a migration barrier to adult salmonids. Similarly, juvenile outmigration and run-backs also occur outside this timeframe. While seasonal dissolved oxygen in the Keno Impoundment/Lake Ewauna would be expected to improve in furtherance of TMDL implementation throughout the Upper Klamath Basin, it would be speculative at this point to identify either the mechanisms necessary to implement the TMDLs or the timing required to achieve full compliance, thus this EIR assumes that trap and haul around the Keno Impoundment/Lake Ewauna would be needed in years of poor water quality for fish to be able to access habitat upstream of Keno Dam.

This alternative would not result in changes to suspended or bedload sediment, flow-related habitat, or algal toxins in this reach.

Upper Klamath River — Hydroelectric Reach
Implementation of the Continued Operations with Fish Passage Alternative would restore steelhead access to the Hydroelectric Reach by providing fishways associated with each of the Lower Klamath Project dams. Available habitat for steelhead would be approximately 58 miles with volitional fishways. If trap and haul were implemented to actively transport steelhead migrants around the Lower Klamath Project reservoirs, there would be approximately 25 miles of newly accessible habitat. The estimate of 58 miles of additional habitat along the mainstem and within accessible tributaries is based on access to a maximum of 58 miles of anadromous fish (steelhead) habitat (NMFS 2006a)[201], habitat in the bypass reaches, and the continuation of around 22 miles of spawning and rearing habitat inundated by Lower Klamath Project reservoirs (Cunanan 2009). It is anticipated that adults will migrate upstream through inundated reservoir habitat, and that juveniles will migrate downstream with mortality from predation and poor water quality considered in the estimates of passage survival discussed in Section 4.4.3.7 *Fish Passage*. As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within fishways is predicted to be around 28 percent, and 58 percent for downstream migrating juveniles (FERC 2007). Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007). Since mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, any upstream migrating adults that migrated past fewer facilities and reservoirs and spawned in Fall or Jenny creeks for example, would have much lower morality (e.g., 10 percent for adults, FERC 2007). The same is true for downstream migrating juveniles; the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality.

It is likely that steelhead recolonization would occur rapidly, as was observed for similar steelhead populations following fish ladder installation at Landsburg Dam on the Cedar River, Washington (Kiffney et al. 2009), and following removal of Condit Dam on the White Salmon River, Washington (Allen et al. 2016).

Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increased base flows, consistent with mandatory conditions (DOI 2007). Under this alternative, the expected overall higher flow releases would result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler water temperatures in late fall and winter. Similar to the Proposed Project, the effect would be to increase water temperatures in the J.C. Boyle Bypass Reach during summer and early fall months relative to existing conditions.

Poor water quality conditions in reservoirs, such as high temperatures with low dissolved oxygen, fluctuations in dissolved oxygen, pH, ammonia associated with algal blooms, and microcystin from *Microcystis aeruginosa* blooms would continue to be stressful to fish from June through September (Dunsmoor and Huntington 2006, FERC 2007).

[201] This also takes into consideration slight differences in the NMFS (2006a) definition of the Project Reach from what is used in this report.

Winter steelhead enter and migrate from August to March; thus, poor water quality could have an effect on these fish as they move through reservoirs. Steelhead generally spawn in tributaries, and juveniles typically outmigrate from April through November, but the peak migration occurs from April through June, so most individuals would be likely to avoid poor reservoir water quality.

Middle and Lower Klamath River
Under the Continued Operations with Fish Passage Alternative, suspended sediment downstream of Iron Gate Dam would be the same as described under existing conditions (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Suspended Sediment]*). Lower Klamath Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment (leading to coarsening of the bed), but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009, Stillwater Sciences 2010a). Current summer steelhead distribution extends from the mouth of the Klamath River upstream to Empire Creek, while winter steelhead are distributed throughout the Lower Klamath River up to Iron Gate Dam (Stillwater Sciences 2010b). Summer and winter steelhead do not spawn in the mainstem Klamath River, nor are they expected to in the future, so spawning habitat would not be affected by alterations to bedload composition downstream from Iron Gate Dam under the Continued Operations with Fish Passage Alternative. Changes to bedload sediment and effects on juvenile rearing and migration would be expected to remain similar to existing conditions.

As described above in Section 4.4.3.4 *Fish Disease and Parasites*, overall incidence of fish disease for steelhead under the Continued Operations with Fish Passage Alternative may be reduced but is unlikely to be eliminated.

Despite modest improvements in dissolved oxygen concentrations from implementation of actions contained within the Reservoir Management Plan (i.e., turbine venting system at Iron Gate Dam; see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1 and Appendix C – *Section C.4.2*), dissolved oxygen concentrations during August through October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August through September and 90 percent saturation from October and November (see Section 3.2.2.5 *Dissolved Oxygen*). In addition, the presence of microcystin, associated with the dense blooms of *Microcystis aeruginosa* in Iron Gate and Copco reservoirs, would continue to occur downstream from Iron Gate Dam, as there is currently no reasonable proposal that would decrease periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs to concentrations that would not exceed water quality standards (see also Potential Impact 4.2.2-7).

Klamath River Estuary and Pacific Nearshore Environment
The Continued Operations with Fish Passage Alternative is not expected to substantially alter steelhead estuarine habitat.

Summary
In the short term, there would be no impact (no change relative to existing conditions) for steelhead from the habitat attributes that would be anticipated to affect the population within a short (less than five years) time frame, such as substantial changes in

suspended sediment like those predicted to occur under the Proposed Project (Section 3.3.5.1 *Suspended Sediment*).

In the long term (more than five years), under this alternative, fishways could result in alterations in habitat availability for steelhead. Under the Continued Operations with Fish Passage Alternative, steelhead could regain access to approximately 414 miles (or fewer if trap and haul were used) of mainstem and tributary habitat in the upper Klamath River and Hydroelectric Reach, and thermal refugia within the Hydroelectric Reach, which would benefit the population. FERC (2007) concluded that implementing fish passage would help to reduce adverse effects to steelhead associated with lost access to upstream spawning habitats. Hamilton et al. (2011) also concluded that access to additional habitat in the Upper Klamath River watershed would benefit steelhead runs. Mortality could occur for migrants from passage through fishways, and from migration through Lower Klamath Project reservoirs.

This alternative would result in continuation of some of the stresses that currently affect steelhead populations. The presence of dams and reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist (although steelhead are more resistant to *C. Shasta* than other salmonids). Due to implementation of actions contained within PacifiCorp's Reservoir Management Plan, these conditions are likely to improve somewhat over the long term, although there is currently no reasonable proposal to improve water temperatures towards full support of cold freshwater habitat (COLD) (Section 4.4.2 *Water Quality*). These reservoir-related conditions would continue to have negative effects on steelhead populations, as compared to a without-dams scenario under the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-9). The overall effect of the Continued Operations with Fish Passage Alternative on fish disease may be slightly improved but is unlikely to be substantially altered from existing conditions.

It is anticipated that as a result of the increased habitat availability under the Continued Operations with Fish Passage Alternative, the summer and winter steelhead within the Klamath River watershed would have an increase in abundance, population spatial structure, and genetic diversity. These increases would confer greater population-level benefits than the expected mortality within the fishways, resulting in overall increases in the viability of summer and winter steelhead in the long term.

Significance

No significant impact for steelhead in the short term

Beneficial for steelhead in the long term

Potential Impact 4.2.3-11 Effects on the Pacific lamprey population due to continued operations of the Lower Klamath Project.

Upper Klamath River and Connected Waterbodies

Available data suggests that Pacific lamprey were in both mainstem and tributary reaches of the Klamath River upstream to and including Spencer Creek at RM 232.6 (Figure 3.3-1, Hamilton et al. 2005). It is not anticipated that under the Continued Operations with Fish Passage Alternative Pacific lamprey would begin to occupy habitat

within the Upper Klamath River and connected waterbodies, and therefore there would be no change from the existing condition.

Upper Klamath River — Hydroelectric Reach

Under the Continued Operations with Fish Passage Alternative, Pacific lamprey would be able to access habitat in the Hydroelectric Reach by ascending the fishways associated with each of the dams. Available habitat for Pacific lamprey would be approximately 58 miles with volitional fishways. If trap and haul were implemented to actively transport Pacific lamprey migrants around the Lower Klamath Project reservoirs, there would be approximately 25 miles of newly accessible habitat. The estimate of 58 miles of additional habitat along the mainstem and within accessible tributaries is based on access to a maximum of 58 miles of anadromous fish (steelhead) habitat (NMFS 2006a)[202], habitat in the bypass reaches, and the continuation of around 22 miles of spawning and rearing habitat inundated by Lower Klamath Project reservoirs (Cunanan 2009). It is anticipated that adults will migrate upstream through inundated reservoir habitat, and that juveniles will migrate downstream with mortality from predation and poor water quality considered in the estimates of passage survival discussed in Section 4.4.3.7 *Fish Passage*. As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within fishways is predicted to be around 28 percent, and 58 percent for downstream migrating ammocoetes (FERC 2007). Since mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, any upstream migrating adults that migrated past fewer facilities and reservoirs and spawned in Fall or Jenny creeks for example, would have much lower morality (e.g., 10 percent for adults, FERC 2007). The same is true for downstream migrants; the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality. Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007).

Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increased base flows. In addition, passage would provide Pacific lamprey with some refuge from high temperatures by allowing cooler tributaries to flow directly into the mainstem Klamath River, adding to the 200 to 250 cfs provided by coldwater springs in the J.C. Boyle Bypass Reach (DOI 2007, FERC 2007, Hamilton et al. 2011). Under this alternative, suspended and bedload sediment, water quality, water temperature, and the occurrence of algal toxins would continue to be the same as under existing conditions.

Poor water quality conditions in reservoirs, such as high temperatures with low dissolved oxygen, changes in dissolved oxygen, pH, and ammonia associated with algal blooms, and microcystin from *Microcystis aeruginosa* blooms would continue to be stressful from June to September (Dunsmoor and Huntington 2006, FERC 2007), although modest improvements in water quality are expected with continued implementation of Reservoir Management Plan actions (see Section 4.4.2 *Water Quality*). Pacific lamprey adults migrate from winter through spring, while juveniles (age 2 to age 10) outmigrate year-round, with peaks during late spring and fall. Seasonally poor reservoir quality would likely not affect migrating adults but could affect juveniles. Juveniles would be subject to

[202] This also takes into consideration slight differences in the NMFS (2006a) definition of the Project Reach from what is used in this report.

some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch (FERC 2007).

Middle and Lower Klamath River

Under the Continued Operations with Fish Passage Alternative, suspended sediment downstream of Iron Gate Dam would be the same as described under existing conditions (Section 3.3.2.3 *Habitat Attributes Expected to be Affected by the Proposed Project [Suspended Sediment]*). Lower Klamath Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment (leading to coarsening of the bed), but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009, Stillwater Sciences 2010a). Spawning and rearing habitat for Pacific lamprey downstream of Iron Gate Dam would be expected to remain similar to existing conditions.

Despite modest improvements in dissolved oxygen concentrations from implementation of actions contained within the Reservoir Management Plan (i.e., turbine venting system at Iron Gate Dam; see discussion in Section 4.4.2.1 *[Continued Operations with Fish Passage] Water Temperature*, Potential Impact 4.2.2-1 and Appendix C – *Section C.4.2*), dissolved oxygen concentrations during August through October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August through September and 90 percent saturation from October and November (see Section 3.2.2.5 *Dissolved Oxygen*). In addition, the presence of microcystin, associated with the dense blooms of *Microcystis aeruginosa* in Iron Gate and Copco reservoirs, would continue to occur downstream from Iron Gate Dam, as there is currently no reasonable proposal that would decrease periodically high algal toxin concentrations in the surface waters of Copco No. 1 and Iron Gate reservoirs to concentrations that would not exceed water quality standards (see also Potential Impact 4.2.2-7).

Klamath River Estuary and Pacific Ocean Nearshore Environment

The Continued Operations with Fish Passage Alternative is not expected to substantially alter Pacific lamprey estuarine habitat.

Summary

In the short term, there would be no impact (no change relative to existing conditions) for Pacific lamprey from the habitat attributes that would be anticipated to affect the population within a short (less than five years) time frame, such as substantial changes in suspended sediment like those predicted to occur under the Proposed Project (Section 3.3.5.1 *Suspended Sediment*).

In the long term (more than five years), under this alternative, fishways could result in alterations in habitat availability for Pacific lamprey. Under the Continued Operations with Fish Passage Alternative, Pacific lamprey would regain access to approximately 58 miles of mainstem and tributary habitat in the upper Klamath River and Hydroelectric Reach, and thermal refugia within the Hydroelectric Reach, which would benefit the population. FERC (2007) concluded that implementing fish passage would help to reduce adverse effects to Pacific lamprey associated with lost access to upstream spawning habitats. Mortality would occur for migrants from passage through fishways, and from migration through Lower Klamath Project reservoirs.

This alternative would result in continuation of some of the stresses that currently affect Pacific lamprey populations. The presence of dams and reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures. Due to implementation of actions contained within PacifiCorp's Reservoir Management Plan, these conditions are likely to improve somewhat over the long term, although there is currently no reasonable proposal to improve water temperatures towards full support of cold freshwater habitat (COLD) (Section 4.4.2 *Water Quality*). These reservoir-related conditions would continue to have negative effects on Pacific lamprey populations, as compared to a without-dams scenario under the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-9).

It is anticipated that, as a result of the increased habitat availability under the Continued Operations with Fish Passage Alternative, the Pacific lamprey population within the Klamath River watershed would have an increase in abundance, population spatial structure, and genetic diversity (NMFS 2006a). These increases would confer greater population-level benefits than the expected mortality within the fishways, resulting in overall increases in the viability of Pacific lamprey in the long term.

Significance
No significant impact for Pacific lamprey in the short term

Beneficial for Pacific lamprey in the long term

Potential Impact 4.2.3-12 Effects on the green sturgeon population due to continued operations of the Lower Klamath Project.
Under the Continued Operations with Fish Passage Alternative, conditions in the area occupied by green sturgeon are unlikely to change relative to existing conditions as green sturgeon occur no further upstream than Ishi Pishi Falls, and this alternative does not have substantial effects relative to existing conditions that extend that far downstream (as described in Section 4.4.3.1 *Suspended Sediment* through Section 4.4.3.6 *Aquatic Habitat and Instream Flows*).

Significance
No significant impact for green sturgeon in the short term and long term

Potential Impact 4.2.3-13 Effects on Lost River and shortnose sucker populations due to continued operations of the Lower Klamath Project.
Under the Continued Operations with Fish Passage Alternative, shortnose and Lost River suckers would continue to be subject to seasonally poor water quality and high rates of predation from non-native fish species within Lower Klamath Project reservoirs, as described in Section 3.3.2.1 *Fish Species [Lost River and shortnose suckers]*. However, with little or no successful reproduction (Buettner et al. 2006), populations downstream from Keno Dam contribute minimally to conservation goals and insignificantly to recovery (Hamilton et al. 2011).

Under the Continued Operations with Fish Passage Alternative, Lost River and shortnose sucker would be able to migrate among habitats within Iron Gate, Copco No. 1, and J.C. Boyle Reservoirs. Since upstream migration at Keno Dam is currently possible to some degree with existing facilities (DOI 2007), suckers would potentially have migratory connectivity from the Lower Klamath Project reservoirs to Upper Klamath

Lake and connected waterbodies. Migratory opportunities may increase access to spawning habitat and increase the abundance and resiliency of the sucker populations (Buettner et al. 2006). However, Miller and Smith (1981) claimed that sucker hybridization was most pronounced in the Lower Klamath Project reservoirs, and Markle et al. (2005) reported hybridization between small scale sucker and both Lost River and shortnose suckers in the Hydroelectric Reach. Hybridization is considered by the sucker recovery plan (USFWS 2013) to be a predominate threat to the populations. Hybridization prompted Buettner et al. (2006) and others to caution against supporting migration of individuals from Iron Gate and Copco reservoirs into the Upper Klamath Lake population. If fish passage were to be provided, there is a potential deleterious effect on the population from increased hybridization (USFWS 2013). Under the Proposed Project, Aquatic Resource Measure AR-6 is included to rescue and salvage suckers from Lower Klamath Project reservoirs prior to their removal. However, AR-6 includes genetic testing for hybridization, and sucker salvage and release is to be only into waterbodies isolated from the Upper Klamath Lake Populations to prevent the risk of further hybridization. As the Continued Operations with Fish Passage Alternative would directly connect the reservoirs for fish, no such measures would be possible, and the risk of hybridization within the Upper Klamath Lake sucker population would be increased. No data are available to predict the extent of potential hybridization or whether it hybridization would have a long-term impact on the Lost River and shortnose sucker population. Overall, it is speculative to determine whether increased access to spawning habitat outweigh the increased risk of hybridization, or vice-versa.

The effect of the Continued Operations with Fish Passage Alternative would be no impact for Lost River and shortnose sucker populations in the short term and long term.

Significance

No significant impact for shortnose and Lost River suckers in the short term and long term

Potential Impact 4.2.3-14 Effects on the redband trout population due to continued operations of the Lower Klamath Project.

Upper Klamath River and Connected Waterbodies

Under existing conditions redband trout can migrate through a fish ladder at Keno Dam, and occasionally through a poorly functioning fish ladder at J.C. Boyle Dam (DOI 2007). Under the Continued Operations with Fish Passage Alternative, redband trout would be able to migrate more successfully from the Hydroelectric Reach to the Upper Klamath Basin (Hamilton et al. 2011) than under existing conditions. New fish passage facilities would improve access to Spencer Creek, which provides important spawning habitat and temperature refugia for redband trout (DOI 2007, Buchanan et al. 2011). New upstream fish passage would also improve connectivity of resident redband populations in the mainstem Klamath River to those in Lake Ewauna, the Link River, and Upper Klamath Lake (DOI 2007).

Redband trout under this alternative could be affected by the reintroduction of anadromous fish, including the potential for competition, predation, and exposure to disease, as described for the Proposed Project in Section 3.3.5.9.

Upper Klamath River — Hydroelectric Reach

Fish passage resulting from the Continued Operations with Fish Passage Alternative would allow redband trout to express the seasonal movements and migration patterns

that were historically in place, restore population connectivity and genetic diversity, and allow greater use of existing habitat and refugia. Effective fishways at J.C. Boyle would greatly improve connectivity to Spencer Creek. Fish passage at Copco No. 1 and Copco No. 2 dams would restore connectivity throughout the Hydroelectric Reach to Shovel Creek, which provides spawning habitat and temperature refugia (DOI 2007). Passage at Iron Gate Dam would also restore connectivity between populations in the mainstem Klamath River and those in the Copco No. 2 Bypass Reach and in Slide, Scotch, Camp, Jenny, Salt, and Fall creeks, which also provide spawning habitat and temperature refugia (DOI 2007). The existing fish screen and ladder at the J.C. Boyle Dam do not meet current state and federal fish passage criteria and the ladder impairs upstream migration (Administrative Law Judge 2006). Improvements in efficiency to the fishway at J.C. Boyle Dam would result in significant trout population migration above the dam over time (Administrative Law Judge 2006). As described in Section 4.4.3.7 *Fish Passage*, upstream migrating adult mortality within all the fishways is predicted to be approximately 28 percent, and 58 percent for downstream migrating juveniles (FERC 2007). Since mortality estimates are cumulative assuming migration through all facilities past all dams and through all reservoirs, any upstream migrating adults that migrated past fewer facilities and reservoirs would have much lower morality. The same is true for downstream migrants; the fewer facilities and reservoirs required during downstream migration, the lower the cumulative mortality. This is especially true for redband trout, which may only migrate past one facility to gain access to spawning habitat, and thus may experience mortality during migration of less than 5 percent (FERC 2007). Increased production resulting from increased habitat access is anticipated to off-set losses from fish passage injury and mortality (FERC 2007).

Under the Continued Operations with Fish Passage Alternative, redband trout would continue to be subject to seasonally poor water quality and high rates of predation from non-native fish species within Lower Klamath Project reservoirs, as described in Section 3.3.2.1 *Fish Species [Redband trout]*. Habitat in the J.C. Boyle Bypass and Peaking reaches and the Copco No. 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increased base flows.

Summary
In the short term, there would be no meaningful impact (relative to existing conditions) for redband trout.

In the long term, fishways at the Lower Klamath Project dams and changes in operations could result in alterations in habitat availability and suitability which could affect redband trout. The Continued Operations with Fish Passage Alternative would improve habitat connectivity throughout the Hydroelectric Reach and to the upper Klamath River in the long term, increasing access to spawning habitat and temperature refugia. Redband trout would still be subject to seasonally poor water quality, and some level of predation within the reservoirs, but increases in connectivity and reduced effects of hydropower peaking operations would likely provide a benefit to redband trout populations. The habitat improvements and increased connectivity would confer greater population-level benefits than the expected mortality within the fishways, resulting in overall benefits to redband trout in the long term.

Significance
No significant impact for redband trout in the short term

Beneficial for redband trout in the long term

Potential Impact 4.2.3-15 Effects on the eulachon population due to continued operations of the Lower Klamath Project.
Under the Continued Operations with Fish Passage Alternative, the extent and quality of eulachon habitat would be expected to remain the same as existing conditions. As eulachon occur far downstream (more than 150 river miles downstream) in the river from the Hydroelectric Reach, mixing and inflows from intervening tributaries would continue to reduce seasonally poor water quality conditions originating in the Lower Klamath Project dams. The effect of the Continued Operations with Fish Passage Alternative would be no impact (no change from existing conditions) for eulachon in the short term and long term.

Significance
No significant impact for eulachon in the short term and long term

Potential Impact 4.2.3-16 Effects on the longfin smelt population due to continued operations of the Lower Klamath Project.
Under the Continued Operations with Fish Passage Alternative, the extent and quality of longfin smelt habitat would be expected to remain the same as existing conditions. As longfin smelt occur far downstream (more than 150 river miles downstream) in the river from the Hydroelectric Reach, mixing and inflows from intervening tributaries would continue to reduce seasonally poor water quality conditions originating in the Lower Klamath Project dams. The effect of the Continued Operations with Fish Passage Alternative would be no impact (no change from existing conditions) for longfin smelt in the short term and long term.

Significance
No significant impact for longfin smelt in the short term and long term

Potential Impact 4.2.3-17 Effects on species interactions between introduced resident fish species and native aquatic species due to continued operations of the Lower Klamath Project.
Introduced fish species threaten the diversity and abundance of native fish species through competition for resources, predation, interbreeding with native populations, and causing potential physical changes to the invaded habitat (Moyle 2002). Introduced resident species occur within reservoirs upstream of Iron Gate Dam, and infrequently downstream from Iron Gate Dam. . Adults yellow perch are opportunistic predators that feed on small fish, potentially including native fish species. Juvenile and adult largemouth bass tend to feed on larger invertebrates and fish as well, potentially including native species. Under the Continued Operations with Fish Passage Alternative, dams in the Hydroelectric Reach would not be removed, allowing reservoir habitat to remain the same as existing conditions. Additionally, anadromous fish that are now prevented from entering the reservoirs would be able to do so. However, connectivity between the reservoirs could increase access to available habitat area for introduced species as well as native species if they are able to migrate through volitional passage facilities. Migratory connectivity is more likely to increase the population abundance and resiliency of native species adapted to more riverine conditions, than reservoir-dependent non-natives. Juvenile native species migrating through reservoirs would be subject to some level of predation by introduced resident species resulting in mortality rates that would depend largely on their size (larger migrants would do better)

(NMFS 2006a). Mortality rates in reservoirs can be substantial (>50 percent; Stillwater Sciences 2018). Based on the reservoir dynamics and the predator population that currently occurs, predation of outmigrating salmonids above Iron Gate Dam is anticipated to be low (NMFS 2006a). In restoration efforts elsewhere in the Pacific Northwest, anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (NMFS 2006a). Overall, the effect of the Continued Operations with Fish Passage Alternative would be less than significant for the effects of introduced resident species on native aquatic species. If passage were provided through trap and haul, these interactions would be further reduced, as fewer juvenile anadromous fish would enter Copco No. 1, Copco No. 2 and Iron Gate reservoirs.

Significance

No significant impact for the effects of introduced resident species on native aquatic species

Potential Impact 4.2.3-18 Effects on aquatic species from interactions among fish species due to continued operations of the Lower Klamath Project.

The Continued Operations with Fish Passage Alternative would restore access for migratory fish species to habitat upstream of Iron Gate Dam, as described in detail above. As described for the Proposed Project (Section 3.3.5.9, Potential Impact 3.3-18), restoration of access would result in Pacific lamprey, anadromous salmon, and steelhead potentially interacting with resident redband trout and bull trout, with the potential for competition and predation. These species evolved together in the Upper Klamath Basin of the Klamath River, and co-existed prior to the construction of dams (Goodman et al. 2011).

Anadromous salmonids currently co-exist with resident rainbow trout and resident cutthroat trout downstream from Iron Gate Dam, without any obvious detriment to these native species or the aquatic ecosystem in which they reside. While there is little information on the nature of any competitive interactions between steelhead and resident trout in the Klamath Basin, research does suggest that in some circumstances, resident trout may have a competitive edge over steelhead (NMFS 2006a). Conversely, research has shown that hatchery salmon supplementation can negatively impact resident trout abundance and salmonid biomass in a Washington watershed (Pearsons and Temple 2010). However, competition between steelhead and currently present indigenous species such as redband trout are not assumed to be a major limiting factor since these species historically co-evolved (Hooton and Smith 2008). There are many examples from nearby river systems in the Pacific Northwest that show wild anadromous steelhead and resident rainbow/redband trout can co-exist and maintain abundant populations without adverse consequences. The Deschutes River in Oregon, the Yakima River in Washington, and the river systems in Idaho are examples (NMFS 2006a). As noted by Buchanan et al. (2011a), existing trout and colonizing anadromous steelhead are expected to co-exist in the Klamath Basin, as they do in other watersheds, although there may be shifts in abundance related to competition for space and food. Overall, there is no predicted substantial short-term or long-term decrease in native aquatic species abundance of a year class, or substantial decrease in habitat quality or quantity, and there would not be a significant impact to the aquatic species populations under the Continued Operations with Fish Passage Alternative in the short term or long term.

Significance
No significant impact for effects to aquatic species from interactions among fish species in the short term and long term

Potential Impact 4.2.3-19 Effects on freshwater mollusks populations due to continued operations of the Lower Klamath Project.
Under the Continued Operations with Fish Passage Alternative, suspended sediment, algal toxins, and other dynamics that potentially affect freshwater mussels would not change substantially from existing conditions, since only modest improvements in water quality are expected with continued implementation of actions contained within PacifiCorp's Reservoir Management Plan (see Section 4.4.2 *Water Quality*). The Continued Operations with Fish Passage Alternative would therefore have no significant impact as compared to the existing condition on mussels in the short term and long term.

Significance
No significant impact for freshwater mussels in the short term and long term

Potential Impact 4.2.3-20 Effects on fish species from alterations to benthic macroinvertebrates due to continued operations of the Lower Klamath Project.
Benthic macroinvertebrates (BMI) are small aquatic animals and the aquatic larval stages of insects. BMI are the primary food source for most freshwater fish species, and therefore, changes in abundance, distribution, or community structure can affect fish populations. A diminished food supply can limit growth of salmonids, and this is especially true at higher temperatures because as water warms, a fish's metabolic rate increases, and it needs more food to sustain growth. Growth is critical to juvenile salmonids because a larger size fish often has a survival advantage during the overwintering period, smolt outmigration, and ocean residence.

Under the Continued Operations with Fish Passage Alternative, reduction in peaking operations in the Hydroelectric Reach would result in a reduction in periodic killing, through stranding, of large numbers of young fish and aquatic invertebrates that are the primary prey food for salmonids (Administrative Law Judge 2006). Increased minimum flows in the bypass reaches may increase BMI production. This would result in a benefit to food availability both for the trout and other fish currently in the reach, and for anadromous species gaining access to the reach.

While the additional flows under this alternative would periodically increase the mobility of existing surficial fine sediment deposits downstream of Iron Gate Dam, in general, suspended sediment, which can affect benthic macroinvertebrates as discussed for the Proposed Project in Section 3.3.5.9, Potential Impact 3.3-20, would also be the same as under existing conditions. Further, since only modest improvements in water quality are expected with continued implementation of actions contained within PacifiCorp's Reservoir Management Plan (see Section 4.4.2 *Water Quality*), the effect of the Continued Operations with Fish Passage Alternative would be no significant impact (no change from existing conditions) on fish species due to alterations to benthic macroinvertebrates in the short term and long term.

Significance
No significant impact for effects of alterations to benthic macroinvertebrates on fish species in the short term and long term

Potential Impact 4.4.3-1 Effects on aquatic resources due to short-term noise disturbance and water quality alterations from fishway construction activities. This analysis relates to the potential impacts to aquatic resources from various construction activities associated with fishways under the Continued Operations with Fish Passage Alternative.

Disturbance to the river channel during construction related to the Continued Operations with Fish Passage Alternative could affect aquatic species. This alternative would require removal of the existing J.C. Boyle fish ladder structure, construction of a new fishways at all dams (Figure 2.3-1), and construction of downstream fish passage at all dams. Fish ladder construction would include building upstream fish ladders, spillway modifications, tailrace barriers, screens, and bypass structures (see Appendix U of this EIR for more details). These actions would include the use of heavy equipment, and blasting as necessary, and have the potential to disturb aquatic species. Activities at the Lower Klamath Project dams would affect the riverine and reservoir species in the Hydroelectric Reach. At Iron Gate Dam and Iron Gate Hatchery, anadromous species could also be affected. These potential effects could include shockwaves associated with construction of fish ladders using heavy equipment, potential crushing of aquatic species from operation of heavy equipment in the river, sedimentation, and release of oil, gasoline, or other toxic substances from construction sites.

Although the duration of construction for any individual facility would range from approximately four months to one year (Table 4.4-1), the entire process of installing fish passage at each of the four Lower Klamath Project dams would take place over a four- to eight--year period (FERC 2007). Unlike under the Proposed Project, these construction activities would not necessarily be limited to the timeframe that generates the least impact on the various life stages of anadromous fish in the Klamath River (i.e., winter and spring months), although since downstream facilities would be installed prior to upstream passage facilities, anadromous fish potentially would not be exposed to construction impacts related to building the downstream facilities.

As some of the construction activities under this alternative would occur directly in the river channel (i.e., “in-water”) or on the banks immediately surrounding the river, the potential for impacts to aquatic species are greater than for work conducted in areas that can be dewatered or dried. To minimize potential construction impacts from crushing, sediment release, toxins, noise, etc., construction areas would be isolated from the river where possible. Areas to be dewatered would be isolated, and fish rescue and relocation efforts would be undertaken to remove any native fish trapped in the work area. Fish would be relocated to an area of suitable habitat within the Klamath River.

Implementation of mitigation measures WQ-1 and HZ-1 would reduce impacts to less than significant for fish passage construction-related activities in the Hydroelectric Reach throughout the four- to eight-year construction period under the Continued Operations with Fish Passage Alternative. If instead of fish ladders, trap and haul, or some combination of fish passage methods were used, there would be the potential for reduced construction compared to the aforementioned activities for fish ladders (see also Section 4.4.1 *[Continued Operations with Fish Passage Alternative] Introduction*).

Based on no predicted substantial short- or long-term decrease in in the abundance of a year class of any aquatic species, or substantial decrease in habitat quality or quantity for any aquatic species, there would not be a significant impact to aquatic resources

under the Continued Operations with Fish Passage Alternative in the short term or long term from fishway construction impacts.

Significance
No significant impact with mitigation in the short term or long term

4.4.4 Phytoplankton and Periphyton

4.4.4.1 Phytoplankton

As discussed in more detail in Section 3.4, phytoplankton are aquatic microscopic organisms, including algae, bacteria, protists, and other single-celled plants, that obtain energy through photosynthesis and float in the water column of still or slowly flowing waters such as lakes or reservoirs. Excess growth of these organisms can cause nuisance water quality conditions, such as extreme diel (daily) fluctuations in dissolved oxygen and pH (see Section 3.4.2.1 *Phytoplankton* for detail. Under the Continued Operations with Fish Passage Alternative, reservoir sediment deposits would not be mobilized in the Hydroelectric Reach, Middle and Lower Klamath River, or the Klamath River Estuary, and there would be no short-term increases in sediment-associated nutrients that could potentially stimulate nuisance and/or noxious phytoplankton growth in those reaches (Potential Impact 3.4-1), and thus there would be no significant impact.

Nutrient reduction measures in Oregon and California due to the Klamath TMDLs would result in some differences between the Continued Operations with Fish Passage Alternative and existing conditions with respect to long-term phytoplankton blooms in the reservoirs. Additionally, PacifiCorp intends to design and implement a Reservoir Management Plan, which would result in some differences between this alternative and existing conditions. These differences are discussed below (Potential Impact 4.4.4-1).

Potential Impact 4.4.4-1 Long-term occurrence of nuisance and/or noxious phytoplankton blooms in the reservoirs.
Because the Lower Klamath Project reservoirs would remain in place, Copco No. 1 and Iron Gate reservoirs would continue to provide beneficial habitat conditions for the proliferation of large seasonal blooms of *Aphanizomenon flos-aquae*, *Anabaena flos-aquae*, and *Microcystis aeruginosa*, which subsequently become the source of these species to the Middle and Lower Klamath River, and eventually the Klamath River Estuary (see also Section 3.4.2.3 *Hydroelectric Reach*). Note that the increase in minimum flows for the Copco No. 2 Bypass Reach under this alternative could increase summertime phytoplankton concentrations in the Bypass Reach relative to existing conditions if the water were to be withdrawn from the Copco No. 1 Reservoir surface waters during an intensive bloom period, however this potential is too speculative to evaluate further.

As discussed in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impact 4.2.2-4, PacifiCorp has developed several iterations of a Reservoir Management Plan that proposed solutions to addressing water quality impairments associated with J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate dams, including seasonal increases in TP, and to a lesser degree TN, in the Hydroelectric Reach due to the release (export) of dissolved forms of phosphorus (ortho-phosphorus) and nitrogen (ammonium) from Copco No. 1 and Iron Gate reservoir sediments during summer and fall, when reservoir bottom waters are anoxic (through internal nutrient loading, see

Figure 3.2-2). The improvement actions described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6 do not indicate that this measure could reduce the extent of phytoplankton blooms in the reservoirs such that they would no longer cause large seasonal blooms of *Microcystis aeruginosa*. Also as described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impacts 4.2.2-2, 4.2.2-4, 4.2.2-5, and 4.2.2-6, nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial with respect to decreasing nuisance phytoplankton blooms. However, the measures necessary to achieve significant reductions are, at this point, unknown and reductions are likely to require decades to achieve. Warmer water temperatures under climate change would further exacerbate seasonal phytoplankton blooms in Copco No. 1 and Iron Gate reservoirs and overall there is currently no reasonable proposal to substantially reduce nuisance and/or noxious phytoplankton blooms, including *Microcystis aeruginosa*, in the surface waters of Copco No. 1 and Iron Gate reservoirs during summer and fall months (Potential Impact 3.4-2), which subsequently become the source for the Middle and Klamath River, and Klamath River Estuary. The Continued Operations with Fish Passage Alternative would result in no change from existing adverse conditions in the short term and long term for these reaches. With respect to the Pacific Ocean nearshore environment, the latter is not suitable habitat for the freshwater phytoplankton species of concern (i.e., *Aphanizomenon flos-aquae, Anabaena flos-aquae, Microcystis aeruginosa*) (Potential Impact 3.4-2), and leaving the dams in place under the Continued Operations with Fish Passage Alternative would result in no significant impact relative to existing conditions.

Significance

No significant impact in the long term for the Hydroelectric Reach, Middle and Lower Klamath River, and the Klamath River Estuary

4.4.4.2 Periphyton

As discussed in more detail in Section 3.4 *Phytoplankton and Periphyton*, periphyton are aquatic organisms including aquatic plants, algae, and bacteria that live attached to underwater surfaces such as rocks on a riverbed. Some degree of periphyton growth is an important part of stream ecosystem function. Excess growth of these organisms can cause nuisance water quality conditions, such as extreme diel (daily) fluctuations in dissolved oxygen and pH (see Section 3.4.2.2 *Periphyton* for detail). Under the Continued Operations with Fish Passage Alternative, reservoir sediment deposits would not be mobilized in the Hydroelectric Reach, Middle and Lower Klamath River, or the Klamath River Estuary, and there would be no short-term increases in sediment-associated nutrients that could potentially stimulate nuisance periphyton growth in those reaches (Potential Impact 3.4-4), and thus there would be no significant impact.

The Continued Operations with Fish Passage Alternative would change the flow regime downstream of J.C. Boyle Dam, Copco No. 2 Dam, and Iron Gate Dam. These differences are discussed below (Potential Impact 4.4.4-2).

Potential Impact 4.4.4-2 Long-term colonization of nuisance periphyton in riverine reaches.

The Continued Operations with Fish Passage Alternative would change the flow regime downstream of J.C. Boyle Dam. This alternative would have the same or similar potential short-term and long-term impacts on periphyton in the Hydroelectric Reach

from the Oregon-California state line to Copco No. 1 Reservoir as those identified for the Proposed Project (Potential Impact 3.4-4). This is because increased minimum flows in the J.C. Boyle Bypass Reach and reduction of peaking operations at J.C. Boyle Powerhouse to one day per week, would result in a similar flow regime in the California portion of the Peaking Reach as that described under the Proposed Project, and it is these flow regime changes that have the potential to increase periphyton habitat. There would be less artificial diel (24-hour) temperature variation during summer and early fall in the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir relative to existing conditions (see also Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality,* Potential Impact 4.2.2-1). J.C. Boyle Reservoir retains relatively little nutrients under existing conditions (see Appendix C, Section C.3.1.1 *Hydroelectric Reach*), and therefore nutrient conditions in this reach would be the same under the Continued Operations with Fish Passage Alternative as under existing conditions since there would be no change in nutrient interception or retention with J.C. Boyle Dam remaining in place (see also Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impact 4.2.2-4). The less diel (24-hour) temperature variations and slight decrease in the maximum water temperature in this reach is not anticipated to affect periphyton colonization. Additionally, the generally high gradient and velocity in the J.C. Boyle Peaking Reach does not currently support excessive periphyton mats and it is not anticipated this reach would support excessive periphyton mats under higher minimum flows and reduce peaking flows. In the short term and long term, increases in periphyton biomass from reduction of peaking flows along with the change in water temperature in this reach are expected to be limited under the Continued Operations with Fish Passage Alternative and any potential increase in periphyton would not result in new or further impairment of designated beneficial uses. For the reasons described above, increased minimum flows and reductions in peaking flows in the Copco No. 2 Bypass Reach under this alternative also would not result in new or further impairment of designated beneficial uses due to periphyton growth. Overall, in the Hydroelectric Reach there would be no significant impact.

Further downstream, the continuing presence of the Lower Klamath Project dams would continue to support periphyton growth in the Middle and Lower Klamath River as described for existing conditions (Section 3.4.2.4 *Middle and Lower Klamath River*), with the exception that the 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam under this alternative would scour the streambed more regularly than under simply the 2013 BiOp Flows that characterize the existing condition. This is likely to reduce dense growth of periphyton in the Middle Klamath River from Iron Gate Dam to approximately the Shasta River confluence (RM 179.5) relative to existing conditions, even as the contribution of the hydroelectric facilities to such nuisance growth remains unchanged, and would be beneficial (see also Potential Impact 4.2.4-1).

PacifiCorp intends to design and implement a Reservoir Management Plan to reduce water quality impairments in the Hydroelectric Reach and immediately downstream of Iron Gate Dam, including seasonal release of nutrients from Copco No. 1 and Iron Gate reservoir sediments during summer and fall, when reservoir bottom waters are anoxic. As described in Section 4.4.2 *[Continued Operations with Fish Passage] Water Quality* Potential Impact 4.2.2-4, results of Reservoir Management Plan studies to date do not indicate that reduced seasonal nutrient releases from the reservoirs would occur under this alternative. Nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial with respect to decreasing overall nutrient concentrations in the

Middle and Lower Klamath River. However, the measures necessary to achieve significant reductions are, at this point, unknown and reductions are likely to require decades to achieve. However, because nutrients do not appear to be limiting periphyton growth in the Klamath River from Iron Gate Dam to approximately Seiad Valley (RM 132.7) (and potentially farther downstream) (see also Potential Impact 3.4-5), nutrient dynamics associated with the Continued Operations with Fish Passage Alternative are not likely to have an effect on periphyton growth in the Middle and Lower Klamath River, such that there would be no new or further impairment of designated beneficial uses.

Overall, the increased scouring of the streambed due to 2017 court-ordered flushing and emergency dilution flows downstream of Iron Gate Dam would reduce dense growth of periphyton in the Middle Klamath River relative to existing conditions, and would be beneficial.

Significance
No significant impact for the Hydroelectric Reach

Beneficial for the Middle Klamath River from Iron Gate Dam to the Shasta River (RM 179.5)
No significant impact for the Middle Klamath River downstream of the confluence with the Shasta River (RM 179.5) and the Lower Klamath River

4.4.5 Terrestrial Resources

4.4.5.1 Vegetation Communities

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to facilitate upstream and downstream fish ladders, at all four Lower Klamath Project dam complexes. These activities would have a reduced construction footprint as compared to that necessary for removal of the Lower Klamath Project dam complexes under the Proposed Project, as fewer structures would be removed and less debris created. These activities would take place within the Limits of Work for the Proposed Project, thus construction-related impacts on wetland and riparian vegetation would generally be similar to, but less than those described for the Proposed Project. As described in Section 3.5.5.1, construction activities resulting in ground disturbance would have short-term impacts on sensitive habitats, including wetlands and riparian habitats along reservoirs and river reaches. Within the construction footprint of the fishways, implementation of Mitigation Measure TER-1 described in Potential Impact 3.5-1 and Mitigation Measure TER-5, would reduce potential short-term construction impacts on sensitive habitats to less than significant.

Implementation of mitigation measures TER-1 and TER-5 would be enforceable through inclusion in a water quality certification and construction-related impacts on wetlands and riparian vegetation communities with mitigation would be reduced for the reasons described in Section 3.5.5.1 *Terrestrial Resources Potential Impacts and Mitigation*. Therefore, construction impacts on wetlands and riparian communities, would be less than significant with mitigation.

Under the Continued Operations with Fish Passage Alternative there would be no impact on wetland and riparian vegetation resulting from short- or long-term habitat loss or gain

as compared with existing conditions, since reservoir drawdown and dam removal activities would not occur (Potential Impacts 3.5-2, 3.5-3, 3.5-4, 3.5-5, and 3.5-8).

Mitigation Measure TER-5 – Identification, protection, and restoration of wetland and riparian habitats.
The KRRC shall conduct a wetland delineation within the limits of construction in accordance with the 1987 U.S. Army Corps of Engineers (USACE) Wetland Delineation Manual (USACE 1987) and applicable Regional Supplements (i.e., Western Mountains, Valleys, and Coast Region [USACE 2010] and Arid West [USACE 2008]). The results of the wetland delineation shall be incorporated into the Continued Operations with a Continued Operations with Fish Passage Alternative design to avoid and minimize direct impacts on wetlands to the maximum extent feasible, and wetland areas adjacent to the construction Limits of Work shall be fenced to prevent inadvertent entry. Where avoidance is not feasible the KRRC shall develop a restoration plan to re-vegetate all areas disturbed during construction with a goal of no net loss of wetland or riparian habitat acreage and functions. The restoration plan shall include details on revegetation native seed mixes based on existing species that will be impacted and installation techniques for container plants and seeds. Wetlands established in restored areas would be monitored for five years or until the performance criteria, as defined in the restoration plant that shall be developed, have been met.

4.4.5.2 Culturally Significant Species

As described in Section 3.5.2.3 many of the species identified by the Native American Tribes in the Klamath River region as culturally significant occur in riparian and wetland habitats. Under the Continued Operations with Fish Passage Alternative, required construction activities including facility development for the fishway prescriptions would result in less ground disturbance than those needed for removal of the Lower Klamath Project dam complexes under the Proposed Project as a result of removing less structures and creating less debris; however, because ground disturbance would occur, the types of potential short- and long-term construction-related impacts on culturally significant species would be similar to those described for the Proposed Project (Potential Impact 3.5-6). Mitigation Measure TER-1 (see Potential Impact 3.5-1) and TER-5 includes wetland buffers to prevent intrusion in wetland habitats, avoid substantial degradation in these areas, and restore with a goal of no net loss of wetland or riparian habitat acreage and function. These measures would reduce short- and long-term impacts on culturally significant species to less than significant under this alternative. Implementation of the TER-1 and TER-5 measures would be enforceable through inclusion in a water quality certification. Therefore, the TER-1 and TER-5 measures are feasible and Potential Impact 3.5-6 would result in no significant impacts from impacts on culturally significant species in riparian and wetland habitats with mitigation for the reasons described in Section 3.5.5.2 *Terrestrial Resources Potential Impacts and Mitigation*.

4.4.5.3 Special-status Species

Under the Continued Operations with Fish Passage Alternative, construction activities for fish passage facilities would constitute major construction in the Limits of Work described in Section 4.4.1. Special-status plant and wildlife species in the Primary Area of Analysis are listed/described in Tables 3.5-4 and 3.5-5. The types of potential short- and long-term construction-related impacts on terrestrial resources would be similar to

those described for the Proposed Project (Potential Impacts 3.5-7, 3.5-9, 3.5-10, 3.5-11, 3.5-12, 3.5-13, 3.5-14, 3.5-28), but would be somewhat less than under the Proposed Project, as there would be less construction-related ground disturbance from the development of fish ladders or trap and haul as compared with removing the dam complexes. As a result, there would be relatively less overall habitat modification and less intensive construction noise due to modifying fewer structures under this alternative as compared with the Proposed Project. However, the entire process may take place over a four- to eight-year period which would result in noise disturbance (potentially from blasting) over a longer period of time to affect terrestrial resources.

Even though there would be less construction activity under the Partial Removal Alternative as compared to the Proposed Project, special-status plants and rare natural communities may be present in the areas where construction activities may be performed. Consequently, short-term impacts on special-status plants and rare natural communities may would be similar to those of the Proposed Project (Potential Impact 3.5-7), though at a reduced scale. Within the construction footprint of the fishways, Recommended Terrestrial Resource Measure TER-1 and measures similar to those described in Appendix B: *Definite Plan – Appendix J* would be required to reduce potential impacts, including surveys for special-status species and rare natural communities, implementation of avoidance measures and invasive species control. To the extent the special-status plants and rare natural communities are a part of wetland or riparian areas, these measures can be feasibly imposed through water quality certification. For other such communities, however, it is not clear whether the hydroelectric project owner or operator would implement the Recommended Terrestrial Measures TER-1 (Potential Impact 3.5-7) or measures similar to those described in the Appendix B: *Definite Plan – Appendix J* through 'good citizen' agreements, as described in the Definite Plan, and it is unclear how these recommended terrestrial measures would be enforced in light of Federal Power Act preemption. Without an enforcement mechanism, these restoration activities cannot be deemed feasible for the purposes of CEQA. Therefore, construction impacts on special-status plants and rare natural communities would be significant and unavoidable.

A reduction in the impacted area as compared to the impacts of the Proposed Project, could reduce the significance of the impact to special-status wildlife species, specifically state species of special concern or BLM sensitive species on BLM lands, because it would reduce the number of potentially affected individuals in a population (Potential Impact 3.5-9). However, for other special-status wildlife species (state listed, state proposed, USFWS listed), it would not reduce the significance of the potential impact, because the significance criteria rely on impacts on a single individual, and this risk remains. For example, removing or modifying fewer structures and eliminating or shrinking the footprint of disposal sites would reduce the chances that construction would occur in an area that would impact special-status bird nests. Large bat maternity roosts have been documented at structures that would be retained under this alternative including Copco No. 1 Dam – C12 Gate house, Copco No. 1 Diversion Tunnel, and Iron Gate Diversion tunnel, and retaining these structures would be the same as existing conditions and reduce population-level impacts on bats compared to the Proposed Project (Potential Impact 3.5-14). However, if state, federal, or proposed-listed bird nests or hibernacula or maternity roosts are within the range of the lesser amount of construction, impacts would still be the same vis-à-vis on those birds or bat colonies and would still be potentially significant.

Compared to the existing condition, the substantial construction involved with constructing fish passage facilities would have the potential to significantly impact special-status wildlife species for the reasons described above and in Section 3.5.5 (Potential Impacts 3.5-10, 3.5-11, 3.5-12, 3.5-13, 3.5-14, and 3.5-28). Implementation of Mitigation Measures TER-2 and TER-3 would reduce construction-related impacts, including in-water work, on all special-status amphibian species to less than significant. Implementation of Recommended Terrestrial Measures 3–12 would reduce impacts on special-status birds and mammals to less than significant. Implementation of the TER-2 and TER-3 measures would be enforceable through inclusion in a water quality certification. Therefore, the TER-2 and TER-3 measures are feasible and Potential Impact 3.5-10 would result in no significant impacts on amphibian and reptile with mitigation from construction-related impacts and Potential Impact 3.5-28 impacts would be reduced for the reasons described in Section 3.5.5.3 *Terrestrial Resources Potential Impacts and Mitigation*. It is not clear, however, whether the hydroelectric project owner or operator would implement the Recommended Terrestrial Measures 3–12 (Potential Impacts 3.5-10, 3.5-11, 3.5-12, 3.5-13, 3.5-14, and 3.5-28) through 'good citizen' agreements, as described in the Definite Plan, and it is unclear how these recommended terrestrial measures would be enforced in light of Federal Power Act preemption. Without an enforcement mechanism, these restoration activities cannot be deemed feasible for the purposes of CEQA. Therefore, this impact on special-status birds, and mammals would be significant and unavoidable.

Since Iron Gate Hatchery operations would not change under the Continued Operations with Fish Passage Alternative, there would be no potential impacts on special-status plant and wildlife species related to changes in hatchery operations (Potential Impact 3.5-26).

Short-term impacts of elevated SSCs in the mainstem Klamath River from reservoir drawdown and dam removal would not occur under the Continued Operations with Fish Passage Alternative since the dams would remain in place and no drawdown would occur (Potential Impacts 3.5-16 and 3.5-18).

There would be no impact resulting from long-term habitat loss (or beneficial gain for willow flycatcher) as compared to existing conditions, since the reservoirs would remain and would continue to provide habitat for western pond turtle, many species of birds, including waterfowl and bald eagles, bats, and other special-status wildlife and plants that are supported by aquatic habitat provided by the reservoirs (Potential Impacts 3.5-21 and 3.5-22). However, fish passage would allow for nutrient distribution upstream of Iron Gate Dam, for reasons described for the Proposed Project (Potential Impact 3.5-30). Additional flow releases in the Middle Klamath River (downstream of Iron Gate Dam) would occur to address the conditions associated with fish disease, and impacts from these (2017) court-ordered flows on foothill yellow-legged frog breeding, if present, would be significant and unavoidable for reasons described for the No Project Alternative (Potential Impact 4.2.5-1) in both the short term and the long term. Potential impacts on western pond turtle would be less than significant for reasons described for the No Project Alternative (Potential Impact 4.2.5-1) in both the short term and the long term.

Under the Continued Operations with Fish Passage Alternative, there would be increased minimum flows in the J.C. Boyle Bypass Reach and peaking operations at J.C. Boyle Powerhouse in Oregon would be limited to one day per week. The habitat

differences from these actions would be more muted in California, as they are attenuated with distance downstream due to tributary inputs and accretion flows, but, as described in Section 3.2.4, there would be slightly lower maximum water temperatures, and less artificial diel temperature variation during summer and early fall (Potential Impact 3.2-1). Thus, the temperature and flow regime would move towards a more natural condition than that under the existing condition, reducing the stressors to amphibian and reptile species located there. Increases in minimum flows for the Copco No. 2 bypass reach, with a release of 70 cfs or inflow, whichever is less, to the bypass reach would occur; this increase would not affect special-status amphibians or reptiles if present. Thus, there would be no dam-related downstream flow fluctuations below the Copco No 2. or the J.C. Boyle Peaking Reach from the Oregon-California state line to Copco No. 1 Reservoir that could otherwise adversely impact amphibian or reptile species located there. Retaining the Lower Klamath Project dams would likely prevent any upward movement of the foothill yellow-legged frog into this reach and as a result no impact on foothill yellow-legged frog is anticipated. A slight decrease in the maximum water temperature in this reach is not anticipated to other wildlife species (e.g., western pond turtle). There would be no impact on special-status wildlife species in California due to the increased minimum flows and limited hydropower peaking flows originated from J. C. Boyle Dam in Oregon or Copco No. 2 Dam operations.

4.4.5.4 Wildlife Corridors and Habitat Connectivity

Under the Continued Operations with Fish Passage Alternative, the reservoirs and dams would continue to present a barrier or hindrance to movement for some terrestrial wildlife species such and amphibians, reptiles, mammals, and riparian birds, as described under Section 3.5.2.6 *Environmental Setting, Wildlife Corridors and Habitat Connectivity*. (Potential Impacts 3.5-19, 3.5-23). With the fishway prescription, salmon and other fish species would be able to access reaches upstream of Iron Gate Dam, and thus would provide nutrient-rich food for terrestrial species located there. Marine-derived nutrients would be subsequently deposited into terrestrial habitats and productivity of the terrestrial ecosystem as a whole could improve from existing conditions, although not to the extent described for the Proposed Project in Potential Impacts 3.5-24 and 3.5-25, because of because of the difference in migration success through fishways and reservoirs compared to through a riverine system. There would be no impact compared with existing conditions.

4.4.6 Flood Hydrology

Continued Operations with Fish Passage Alternative does not include physical or operational changes that would affect flood hydrology, and therefore would present no change from the existing condition. Flow increases in the J.C. Boyle and Copco No. 2 bypass reaches are related to minimum instream flows and would not impact peak flows during flood events.

4.4.7 Groundwater

Continued Operations with Fish Passage Alternative does not include physical or operational changes that would affect groundwater, and therefore would present no change from the existing condition.

4.4.8 Water Supply/Water Rights

Flow increases in the J.C. Boyle and Copco No. 2 bypass reaches are related to minimum instream flows in the Hydroelectric Reach and would not impact water supply or water rights downstream of Iron Gate Dam. Similarly, there would be no changes to water supply/water rights related to the 2017 flow requirements, which is discussed in detail in Potential Impact 4.2.8-1. Overall, the Continued Operations with Fish Passage Alternative would not affect water supply/water rights as compared with the existing condition.

4.4.9 Air Quality

Under the Continued Operations with Fish Passage Alternative, construction activities to install fish ladders would occur at all four Lower Klamath Project dam complexes. Construction activities would result from the development of structures to support these fish passage options; however, the overall area of ground disturbance would be reduced as less structures would be removed and less debris would be created as compared to the Proposed Project (see also Section 4.4.1 *[Continued Operations with Fish Passage Alternative] Alternative Description*) Under this alternative, fugitive dust emissions would be caused by movement of construction equipment on the soil and internal haul roads and a small amount of cut/fill activities. As construction activities required for implementing fish passage would be less than those necessary for removal of the Lower Klamath Project dam complexes under the Proposed Project, the level of overall construction activities and thus peak daily emissions of air pollutants (i.e., VOCs, CO, NOx, SOs, PM_{10}, $PM_{2.5}$) in the Hydroelectric Reach in California would be less than those described under the Proposed Project (Potential Impact 3.9-1). Further, since the construction activities may occur over a period of four to eight years for all of the fish passage facilities, the estimated maximum daily emissions would be less than the subtotal of activities for each dam (Table 4.4-2). Construction-related emissions would not exceed the Siskiyou County Air Pollution Control District's (SCAPCD) thresholds of significance in Rule 6.1 (Construction Permit Standards for Criteria Air Pollutants) for the Continued Operations with Fish Passage Alternative.

Table 4.4-2. Summary of Peak Daily Emissions (pounds per day)[1,2] for Construction Activities for the Continued Operations with Fish Passage Alternative.

Dam	Peak Daily Emissions (pounds per day)[1,2]					
	VOC	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Iron Gate Subtotal	11	63	59	<1	8	3
Copco No. 1 Subtotal	9	51	37	<1	2	1
Copco No. 2 Subtotal	10	58	50	<1	5	2
J.C. Boyle Subtotal	9	16	50	4	11	6
Maximum Daily Emissions	11	63	59	4	11	6
Significance Criterion	250	2,500	250	250	250	250

[1] Data from 2012 KHSA EIS/EIR.

[2] Breakdown of peak daily emissions associated with types of construction activities under the Continued Operation with Fish Passage Alternative is provided in Appendix N, Table N-16.

Key:

VOC = volatile organic compounds

CO = carbon monoxide

NOx = nitrogen oxides

SOx = sulfur oxides
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

This alternative would not include operational changes that would affect air emissions in the long term for implementation of fish ladders and there would be no significant impact (Potential Impact 3.9-1).

If trap and haul facilities were to be constructed instead of fish ladders, peak daily emissions due to construction activities would be less than those described above. Long term trap and haul operations would consist of trapping adult upstream migrants downstream of Iron Gate Dam and releasing them in J.C. Boyle Reservoir as an ongoing activity. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir, and released downstream of Iron Gate Dam. Although the exact extent and timing of these ongoing hauling activities is not known, peak daily air quality emissions would be considerably less than those estimated above because it is unlikely that more than ten truck trips per day would be necessary, including a conservative assumption of round trip (i.e., upstream and downstream) hauling for 60 to 70 miles each way between Iron Gate Dam and J.C. Boyle Reservoir. Therefore, the long-term potential impact on air quality emissions due to trap and haul operations would be less than significant.

4.4.10 Greenhouse Gas Emissions

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to facilitate upstream and downstream fishways, which may include installing fish ladders, trap and haul, or experimental fish cannons, at all four Lower Klamath Project dam complexes. This construction would release greenhouse gasses as described under the Proposed Project (Potential Impact 3.10-1). As construction activities required for fish passage facilities would be less than those necessary for removal of the Lower Klamath Project dam complexes under the Proposed Project, uncontrolled direct total GHG emissions from construction under this alternative also would be below the SCAQMD's 10,000 MTCO2e significance threshold and would result in no significant impact.

The Continued Operations with Fish Passage Alternative would not remove a source of renewable power and thus would have no indirect effect on production of greenhouse gas emissions relative to existing conditions (Potential Impact 3.10-2).

If trap and haul facilities were to be constructed instead of fish ladders, greenhouse gas emissions due to construction activities would be less than those described above. Long term trap and haul operations would consist of trapping adult upstream migrants downstream of Iron Gate Dam and releasing them in J.C. Boyle Reservoir as an ongoing activity. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir, and released downstream of Iron Gate Dam. Although the exact extent and timing of these ongoing hauling activities is not known, greenhouse gas emissions would be considerably less than those estimated above because it is unlikely that more than ten truck trips per day would be necessary, including a conservative assumption of round trip (i.e., upstream and downstream) hauling for 60 to 70 miles each way between Iron Gate Dam and J.C. Boyle Reservoir. Therefore, the long-term potential impact on greenhouse gas emissions due to trap and haul operations would be less than significant.

4.4.11 Geology, Soils, and Mineral Resources

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install upstream and downstream fish ladders, at all four Lower Klamath Project dam complexes. While these activities would be less than those described for the Proposed Project, there would still be potential for soil disturbance associated with heavy vehicle use, excavation, and grading during the construction of fish passage facilities, which could result in erosion at Iron Gate, Copco No. 2, and J.C. Boyle reservoirs and could exacerbate existing erosion at Copco No. 1 Reservoir (see also Potential Impact 3.11-2). For reasons described for the Proposed Project, implementation of BMPs to prevent erosion during demolition activities would minimize the potential for erosion and sediment delivery into the reservoir areas and there would be no significant impact due to soil disturbance associated with construction activities (Potential Impact 3.11-2).

Increases in minimum flows and decreases in peaking flows due to changes in J.C. Boyle Dam and Copco No. 2 Dam operations, plus the winter-spring surface flushing flows and deep flushing flow requirements at Iron Gate Dam (and emergency dilution flows, if needed) (see also Section 4.2.1.1 *[No Project] Alternative Description – Summary of Available Hydrology Information for the No Project Alternative)*, would result in an overall increase in flows under this alternative compared to existing conditions. While the additional flows would increase the mobility of existing surficial fine sediment deposits and infilled fine sediment from the armor layer, with potential for slight mobilization of the armor layer in some locations, new sediment supply would not occur and overall maintenance of static channel features would represent no change from existing adverse conditions for the Middle Klamath River between Iron Gate Dam and the confluence with the Scott River.

For reasons described for the No Project Alternative, there would be no other significant impacts of this alternative on geology and soils.

4.4.12 Historical Resources and Tribal Cultural Resources

Under the Continued Operations with Fish Passage Alternative, there would be no significant impacts to tribal cultural resources due to potential shifting and/or exposure of resources within the Lower Klamath Project reservoir footprints or located along the Klamath River (Potential Impacts 3.12-2, 3.12-3, 3.12-7), nor increased potential for looting (Potential Impacts 3.12-6, 3.12-8), since reservoir drawdown would not occur. The potential for impacts to tribal cultural resources due to wave erosion in the annual reservoir fluctuation zone would continue, as described under Potential Impacts 3.12-2 and 3.12-8 of the Proposed Project. Potential impacts to submerged historic-period archaeological resources (Potential Impacts 3.12-12 through 3.12-16) within the reservoir footprints and along the Klamath River also would not occur since the dams would not be removed and reservoir drawdown would not occur.

Salmonid habitat would increase due to fish passage installation under this alternative, and 2017 court-ordered flushing and emergency dilution flows would reduce the incidence of fish disease and parasites in the Klamath River, both of which would improve conditions for the Klamath Cultural Riverscape related to fisheries (Potential Impact 3.12-9) relative to existing conditions. This would be a beneficial effect.

Since only modest improvements in water quality would occur under this alternative, the ability of tribes to use the Middle and Lower Klamath River for ceremonial and other purposes would remain limited by existing, adverse conditions (Potential Impact 3.12-10). The Continued Operations with Fish Passage Alternative would continue to result in the same elevated concentrations of algal toxins in the water that commonly exceed public health advisory postings for water contact and inhibit the use of the Middle and Lower Klamath River for tribal purposes as under existing conditions (see also Potential Impact 3.12-10). As described under Potential Impact 4.2.2-7, there would be no change from existing adverse conditions related to algal toxins under this alternative, despite development and implementation of PacifiCorp's Reservoir Management Plan. Further, while nutrient reduction measures in Oregon and California's TMDLs would, over time, be beneficial with respect to decreasing the prevalence of toxin-producing nuisance blue-green algal species such as *Microcystis aeruginosa*, it is anticipated that full attainment of the Oregon and California TMDLs would require decades to achieve. Warmer water temperatures under climate change would further exacerbate seasonal blooms of nuisance algal species in Copco No. 1 and Iron Gate reservoirs and overall there is currently no reasonable proposal to achieve water quality standards with the dams in place. Overall, the Continued Operations with Fish Passage Alternative would result in no change from existing adverse conditions with respect to Cultural Use of Klamath River waters without risk of adverse health effects (Potential Impact 3.12-10) and there would be no significant impact.

Under the Continued Operations with Fish Passage Alternative, construction activities to install fish ladders would occur at all four Lower Klamath Project dam complexes. Construction activities would result from the development of structures to support these fish passage options; however, the overall area of ground disturbance would be reduced as less structures would be removed. While construction-related impacts under this alternative would be less than those described for the Proposed Project, there would still be potential for construction-related impacts due to ground-disturbance, heavy equipment, and blasting such that Potential Impacts 3.12-1, 3.12-4, and 3.12-5 for tribal cultural resources and Potential Impacts 3.12-12, 3.12-15, and 3.12-16 for historic-period archaeological resources, would occur in the manner described for the Proposed Project. Implementation of Mitigation Measure TCR-1 (Tribal Resource Management Plan), including the specific terms one through seven thereunder enumerated, would reduce impacts to tribal cultural resources and historic-period archaeological resources from construction activities. It is not clear, however, whether the hydroelectric project owner or operator would implement these measures through good citizen agreements, as described in the Definite Plan, and it is unclear how these measures would be enforced, outside of the measures required under the National Historic Preservation Act and the Native American Graves Protection and Repatriation Act. Without an enforcement mechanism, these measures cannot be deemed feasible for the purposes of CEQA. Therefore, the aforementioned short-term construction-related impacts under the Continued Operations with Fish Passage Alternative would be significant and unavoidable.

4.4.13 Paleontologic Resources

The Continued Operations with Fish Passage Alternative does not include physical or operational changes that would affect paleontologic resources as compared to existing conditions (Section 3.13.2 *[Paleontologic Resources] Environmental Setting*).

4.4.14 Land Use and Planning

The Continued Operations with Fish Passage Alternative does not include physical or operational changes that would affect land use and planning and thus there would be no change from existing conditions (Section 3.14.2 *[Land Use and Planning] Environmental Setting*).

4.4.15 Agriculture and Forestry Resources

The Continued Operations with Fish Passage Alternative does not include physical or operational changes that would affect agriculture and forestry resources thus there would be no change from existing conditions Section 3.15.2 *[Agricultural and Forestry Resources] Environmental Setting*).

4.4.16 Population and Housing

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install fish ladders at all four Lower Klamath Project dam complexes. The estimated average construction workforce would be less than that of the Proposed Project (see Table 4.4-1 and Table 2.7-8) since the level of construction under this alternative would be less. Further, the process for constructing fish ladder facilities may occur over a period of four to eight years, which is a longer timeline as compared to that described for the Proposed Project, such that fewer construction workers may be present at any given time as compared with the Proposed Project. For construction of trap and haul facilities, the construction workforce would be even less. Although long-term employment to manage a trap and haul system would require more labor as compared to the fishway, the number of workers would be relatively small and overall the Continued Operations with Fish Passage Alternative would not result in a substantial influx of population (Potential Impact 3.16-1), nor would there be a need to displace existing residents or build replacement housing elsewhere (Potential Impact 3.16-2), for either short-term construction-related activities or long-term operational needs, and there would be no significant impacts.

4.4.17 Public Services

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install upstream and downstream fish ladders at all four Lower Klamath Project dam complexes. Construction activities required for fish passage facilities would be less than those necessary for removal of the Lower Klamath Project dam complexes under the Proposed Project and would occur with less intensity since they may occur over a period of four to eight years. However, during periods of construction for this alternative, there would still be the potential for increased response times for emergency fire, police, and medical services due to construction-related traffic (Potential Impact 3.17-1), which may occur over a four-to eight-year period. This would be a significant impact. Implementation of Mitigation Measure HZ-1 (Section 3.21 *Hazards and Hazardous Materials*) would reduce this impact to less than significant for reasons described under the Proposed Project. Overseeing development and implementation of a Hazardous Materials Management Plan, as required under Mitigation Measure HZ-1 falls within the scope of the State Water Board's water quality certification authority. It is not clear, however, whether the hydroelectric project owner or operator would implement

measures relating to traffic management (such as Recommended Measure TR-1), emergency response, and construction-related fire management through 'good citizen' agreements, as described in the Definite Plan, and it is unclear how these measures would be enforced. Because the State Water Board cannot ensure implementation of these additional measures, it has determined that the construction-related impact on increased response times for emergency, fire, police, and medical services to be significant and unavoidable under this alternative.

Under the Continued Operations with Fish Passage Alternative, the Lower Klamath Project reservoirs would remain in place and there would be no change from the existing condition in terms of the facilities' availability to serve as a long-term water source for fighting wildfires. Therefore, there would be no impact (Potential Impact 3.17-2).

The Continued Operations with Fish Passage Alternative does not have the potential to affect schools in terms of additional students or longer bus routes, nor would it generate the need for additional classrooms or school services, and as identified under the Proposed Project (Potential Impact 3.17-3), would result in no significant impact.

4.4.18 Utilities and Service Systems

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install upstream and downstream fish ladders at all four Lower Klamath Project dam complexes. Construction activities required for fish passage facilities would be of a type similar to those described for the Proposed Project, but would be less than those necessary for removal of the Lower Klamath Project dam complexes and would occur with less intensity since they may occur over a period of four to eight years. However, during periods of construction for this alternative, there would still be the potential for impacts related to utilities and service systems, as described below.

The Continued Operations with Fish Passage Alternative would include the use of temporary wastewater treatment (i.e., portable chemical toilet facilities that are regularly cleaned, pumped, and have wastes disposed of by the toilet providers), stormwater drainage, and/or solid waste disposal facilities, albeit at a lower level than that described for the Proposed Project (Potential Impacts 3.18-1 through 3.18-4). Since the total area of construction-related activities for this alternative would amount to greater than one acre, the Proposed Project would be required to obtain coverage under the State Water Board Construction General Permit (2009-0009-DWQ as amended by 2010-0014-DWQ and 2012-0006-DWQ) (CGP). Each of the proposed construction areas, including staging, stockpiling, onsite disposal, and access-related areas, must be covered by the CGP. The CGP requires the applicant to address such items as employee wastewater generated during construction and spill containment and clean-up. Thus, meeting CGP requirements for onsite toilet facilities for short-term use by construction crews would not result in a significant impact as there would not be an increased need for permanent wastewater treatment facilities or an anticipated demand for additional wastewater treatment facilities.

Long-term employment to support operations of a trap and haul system would require relatively more labor as compared to that for fish ladders; however, overall the number of long-term workers would be relatively small and would not rise to the level that would affect utilities and service systems. Thus, this alternative would cause no change from existing conditions in the long term.

4.4.19 Aesthetics

Under the Continued Operations with Fish Passage Alternative, construction activities to install upstream and downstream fish ladders would occur at all four Lower Klamath Project dam complexes. This activity would take place within the Limits of Work for the Proposed Project. and would involve construction equipment, as well as use of staging areas and demolition areas. However, since construction of new infrastructure to support fish passage would occur near and potentially directly adjacent to the existing infrastructure (Potential Impact 3.19-5), the construction activities and the facilities themselves would not distract from a natural view relative to existing conditions in the short term or the long term and this alternative would result in a less than significant impact. No construction of new recreational facilities or improvements to existing recreational facilities would occur under this alternative. The level of overall construction is anticipated to be less under Continued Operations with Fish Passage Alternative than that described for the Proposed Project; thus the intensity and duration of the potential aesthetics impacts would also be less than those described for the Proposed Project and there would be no significant impact (Potential Impact 3.19-6). However, for reasons described for the Proposed Project, construction lighting would have significant and unavoidable impacts on nighttime views (Potential Impact 3.19-7). It is not clear whether the hydroelectric project owner or operator would implement measures to reduce nighttime light and glare on surrounding residences during construction. Overseeing development and implementation of measures to reduce impacts to nighttime views does not fall within the scope of the State Water Board's water quality certification authority. Without an enforcement mechanism, such measures cannot be deemed feasible for the purposes of CEQA. Therefore, the impact of this alternative on nighttime views would be significant and unavoidable during the period of construction activities.

The existing Lower Klamath Project dam complexes are already a part of the environmental baseline. Under the Continued Operations with Fish Passage Alternative, there would be no loss of open water vistas (Potential Impact 3.19-1), no significant changes in flows or channel morphology (Potential Impact 3.19-2), no changes in visual water quality due during periods of elevated SSCs (Potential Impact 3.19-3), and no exposure of bare areas of sediment and rock (Potential Impact 3.19-4), since the reservoirs would remain in place. Thus, this alternative would have no significant impact relative to existing conditions for these aspects of aesthetics. As the Continued Operations with Fish Passage Alternative does not include other physical or operational changes that would affect aesthetics in the long term, this determination also applies in the long term (5+ years).

4.4.20 Recreation

Unlike under the Proposed Project, reservoir-based recreation would continue under the Continued Operations with Fish Passage Alternative.

Under the Continued Operations with Fish Passage Alternative, construction activities would occur due to install upstream and downstream fish ladders at all four Lower Klamath Project dam complexes. While construction activities required for fishway facilities would be less than those required for removal of the Lower Klamath Project dam complexes under the Proposed Project, they would still result in potential restrictions, noise, and dust. However, for reasons described for the Proposed Project, these impacts would be less than significant (Potential Impact 3.20-1). Although these

impacts may be spread across a four- to eight-year period, no one site would be affected for that entire length of time and thus there still would be no significant impact compared with existing conditions. Facility construction and any related potential recreational impacts for trap and haul would be less than that described for fish ladders. Under this alternative, there would be no changes to or loss of local or regional reservoir-based recreation activities and facilities compared with existing conditions (Potential Impact 3.20-2 and 3.20-3), and no construction of new or expanded recreational facilities (Potential Impact 3.20-4) due to dam removal.

The Continued Operations with Fish Passage Alternative would increase minimum flows in the J.C. Boyle Bypass Reach and limit peaking operations at J.C. Boyle Powerhouse to one day per week. Since recreational flows in the Hydroelectric Reach would be limited under this alternative, the loss of whitewater boating opportunities in the Hell's Corner Reach[203] would be similar to those described for the Proposed Project (Potential Impact 3.20-5), except that the white water boating would be available one day per week. However, for the remaining six days per week during the late summer and early fall, when other regional alternative rafting opportunities are less available, see discussion in Potential Impact 3.20-5), this alternative would result in the loss of a unique opportunity in the region to raft Class IV+ rapids. This would affect up to 250 people per day during that time, as well as 10 commercial outfitters and would be a significant and unavoidable impact for the Hell's Corner Reach. There would be no significant impact in the Middle and Lower Klamath River since the effect of the altered river flows would be muted in California.

Under the Continued Operations with Fish Passage Alternative, construction of upstream and downstream fish passage at all Lower Klamath Project dams would benefit recreational fishing of anadromous fish throughout the Klamath River in California, including the Hydroelectric Reach, in a similar manner to that discussed under Potential Impact 3.20-6, although to a lesser degree. This alternative would result in continuation of some of the stresses that currently affect Chinook salmon populations. The presence of dams and reservoirs under the Continued Operations with Fish Passage Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist. Due to implementation of actions contained within PacifiCorp's Reservoir Management Plan, these conditions are likely to improve somewhat over the long term, however not to the degree expected under the Proposed Project. Overall, the Continued Operations with Fish Passage Alternative would have a beneficial effect on fishing for anadromous fish compared with existing conditions.

There would be no potential impacts on Wild and Scenic River resources, designations, or eligibility for listing due to construction of fish passage facilities (Potential Impact 3.20-7). In summary, with the exception of the loss of whitewater boating opportunities in the Hell's Corner Reach relative to existing conditions (which would be a significant and unavoidable impact), improvements in recreational fishing opportunities due to an increase in anadromous fish habitat (which would be a beneficial effect), and minor visual changes due to fish passage improvements (which would result in no significant impacts), scenery, recreation, fisheries, and wildlife conditions would remain consistent

[203] This reach is within the Hydroelectric Reach, extending approximately 16.4 river miles from J.C. Boyle Reservoir to Copco No. 1 Reservoir.

with existing conditions and there would be no short-term (0−5 years) or long-term (5+ years) impacts to recreational resources.

4.4.21 Hazards and Hazardous Materials

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install upstream and downstream fish ladders at all four Lower Klamath Project dam complexes. Construction activities required for fish passage facilities would be within the construction Limits of Work for the Proposed Project and would have similar potential for hazards and hazardous materials-related impacts as described in Section 3.21.5 *[Hazards and Hazardous Materials] Potential Impacts and Mitigation*. However, the level of construction under this alternative would be less than the level of construction necessary for removal of the Lower Klamath Project dam facilities under the Proposed Project and would result in less transport, use, and disposal of general construction waste materials (i.e., transport of waste materials from the removed dam facilities would not occur) and of hazardous materials from decommissioning of generation and transmission facilities (Potential Impacts 3.21-1, 3.21-2, and 3.21-4). For the reasons described under the Proposed Project, implementation of Mitigation Measure HZ-1 would result in no significant impacts.

The existing hazardous materials that have been identified at the Lower Klamath Project dam complexes would not be altered compared with existing conditions (Potential Impact 3.21-4). Therefore, there would be no significant impact.

For the reasons described under the Proposed Project, there would be no significant impacts due to hazards or hazardous materials in relation to schools (Potential Impact 3.21-3), public airports (Potential Impact 3.21-5), or private airstrips (Potential Impact 3.21-6).

Although the level of construction under this alternative would be less than the level of construction necessary for removal of the Lower Klamath Project dam facilities under the Proposed Project, this alternative could still result in short term impacts consisting of an increase in traffic on narrow rural roads from commuting workers, hauling of large equipment, and disposal of wastes. This additional traffic could interfere with emergency response vehicles as well as create a situation requiring an additional need for emergency response due to personal and vehicular accidents, natural and worksite-caused fires, and accidental releases of hazardous materials in the same manner as under the Proposed Project, though to a lesser degree (Potential Impact 3.21-7). This alternative could also result in an increased risk of wildland fires in the short term due to construction site activities (Potential Impact 3.21-8). It is not clear whether the hydroelectric project owner or operator would implement measures relating to traffic management, emergency response, and construction-related fire management through ‘good citizen’ agreements, as described in the Definite Plan, and it is unclear how these measures would be enforced. Without an enforcement mechanism, these measures cannot be deemed feasible for the purposes of CEQA. Therefore, these impacts would be significant and unavoidable.

In the long term, there would be no impact related to the potential for longer response times and limitations on access to Klamath River water for fighting wildland fires under this alternative since the Lower Klamath Project reservoirs would not be removed (Potential Impact 3.21-8). This alternative would be the same as existing conditions. As

the Continued Operations with Fish Passage Alternative does not include physical or operational changes that would affect other aspects of hazards and hazardous materials in the long term, there would be no significant long-term impact related to hazards and hazardous materials.

4.4.22 Transportation and Traffic

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install upstream and downstream fish ladders at all four Lower Klamath Project dam complexes. These construction activities would include the type of transportation and traffic impacts described for the Proposed Project (Potential Impacts 3.22.5-1 through 3.22.5-6). Although the level of construction under this alternative would be less than the level of construction necessary for removal of the Lower Klamath Project dam complexes under the Proposed Project, this alternative could still result in an increase in traffic on narrow rural roads from commuting workers, hauling of large equipment, and disposal of wastes, particularly for fishway construction at Iron Gate Dam and Copco No. 1 dams, which would last for 12 months and 9 months, respectively (Table 4.4-1). For reasons described for the Proposed Project (Section 3.22 *[Traffic and Transportation] Potential Impacts and Mitigation*), this would be a significant impact compared with existing conditions. Implementation of measures such as those contained in the Traffic Management Plan and Emergency Management Plan proposed by the KRRC, as well as Recommended Measure TR-1, would be expected to reduce construction-related impacts to less than significant under this alternative. It is not clear, however, whether the hydroelectric project owner or operator would implement these measures through 'good citizen' agreements, as described in the Definite Plan, and it is unclear how these measures would be enforced. Without an enforcement mechanism, these measures cannot be deemed feasible for the purposes of CEQA. Therefore, this alternative would result in significant and unavoidable traffic and transportation impacts.

Facility construction, and thus any related potential transportation and traffic impacts, for trap and haul would be less than that described for fish ladders. Long term trap and haul operations would consist of trapping adult upstream migrants downstream of Iron Gate Dam and releasing them in J.C. Boyle Reservoir as an ongoing activity. Similarly, downstream migrating smolts would be trapped at J.C. Boyle Reservoir, and released downstream of Iron Gate Dam. Roads within the traffic and transportation Area of Analysis currently carry substantially fewer vehicles than the planning capacity (Table 3.22-2 and Section 3.22.2.1*Traffic Flow*), such that additional truck trips, assuming both upstream and downstream trap and haul operations, would not substantially change traffic conditions. Although the exact extent and timing of these ongoing hauling activities is not known, it is unlikely that more than ten truck trips per day would be necessary, including a conservative assumption of round trip (i.e., upstream and downstream) hauling for 60 to 70 miles each way between Iron Gate Dam and J.C. Boyle Reservoir. Therefore, trap and haul traffic would be a less than significant impact.

Significance
No significant impact

4.4.23 Noise

Under the Continued Operations with Fish Passage Alternative, construction activities would occur to install upstream and downstream fish ladders at all four Lower Klamath Project dam complexes. Construction activities would result in potential noise impacts in the same manner as described for the Proposed Project in Section 3.23.5 *[Noise] Potential Impacts and Mitigation*. Although the level of construction required for fish passage facilities would be less than construction required for removal of the Lower Klamath Project dam complexes, any use of dozers, jackhammers, and/or tractors would constitute an exceedance of the maximum allowable noise levels identified in the Siskiyou County General Plan Noise Element (Siskiyou County 1978) and would be a significant impact (Potential Impact 3.23-1). Implementation of a noise and vibration control plan such as that proposed by the KRRC (Appendix B: *Definite Plan – Appendix O5*) would reduce the short-term noise-related impacts from fish passage construction activities at Copco No. 1, Copco No. 2, and Iron Gate dams (Impacts 3.23-1 through 3.23-6). It is not clear, however, whether the hydroelectric project owner or operator would implement noise and vibration control measures through 'good citizen' agreements, as described in the Definite Plan, and it is unclear how these measures would be enforced. Without an enforcement mechanism, the NVCP cannot be deemed feasible for the purposes of CEQA. Further, since any use of dozers, jackhammers, and/or tractors would constitute an exceedance of the maximum allowable County noise levels, noise-related impacts on sensitive receptors at Copco No. 1 and Iron Gate dams would remain significant and unavoidable (Potential Impact 3.23-1).

Due to the natural topography surrounding Copco No. 2 Dam and the distance between the dam and the closest receptor (see Potential Impact 3.23-3), noise from on-site construction activities at the Copco No. 2 Dam would be reduced by more than 65 dB (approximately 35 dB by the distance and an additional 30 dB due to the topography). This amount of noise and vibration reduction would reduce impacts on sensitive receptors such that there would not be a substantial increase and there would be no significant impact at sensitive receptors.

Activities associated with the implementation of seasonal trap and haul operation prescriptions for a new FERC license for the Continued Operations with Fish Passage Alternative could increase traffic noise on local roads. However, the number of trucks and travel frequency would be significantly less than during the construction phase of the project and there would be no significant traffic noise impact to sensitive receptors. If trap and haul is combined with an additional fishway prescription, such that it is used for either upstream or downstream fish passage from below Iron Gate Dam to above J.C. Boyle Dam, truck trips would be less and there also would be no substantial increase in noise and vibration on sensitive receptors and there would be no significant impact. Therefore, noise-related impacts due to traffic noise along haul routes (Potential Impact 3.23-7) would not result in a substantial increase of noise on sensitive receptors and would result in no significant impact.

Moving or elevating structures with flood risk and modification of downstream water intakes, and construction activities related to deepening or replacement of existing groundwater wells, would not occur under this alternative, and would therefore result in no noise change from the existing condition (Potential Impacts 3.23-8, 3.23-9, and 3.23-10, respectively).